

UNIVERSIDAD DE MÁLAGA

TESIS DOCTORAL

Estimulación asistida del lenguaje: Comparación de la intervención con enfoque tradicional frente al uso de la tecnología de la información y comunicación en niños con trastorno del espectro autista

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Programa de Doctorado en Psicología

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Departamento de Psicología Básica, Facultad de Psicología y Logopedia de la Universidad de Málaga (UMA)

Tesis Doctoral

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Estimulación asistida del lenguaje: Comparación de la intervención con enfoque tradicional frente al uso de la tecnología de la información y comunicación en niños con trastorno del espectro autista

Tesis presentada para obtener el Título de *Doctor en Psicología*

UNIVERSIDAD DE MÁLAGA

Autor: Antonio Javier Zurita Díaz

Directora y tutora: Dra. Marina Calleja Reina

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D. Antonio Javier Zurita Díaz
Estudiante del programa de Doctorado de Psicología de la Universidad de Málaga, autor de la tesis, presentada para la obtención del título de doctor por la Universidad de Málaga, titulada *Estimulación asistida del lenguaje: Comparación de la intervención con enfoque tradicional frente al uso de la tecnología de la información y comunicación en niños con trastorno del espectro autista*

Realizada bajo la tutorización y dirección de Dra. Marina Calleja Reina

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En Málaga, a 17 de julio de 2025

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Asimismo, de acuerdo con lo que regula el Real Decreto 778/1998, de 30 de abril (B.O.E. 1 de mayo de 1998), el trabajo de investigación realizado por el Doctorando bajo mi dirección, reúne todas las condiciones exigidas para ser aceptado como Tesis Doctoral y ha alcanzado los objetivos de investigación propuestos, estando debidamente cualificada para su defensa.

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Resumen

Esta tesis se enmarca en el Programa de Doctorado en Psicología de la Universidad de Málaga, dentro de la línea de investigación sobre Necesidades Complejas de Comunicación e Intervención Logopédica basada en Nuevas Tecnologías. Ha sido aprobada por el Comité Ético de Experimentación de la Universidad de Málaga (Referencia: 19-2023-H) y se ha desarrollado principalmente en centros especializados en autismo y otros trastornos del neurodesarrollo en la provincia de Málaga (España), con la colaboración de profesionales de la logopedia.

La investigación se desarrolla en el proyecto "Herramienta digital para evaluar comunicación y lenguaje en personas con necesidades complejas de comunicación: Comunicación Inclusiva", financiado por el Programa de Ayudas (B.2) para el Fomento de Proyectos de Investigación en Estudios de Género, Inclusión y Sostenibilidad Social de la Universidad de Málaga (II Plan Propio, Referencia B2-2022_02). Asimismo, ha contado con el apoyo del Proyecto Red Temática de Investigación: Prácticas eficientes de comunicación inclusiva en poblaciones con enfermedades infrecuentes (COMIN-ENIN) (Referencia D5-2022_01) y del proyecto Comunicación Inclusiva (COMIN) para personas con enfermedades raras y necesidades complejas de comunicación (Referencia B4-2023-18).

Además, el estudio descrito en el Capítulo 6 se llevó a cabo en colaboración con la Faculdade de Psicologia e de Ciências da Educação de la Universidad de Coímbra (Portugal) durante la estancia de investigación internacional del doctorando, bajo la supervisión de la Dra. Ana Paula Mendes Correia Couceiro Figueira.

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La comunicación humana se fundamenta en la transmisión de señales a través de un código compartido, mientras que el lenguaje constituye el sistema simbólico, arbitrario y estructurado que permite dicha transmisión. En el caso de los niños con trastorno del espectro autista (TEA), las habilidades comunicativas se ven frecuentemente comprometidas tanto a nivel verbal como no verbal, lo que repercute de manera significativa en su desarrollo social, académico y conductual, afectando directamente su calidad de vida.

El TEA se considera una condición de base neurobiológica y origen multifactorial, en la que intervienen alteraciones funcionales y estructurales del sistema nervioso central con componentes genéticos y epigenéticos bien documentados. De acuerdo con a la versión más actual hasta la fecha del *Diagnostic and Statistical Manual of Mental Disorders*, en su quinta edición (DSM-5), el TEA forma parte de los trastornos del neurodesarrollo y se caracteriza por la presencia de dificultades persistentes en la comunicación e interacción social, así como por patrones de comportamiento restringidos, repetitivos y, en ocasiones, sensorialmente atípicos.

Entre los criterios diagnósticos recogidos en el DSM-5 se incluyen: problemas en la reciprocidad socioemocional, limitaciones en el uso de la comunicación no verbal, dificultades para comprender las normas implícitas de las relaciones sociales y rigidez ante los cambios de contexto. Además, pueden presentarse intereses intensos y específicos, conductas repetitivas, hiper- o hiporreactividad sensorial y búsqueda de estímulos inusuales. Se estima que esta condición afecta a más de 70 millones de personas en todo el mundo, con variaciones en la prevalencia según los estudios. En el contexto español, se calcula que alrededor de medio millón de personas conviven con un diagnóstico de TEA.

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El DSM-5 establece tres niveles de gravedad, definidos en función del nivel de apoyo que la persona requiere para desenvolverse en su vida cotidiana. El Grado 1 ("requiere apoyo") engloba a aquellos que pueden desarrollar un lenguaje oral funcional, aunque presentan dificultades en el uso social del mismo. Estas incluyen problemas para interpretar el lenguaje figurado, mantener una conversación fluida o utilizar gestos y entonaciones adecuados. En el Grado 2 ("requiere apoyo notable") las dificultades lingüísticas son más marcadas: se observan emisiones limitadas, ecolalias y problemas tanto en la comprensión como en la expresión verbal. Finalmente, en el Grado 3 ("requiere apoyo muy notable") las alteraciones en la comunicación son severas, con escasa o nula producción verbal y dificultades significativas para interpretar gestos, expresiones faciales o el tono emocional de los mensajes.

La baja intención comunicativa, junto con una limitada respuesta a la retroalimentación verbal del entorno, puede interferir en el aprendizaje, la adaptación social y el desarrollo cognitivo general, favoreciendo la aparición de conductas disruptivas derivadas de la frustración. Se estima que aproximadamente un 30 % de las personas con TEA —especialmente aquellas diagnosticadas en el Grado 3— presentan necesidades complejas de comunicación. Esto implica una afectación profunda en la expresión verbal, escrita o gestual, así como en la comprensión de los mensajes del interlocutor, dificultando la reciprocidad en la interacción social y limitando su participación en contextos naturales.

Ante esta realidad, la comunicación aumentativa y alternativa (CAA) se ha consolidado como una herramienta esencial para promover la comunicación funcional en personas con TEA. Este enfoque incluye un amplio conjunto de estrategias, sistemas y recursos que facilitan la expresión de deseos, pensamientos, emociones y necesidades. La CAA puede utilizarse como un complemento del

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habla o como un sustituto cuando el lenguaje oral no se desarrolla de forma efectiva. Su principio básico radica en el uso de signos visibles o auditivos que representan significados mentales, como pictogramas, imágenes, objetos, señales táctiles o digitales, cuya comprensión puede variar según su nivel de iconicidad, un aspecto especialmente relevante en el perfil cognitivo del TEA.

Los sistemas de CAA se organizan sobre soportes físicos (como tableros de comunicación o cuadernos) o digitales (aplicaciones, dispositivos móviles o software especializado), facilitando la interacción y ajustándose a las necesidades del usuario. Las tecnologías de la información y la comunicación (TIC) han permitido una notable expansión de las posibilidades de intervención, ofreciendo herramientas y soportes digitales configurables, motivadoras y adaptables a diferentes perfiles funcionales.

Tradicionalmente, la CAA se clasifica en dos grandes categorías: los sistemas sin ayuda tecnológica (CAA-a), que emplean recursos no electrónicos como gestos, lenguaje corporal o pictogramas impresos; y los sistemas asistidos tecnológicamente (CAA+a), que incluyen dispositivos electrónicos con o sin salida de voz. Ambos enfoques han demostrado ser eficaces cuando se implementan de forma individualizada y contextualizada, favoreciendo la generalización de habilidades comunicativas en entornos naturales. No obstante, la amplia variedad de herramientas disponibles puede generar incertidumbre a la hora de seleccionar los recursos más apropiados para cada caso, lo que plantea un reto tanto clínico como educativo.

Una de las metodologías más prometedoras en el ámbito de la CAA es la estimulación asistida del lenguaje, una estrategia centrada en el uso simultáneo del lenguaje oral y visual por parte del interlocutor. Esta técnica busca promover el desarrollo de la comunicación funcional a través de la asociación entre palabras

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habladas y símbolos visuales en contextos cotidianos o terapéuticos. Su implementación permite ofrecer modelos lingüísticos accesibles, facilitar la comprensión y fomentar la iniciativa comunicativa del usuario. Los objetivos principales incluyen aumentar la intención comunicativa, mejorar la comprensión de símbolos y estimular la producción de lenguaje, tanto verbal como no verbal.

La estimulación asistida del lenguaje puede aplicarse mediante sistemas sin asistencia, como tableros físicos o pictogramas impresos, o bien mediante dispositivos tecnológicos adaptados. Sin embargo, aunque existen datos prometedores sobre su efectividad, todavía se dispone de escasa evidencia empírica en contextos de habla española, especialmente en relación con las diferencias en los resultados según el tipo de soporte utilizado. Esta falta de evidencia representa una línea de investigación prioritaria para avanzar en la personalización y eficacia de las intervenciones con personas con TEA.

La presente tesis doctoral se plantea como una aportación al avance del conocimiento científico sobre la estimulación asistida del lenguaje, con especial énfasis en su aplicación a niños con TEA de Grado 3 que presentan necesidades complejas de comunicación. El objetivo principal es comparar la eficacia de dos enfoques distintos para estimular el lenguaje: uno de corte tradicional y otro apoyado en las TIC. Se busca determinar cuál de estas alternativas favorece mayores progresos en las áreas más afectadas de esta población.

El estudio se articula en torno a tres grandes líneas de trabajo. En primer lugar, una dimensión metodológica, que emplea un diseño cuasiexperimental para implementar la intervención, utilizando herramientas específicas de evaluación y análisis estadístico para medir sus efectos. En segundo lugar, una dimensión experimental, centrada en examinar cómo distintos recursos de CAA influyen en la intervención, identificando patrones de eficacia y reconociendo tanto sus

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fortalezas como sus posibles limitaciones. Y en tercer lugar, una dimensión comparativa, orientada a explorar cómo las características del diseño y la funcionalidad de los distintos soportes afectan la interacción entre el usuario y el interlocutor durante la aplicación de la estimulación asistida del lenguaje.

Para la formulación y desarrollo de esta investigación se adopta la estrategia PICO, que permite delimitar el problema en una muestra concreta de niños con TEA, definir la intervención basada en la estimulación asistida del lenguaje, establecer la comparación entre diferentes recursos de CAA y valorar los resultados mediante indicadores objetivos de mejora en habilidades comunicativas, sociales y conductuales observadas a lo largo del proceso.

Sobre esta base, los objetivos específicos de la investigación son los siguientes:

1. Presentar un modelo de intervención logopédica centrado en la estimulación asistida del lenguaje, adaptado al contexto hispanohablante y orientado a las necesidades específicas de los niños con TEA.
2. Evaluar la eficacia de dicha estrategia de intervención en el desarrollo de habilidades comunicativas, incluyendo componentes receptivos, expresivos y vinculados a la lectoescritura.
3. Analizar el impacto de la intervención en las habilidades sociales de los participantes, especialmente en lo que respecta a la interacción interpersonal, el juego, el uso funcional del tiempo libre y la capacidad de adaptación al entorno.
4. Comprobar si la intervención produce cambios en la conducta, especialmente en términos de reducción de comportamientos disruptivos en niños con TEA de Grado 3.

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5. Comparar el rendimiento comunicativo y social asociado al uso de recursos de CAA en papel frente a dispositivos tecnológicos, identificando sus ventajas, limitaciones y posibles aplicaciones terapéuticas.

6. Estudiar la influencia de dos tipos de soportes digitales diferenciados sobre la efectividad de la estimulación asistida del lenguaje, y realizar una comparación análoga entre dos formatos impresos de CAA, sin mediación tecnológica.

Con el fin de sustentar teóricamente los estudios que integran esta tesis doctoral, se llevó a cabo una revisión exploratoria de alcance (*scoping review*) previa al desarrollo experimental. Esta revisión tenía como propósito establecer un marco conceptual riguroso que respaldara tanto la planificación metodológica como las decisiones prácticas adoptadas en la intervención. La estimulación asistida del lenguaje ha emergido como una estrategia prometedora para la población con TEA que presentan importantes dificultades comunicativas. No obstante, las revisiones previas sobre esta técnica resultan escasas, presentan limitaciones metodológicas o se centran en otras formas de modelado del lenguaje, sin abordar de forma específica la combinación del input oral y visual que caracteriza a esta estrategia de intervención.

El objetivo principal de esta revisión fue sistematizar el conocimiento actual sobre la eficacia de esta estrategia en niños y adolescentes con diagnóstico de TEA. Para su desarrollo, se siguieron las directrices del marco PRISMA-ScR, aplicando criterios de inclusión centrados en estudios experimentales publicados entre los años 2010 y 2024, que utilizaran intervenciones basadas en la estimulación asistida del lenguaje. La búsqueda se realizó en bases de datos científicas de alto impacto (Web of Science, Scopus, Semantic Scholar, PubMed

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y PsycInfo), identificándose un total de 1141 publicaciones, de las cuales 17 cumplían con todos los requisitos establecidos. Los estudios incluidos fueron realizados en países como Estados Unidos, Canadá, Reino Unido y Sudáfrica, e involucraron a 184 participantes con TEA que no presentaban déficits visuales ni auditivos.

Las intervenciones analizadas se llevaron a cabo principalmente en entornos educativos y clínicos, con la participación de investigadores y equipos interdisciplinares formados por profesionales como logopedas, docentes y familiares. En cuanto a la evaluación de los resultados, se utilizaron herramientas estandarizadas y listas de verificación, entre las que destacan la Escala de Autismo Infantil (CARS), el *Peabody Picture Vocabulary Test Fourth Edition* (PPVT-4) y la Escala Vineland-II.

Los resultados de esta revisión apuntan a que la estimulación asistida del lenguaje es eficaz en esta población, ya que facilita la asociación entre el lenguaje hablado y sus correspondientes representaciones visuales, lo que a su vez mejora la comprensión de instrucciones orales, el aprendizaje de vocabulario y la producción de mensajes. Se observó que los usuarios con TEA suelen beneficiarse de apoyos visuales para decodificar el lenguaje verbal, lo que refuerza la necesidad de personalizar las intervenciones y utilizar recursos CAA adecuados a las capacidades y preferencias de cada participante.

Los estudios revisados mostraron una gran diversidad de formatos de CAA, desde materiales impresos en papel hasta aplicaciones digitales y dispositivos tecnológicos, todos ellos compatibles con la estimulación asistida del lenguaje. Entre los beneficios más destacados se encuentran las mejoras en los componentes receptivo y expresivo del lenguaje, la disminución de conductas desafiantes y un mayor desarrollo de habilidades sociales.

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Pese a estos resultados positivos, se identificaron ciertas limitaciones relevantes, como la escasa representación de estudios en contextos de habla española, la diversidad del TEA y la variabilidad de los diseños experimentales, lo que dificulta establecer conclusiones generalizables. Además, el tamaño reducido de las muestras compromete la extrapolación de los hallazgos a poblaciones más amplias.

En consonancia con el primer objetivo específico de esta investigación, se definieron criterios de inclusión comunes para los participantes en el estudio empírico: niños de entre 6 y 12 años, cuya lengua materna sea el español, diagnosticados con TEA de Grado 3 según los criterios del DSM-5, con dificultades severas en la comunicación y sin déficits sensoriales que interfieran en la intervención. Se requería además que los participantes pudieran mantener la atención durante al menos 10 minutos consecutivos.

La intervención consistió en 45 sesiones distribuidas a lo largo de 16 semanas, e incluyó tres momentos de evaluación mediante la escala Vineland-3, centrada en las áreas de comunicación, interacción social y comportamiento adaptativo, en línea con los objetivos específicos 2, 3 y 4 de la tesis. Las actividades se desarrollaron en contextos comunicativos estructurados, como juegos con diferentes objetos o estímulos, interacciones con el logopeda y el seguimiento de conductas problemáticas. El logopeda asumió un papel activo no solo como interlocutor, sino también como responsable del diseño y conducción de las tareas, del control del entorno y del fomento del intercambio comunicativo. Para ello, hizo uso de símbolos pictográficos y aplicó técnicas de estimulación asistida del lenguaje que ayudaran a los niños a comprender y utilizar el lenguaje en situaciones significativas. La colocación física del profesional junto al niño favoreció un entorno de interacción fluida y eficaz.

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Tras la elaboración del modelo de intervención, se llevaron a cabo tres investigaciones con diseño cuasiexperimental, en las que se compararon distintos tipos de recursos y soportes de CAA aplicados a dos grupos de participantes con diagnóstico de TEA. El primero de estos estudios, alineado con el quinto objetivo específico de la tesis, evaluó el uso de la aplicación EC+, una herramienta multimodal desarrollada en el marco del proyecto Erasmus+ por la Universidad de Málaga. Esta app permite representar cualquier ítem mediante diversos formatos —como pictogramas, fotografías reales, vídeos o palabras escritas—, lo que permite adaptar el estímulo a las características del usuario. En este trabajo, se contrastó el desempeño de los participantes que utilizaron EC+ con el de aquellos que trabajaron con pictogramas impresos del portal Aragonés de la Comunicación Aumentativa y Alternativa (ARASAAC). Los hallazgos señalaron que la multimodalidad de EC+ constituye una ventaja clave en contextos de estimulación asistida del lenguaje, ya que combina estímulos visuales, auditivos y táctiles, generando una experiencia comunicativa más rica e inmersiva. Asimismo, el uso de tecnología resultó ser especialmente motivador y efectivo para mantener la atención y fomentar la implicación de los participantes en las tareas.

A raíz de los buenos resultados obtenidos con los pictogramas impresos, se diseñó un segundo estudio para profundizar en este tipo de material visual. ARASAAC, una iniciativa gratuita promovida por el Gobierno de Aragón, proporciona pictogramas organizados por categorías semánticas, de alta iconicidad y fácil comprensión, lo que facilita su uso en personas con dificultades comunicativas. En esta fase, además de los pictogramas de ARASAAC, se utilizaron los materiales de Mi Estuche de Pictos ®, un recurso comercial de Editorial GEU compuesto por tarjetas plastificadas de 7 x 7 cm, diseñadas específicamente para niños con TEA, alteraciones del lenguaje o en proceso de alfabetización. Al término de la intervención, el grupo que utilizó los pictogramas

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de ARASAAC mostró avances notables en habilidades comunicativas, como el uso más frecuente de gestos, una mejor organización del turno conversacional y una asociación más precisa entre objetos y símbolos visuales. También se registraron mejoras en la atención al entorno, mayor participación en las interacciones sociales y una regulación conductual más adecuada durante las sesiones.

El tercer y último estudio se enfocó en comparar dos soluciones tecnológicas de CAA, como parte del cumplimiento del sexto objetivo específico. En este caso, se volvió a emplear la app EC+ y se contrastaron sus resultados con los obtenidos a través de la aplicación SymboTalk – AAC Talker ®, una herramienta gratuita y multiplataforma compatible con PC, Android e iOS. SymboTalk ® permite configurar tableros de comunicación personalizados, con entre 4 y 50 casillas, empleando los pictogramas de ARASAAC y permitiendo editar o incorporar nuevos elementos según las necesidades del usuario. Los resultados de esta investigación reflejaron que SymboTalk ® fue especialmente eficaz para fortalecer el componente receptivo y expresivo del lenguaje, así como para mejorar las habilidades sociales de los participantes. Aunque EC+ también promovió avances significativos en la comunicación, no se observaron diferencias sustanciales entre ambos grupos en lo relativo al comportamiento. Los datos sugieren que los usuarios con TEA tienden a beneficiarse especialmente de los estímulos visuales frente a los auditivos, especialmente cuando los elementos comunicativos se presentan de forma agrupada en un único panel, como en SymboTalk ®. La elevada iconicidad de los pictogramas utilizados favoreció su interpretación y utilidad en ambas aplicaciones.

A partir de los tres estudios realizados, en los que se aplicó la estrategia de estimulación asistida del lenguaje mediante distintos sistemas de CAA tanto con

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soporte digital (CAA+a) como sin asistencia tecnológica (CAA-a), se han obtenido los siguientes resultados generales:

- La estimulación asistida del lenguaje, que consiste en la presentación conjunta de estímulos orales por parte del interlocutor y apoyos visuales a través de CAA, se confirma como una intervención eficaz para niños con TEA de Grado 3 con necesidades complejas de comunicación en contextos de habla española.
- La aplicación de esta estrategia no solo contribuyó a la mejora de las habilidades comunicativas, sino que también generó efectos positivos en el desarrollo social y en la regulación de la conducta, mostrando un impacto transversal en diversas áreas del funcionamiento adaptativo.
- Los distintos recursos utilizados, tanto en formato digital como impreso, han mostrado fortalezas específicas. Cada sistema de CAA evaluado —incluyendo pictogramas físicos, aplicaciones móviles y plataformas interactivas— ha aportado beneficios diferenciados, lo que refuerza la importancia de seleccionar el recurso más adecuado según el perfil individual del usuario.
- La intervención requiere un entorno bien estructurado y controlado, en el que la preparación previa de materiales y actividades es clave para el éxito. Mientras que los recursos impresos exigen mayor trabajo manual y organización, las soluciones digitales ofrecen un manejo más ágil e intuitivo, facilitando su aplicación en contextos terapéuticos dinámicos.
- En los casos estudiados, el modelo de intervención ha resultado adecuado y efectivo. La herramienta de evaluación Vineland-3 (versión adaptada al español) ha demostrado ser útil para valorar los progresos

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en comunicación, interacción social y comportamiento, permitiendo un seguimiento preciso de los cambios observados a lo largo del tiempo.

En cuanto al desarrollo de habilidades comunicativas, esta tesis concluye que:

- La estrategia de estimulación asistida del lenguaje ha demostrado ser altamente eficaz para mejorar tanto la comprensión como la expresión oral, gracias a la integración simultánea de los canales auditivo y visual. No obstante, para estimular habilidades más avanzadas como la lectoescritura, será necesario complementar esta estrategia con otros enfoques didácticos.
- Entre los recursos empleados, los pictogramas de ARASAAC han sido especialmente efectivos, tanto en su formato físico como integrados en plataformas digitales como SymboTalk ®, facilitando la comprensión semántica y la producción verbal.
- Los soportes digitales de CAA han mostrado mejores resultados que los materiales impresos en términos de atención sostenida, motivación y fluidez comunicativa, posiblemente debido a su capacidad para reducir la carga cognitiva y fomentar la interacción.
- En comparación directa, SymboTalk – AAC Talker ® se posiciona como la herramienta tecnológica más eficaz para mejorar las habilidades comunicativas de los participantes del estudio.

Respecto al impacto en las habilidades sociales, se concluye que:

- La intervención también ha producido mejoras significativas en las relaciones interpersonales, el uso funcional del juego y el ocio, y la interacción con el entorno, especialmente cuando se ha combinado la estimulación asistida del lenguaje con soportes visuales adecuados.

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- Sin embargo, el progreso en las habilidades adaptativas ha sido más limitado, lo que sugiere que es necesario complementar esta estrategia con otras intervenciones más específicas dirigidas a estas competencias.
- Los soportes tecnológicos, y en particular el uso de la Tablet, han favorecido la interacción dinámica, el uso del turno de palabra y la atención compartida, generando entornos de comunicación más estimulantes y colaborativos.
- Una vez más, SymboTalk ® ha sido la herramienta que ha producido mayores avances en el desarrollo de las habilidades sociales, seguida de cerca por el uso de pictogramas de ARASAAC en sus diferentes formatos.

Por último, en cuanto a la influencia de la estimulación asistida del lenguaje en las habilidades conductuales, se concluye que:

- La estimulación asistida del lenguaje ha contribuido a establecer una comunicación más natural y fluida durante las sesiones, lo que ha favorecido la reducción de conductas disruptivas y ha facilitado la estructuración de actividades, juegos y rutinas, promoviendo mayor flexibilidad conductual.
- Los distintos recursos de CAA han demostrado ser útiles para canalizar la expresión emocional, permitir la anticipación de acontecimientos y distinguir entre comportamientos apropiados e inapropiados, apoyando así el desarrollo de la autorregulación.
- En esta dimensión, la aplicación EC+ ha mostrado un rendimiento especialmente positivo, con mejoras destacadas en la regulación conductual, aunque SymboTalk ® también ha registrado resultados favorables, situándose como una alternativa eficaz.

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Summary

This thesis is part of the Doctoral Program in Psychology at the University of Málaga, within the research line on Complex Communication Needs and Speech-Language Intervention Based on New Technologies. It has been approved by the Ethical Committee for Experimentation of the University of Málaga (Reference: 19-2023-H) and has been primarily conducted in specialized centers for autism and other neurodevelopmental disorders in the province of Málaga (Spain), with the collaboration of speech-language professionals.

The research is developed within the project "Digital Tool for Assessing Communication and Language in Individuals with Complex Communication Needs: Inclusive Communication," funded by the Aid Program (B.2) for the Promotion of Research Projects on Gender Studies, Inclusion, and Social Sustainability of the University of Málaga (II Own Plan, Reference B2-2022_02). Additionally, it has been supported by the Thematic Research Network Project: Efficient Practices for Inclusive Communication in Populations with Rare Diseases (COMIN-ENIN) (Reference D5-2022_01) and the Inclusive Communication (COMIN) project for people with rare diseases and complex communication needs (Reference B4-2023-18).

Furthermore, the study described in Chapter 6 was carried out in collaboration with the Faculdade de Psicologia e de Ciências da Educação at the University of Coimbra (Portugal) during the doctoral student's international research stay, under the supervision of Dr. Ana Paula Mendes Correia Couceiro Figueira.

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Human communication is based on the transmission of signals through a shared code, while language constitutes the symbolic, arbitrary, and structured system that enables this transmission. In the case of children with autism spectrum disorder (ASD), communication skills are frequently compromised at both verbal and nonverbal levels, significantly impacting their social, academic, and behavioral development, and directly affecting their quality of life.

ASD is considered a neurobiological condition with a multifactorial origin, involving functional and structural alterations of the central nervous system, with well-documented genetic and epigenetic components. According to the most recent edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), ASD falls under the category of neurodevelopmental disorders and is characterized by persistent difficulties in communication and social interaction, along with restricted, repetitive, and sometimes atypical sensory behaviors.

The diagnostic criteria outlined in the DSM-5 include issues with socioemotional reciprocity, limitations in the use of nonverbal communication, difficulties in understanding the unspoken rules of social relationships, and rigidity in adapting to contextual changes. Additionally, individuals may exhibit intense and specific interests, repetitive behaviors, hyper- or hypo-reactivity to sensory input, and a tendency to seek unusual stimuli. It is estimated that this condition affects over 70 million people worldwide, with variations in prevalence depending on the study. In the Spanish context, approximately half a million people are estimated to live with an ASD diagnosis.

The DSM-5 defines three levels of severity based on the amount of support an individual requires to function in daily life. Level 1 (“requiring support”) includes individuals who may develop functional oral language but experience difficulties using it socially, such as interpreting figurative language, maintaining

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fluid conversations, or using appropriate gestures and intonation. At Level 2 ("requiring substantial support"), language difficulties are more pronounced, including limited verbal output, echolalia, and problems with both comprehension and verbal expression. Finally, Level 3 ("requiring very substantial support") involves severe communication impairments, with minimal or no verbal production and significant difficulties interpreting gestures, facial expressions, or emotional tone.

Low communicative intent, along with limited responsiveness to verbal feedback from the environment, can interfere with learning, social adaptation, and overall cognitive development, often leading to disruptive behaviors caused by frustration. It is estimated that approximately 30% of individuals with ASD—particularly those diagnosed at Level 3—have complex communication needs. This involves significant impairments in verbal, written, or gestural expression, as well as in understanding messages from others, making reciprocal social interaction difficult and limiting participation in natural contexts.

In response to this reality, augmentative and alternative communication (AAC) has become an essential tool to promote functional communication in individuals with ASD. This approach encompasses a broad set of strategies, systems, and resources that facilitate the expression of desires, thoughts, emotions, and needs. AAC can be used as a complement to speech or as a substitute when oral language does not develop effectively. Its core principle lies in the use of visible or auditory signs that represent mental meanings—such as pictograms, images, objects, tactile or digital signals—whose comprehensibility may vary depending on their level of iconicity, a particularly relevant factor in ASD cognitive profiles.

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AAC systems are implemented using physical supports (such as communication boards or books) or digital supports (apps, mobile devices, or specialized software), enabling interaction and adapting to user needs. Information and communication technologies (ICT) have significantly expanded intervention possibilities, offering digital tools and supports that are customizable, motivating, and adaptable to various functional profiles.

Traditionally, AAC is divided into two main categories: unaided AAC systems (AAC-a), which use non-electronic resources such as gestures, body language, or printed pictograms; and aided AAC systems with technology (AAC+a), which include electronic devices with or without voice output. Both approaches have proven effective when implemented in individualized and contextually appropriate ways, promoting the generalization of communication skills in natural environments. However, the wide variety of available tools can create uncertainty when selecting the most suitable resources for each case, posing both clinical and educational challenges.

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One of the most promising methodologies in the field of AAC is aided augmented input, a strategy focused on the simultaneous use of spoken and visual language by the communication partner. This technique seeks to foster the development of functional communication by associating spoken words with visual symbols in everyday or therapeutic contexts. Its implementation allows for the provision of accessible language models, enhances comprehension, and encourages the user's communicative initiative. The main objectives include increasing communicative intent, improving symbol comprehension, and stimulating both verbal and nonverbal language production.

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Aided augmented input can be applied through unaided systems, such as physical boards or printed pictograms, or through adapted technological devices.

However, while there are promising data regarding its effectiveness, empirical evidence in Spanish-speaking contexts remains limited, particularly concerning differences in outcomes depending on the type of support used. This gap represents a priority research area to advance the personalization and effectiveness of interventions with individuals with ASD.

This doctoral dissertation aims to contribute to the advancement of scientific knowledge on aided augmented input, with a special focus on its application to children with Level 3 ASD and complex communication needs. The primary goal is to compare the effectiveness of two different approaches to language stimulation: one using traditional methods and the other supported by ICT. The aim is to determine which of these alternatives leads to greater progress in the most affected areas of this population.

The study is structured around three main areas of work. First, a methodological dimension, using a quasi-experimental design to implement the intervention, with specific assessment tools and statistical analysis to measure its effects. Second, an experimental dimension, focused on examining how different AAC resources influence the intervention, identifying patterns of effectiveness and recognizing both their strengths and limitations. Third, a comparative dimension, aimed at exploring how the design and functionality of different supports affect the interaction between the user and the communication partner during the implementation of aided augmented input.

To guide the formulation and development of this research, the PICO strategy was adopted, allowing for the definition of the problem in a specific sample of children with ASD, the description of the intervention based on aided augmented input, the comparison between different AAC resources, and the evaluation of

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outcomes through objective indicators of improvement in communicative, social, and behavioral skills observed throughout the process.

Based on this framework, the specific objectives of the research are as follows:

1. To present a speech-language intervention model based on aided augmented input, adapted to Spanish-speaking contexts and oriented toward the specific needs of children with ASD.
2. To evaluate the effectiveness of this intervention strategy in the development of communication skills, including receptive, expressive, and literacy-related components.
3. To analyze the impact of the intervention on participants' social skills, particularly in interpersonal interaction, play, use of leisure time, and environmental adaptability.
4. To assess whether the intervention produces changes in behavior, particularly in terms of reducing disruptive behaviors in children with Level 3 ASD.
5. To compare communicative and social performance associated with paper-based AAC resources versus technological devices, identifying their advantages, limitations, and potential therapeutic applications.
6. To study the influence of two different types of digital supports on the effectiveness of aided augmented input and to conduct a similar comparison between two printed AAC formats without technological mediation.

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To support the studies included in this doctoral dissertation, a preliminary scoping review was conducted before the experimental development. The purpose of this review was to establish a rigorous conceptual framework to support both the methodological planning and the practical decisions made during the

intervention. Aided augmented input has emerged as a promising strategy for individuals with ASD who face significant communicative challenges. However, prior reviews on this technique are scarce, present methodological limitations, or focus on other forms of language modeling, without specifically addressing the combination of oral and visual input that defines this intervention strategy.

The main objective of the review was to systematize current knowledge regarding the effectiveness of this strategy in children and adolescents diagnosed with ASD. The review followed the PRISMA-ScR framework and included experimental studies published between 2010 and 2024 that implemented interventions based on aided augmented input. The search was conducted in high-impact scientific databases (Web of Science, Scopus, Semantic Scholar, PubMed, and PsycInfo), identifying a total of 1.41 publications, of which 17 met all inclusion criteria. The selected studies were conducted in countries such as the United States, Canada, the United Kingdom, and South Africa, and involved 184 participants with ASD who did not present with visual or hearing impairments.

The analyzed interventions were mainly carried out in educational and clinical settings, with the participation of researchers and interdisciplinary teams composed of professionals such as speech-language pathologists, teachers, and family members. Regarding outcome assessment, standardized tools and checklists were used, including the Childhood Autism Rating Scale (CARS), the Peabody Picture Vocabulary Test, Fourth Edition (PPVT-4), and the Vineland Adaptive Behavior Scales, Second Edition (Vineland-II).

The results of this review suggest that aided augmented input is effective in this population, as it facilitates the association between spoken language and its corresponding visual representations. This, in turn, enhances the comprehension of oral instructions, vocabulary learning, and message production. It was observed

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that individuals with ASD often benefit from visual supports to decode verbal language, which underscores the importance of tailoring interventions and using AAC resources suited to each participant's abilities and preferences.

The reviewed studies showed a wide variety of AAC formats, ranging from printed materials to digital applications and technological devices, all compatible with aided augmented input. Among the most notable benefits were improvements in both receptive and expressive language components, a reduction in challenging behaviors, and greater development of social skills.

Despite these positive outcomes, several relevant limitations were identified, such as the scarce representation of studies conducted in Spanish-speaking contexts, the heterogeneity of ASD, and the variability in experimental designs, which make it difficult to draw generalizable conclusions. Furthermore, the small sample sizes limit the extrapolation of findings to broader populations.

In line with the first specific objective of this research, common inclusion criteria were defined for participants in the empirical study: children aged 6 to 12, whose native language is Spanish, diagnosed with Level 3 ASD according to DSM-5 criteria, with severe communication difficulties and no sensory deficits that could interfere with the intervention. Additionally, participants were required to be able to maintain attention for at least 10 consecutive minutes.

The intervention consisted of 45 sessions over the course of 16 weeks and included three evaluation points using the Vineland-3 scale, focused on the domains of communication, social interaction, and adaptive behavior, in accordance with specific objectives 2, 3, and 4 of the dissertation. Activities took place in structured communicative contexts, such as play with various objects or stimuli, interactions with the speech-language therapist, and monitoring of problematic behaviors. The speech-language therapist played an active role not

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only as an interlocutor but also as the person responsible for task design and execution, environmental control, and the promotion of communicative exchanges. To do so, pictographic symbols were used, along with aided augmented input techniques to help children understand and use language in meaningful situations. The professional's physical positioning next to the child promoted a smooth and effective interaction environment.

After designing the intervention model, three quasi-experimental studies were carried out to compare different types of AAC resources and supports applied to two groups of participants diagnosed with ASD. The first of these studies, aligned with the fifth specific objective of the dissertation, evaluated the use of the EC+ app, a multimodal tool developed within the Erasmus+ project by the University of Málaga. This app allows any item to be represented using various formats—such as pictograms, real photographs, videos, or written words—making it possible to tailor the stimuli to the user's characteristics. This study compared the performance of participants who used EC+ with those who worked with printed pictograms from the Aragonese Portal of Augmentative and Alternative Communication (ARASAAC). The findings indicated that the multimodality of EC+ is a key advantage in aided augmented input contexts, as it combines visual, auditory, and tactile stimuli, generating a richer and more immersive communicative experience. Additionally, the use of technology proved particularly motivating and effective for maintaining attention and fostering participant engagement in the tasks.

Following the positive results obtained with printed pictograms, a second study was designed to further explore this type of visual material. ARASAAC, a free initiative promoted by the Government of Aragón, provides pictograms organized by semantic categories, which are highly iconic and easy to understand, facilitating their use by individuals with communication difficulties. In this phase,

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in addition to ARASAAC pictograms, materials from Mi Estuche de Pictos ®, a commercial resource from Editorial GEU, were also used. This resource includes laminated cards (7 x 7 cm) specifically designed for children with ASD, language impairments, or those in the early stages of literacy. At the end of the intervention, the group that used ARASAAC pictograms showed notable progress in communication skills, such as more frequent use of gestures, better conversational turn-taking, and more accurate associations between objects and visual symbols. Improvements were also observed in attention to the environment, greater participation in social interactions, and better behavioral regulation during sessions.

The third and final study focused on comparing two technological AAC solutions, as part of addressing the sixth specific objective. In this case, the EC+ app was again used and its results were compared with those obtained through the application SymboTalk – AAC Talker ®, a free, cross-platform tool compatible with PC, Android, and iOS. SymboTalk ® allows the creation of customizable communication boards with between 4 and 50 cells, using ARASAAC pictograms and offering the option to edit or add new elements according to the user's needs. The results of this study showed that SymboTalk ® was particularly effective in strengthening both receptive and expressive language components, as well as improving participants' social skills. While EC+ also promoted significant advances in communication, no substantial differences were observed between the two groups regarding behavior. The data suggest that individuals with ASD particularly benefit from visual stimuli over auditory ones, especially when communicative elements are grouped into a single panel, as in SymboTalk ®. The high iconicity of the pictograms used favored their interpretation and usefulness in both applications.

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Based on the three studies conducted—each implementing the strategy of aided augmented input through various AAC systems, both with digital support (AAC+a) and without technological assistance (AAC-a)—the following general findings were obtained:

- Aided augmented input, which involves the simultaneous presentation of oral stimuli by the communication partner and visual supports via AAC, is confirmed to be an effective intervention for Spanish-speaking children with Level 3 ASD and complex communication needs.
- The application of this strategy not only contributed to the improvement of communication skills but also generated positive effects on social development and behavioral regulation, demonstrating a broad impact across various areas of adaptive functioning.
- The different resources used, whether digital or printed, showed specific strengths. Each AAC system evaluated—including physical pictograms, mobile apps, and interactive platforms—provided distinct benefits, reinforcing the importance of selecting the most appropriate resource based on the individual user's profile.
- The intervention requires a well-structured and controlled environment, where prior preparation of materials and activities is key to success. While printed resources demand more manual work and organization, digital solutions offer more agile and intuitive management, facilitating their application in dynamic therapeutic contexts.
- In the cases studied, the intervention model proved to be appropriate and effective. The Vineland-3 assessment tool (Spanish-adapted version) was shown to be useful in evaluating progress in

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communication, social interaction, and behavior, allowing for precise monitoring of changes over time.

Regarding the development of communication skills, this thesis concludes that:

- The aided augmented input strategy has proven highly effective in improving both comprehension and oral expression, thanks to the simultaneous integration of auditory and visual channels. However, to foster more advanced skills such as literacy, this strategy will need to be complemented with other instructional approaches.
- Among the resources used, ARASAAC pictograms were especially effective—both in physical format and integrated into digital platforms like SymboTalk ®—by facilitating semantic understanding and verbal production.
- Digital AAC tools showed better outcomes than printed materials in terms of sustained attention, motivation, and communicative fluency, likely due to their ability to reduce cognitive load and promote interaction.
- In direct comparison, SymboTalk – AAC Talker ® emerged as the most effective technological tool for enhancing the communicative skills of study participants.

In terms of impact on social skills, the findings indicate that:

- The intervention also led to significant improvements in interpersonal relationships, functional use of play and leisure, and interaction with the environment, particularly when aided augmented input was combined with appropriate visual supports.

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- However, progress in adaptive skills was more limited, suggesting the need to supplement this strategy with more targeted interventions aimed at those competencies.
- Technological supports—particularly the use of tablets—promoted dynamic interaction, turn-taking, and shared attention, creating more engaging and collaborative communication environments.
- Once again, SymboTalk ® was the tool that generated the most progress in the development of social skills, closely followed by the use of ARASAAC pictograms in their various formats.

Finally, regarding the influence of aided augmented input on behavioral skills, the study concludes that:

- Aided augmented input contributed to more natural and fluid communication during sessions, which helped reduce disruptive behaviors and facilitated the structuring of activities, games, and routines, promoting greater behavioral flexibility.
- The various AAC resources proved useful in channeling emotional expression, enabling anticipation of events, and distinguishing between appropriate and inappropriate behaviors, thus supporting the development of self-regulation.
- In this domain, the EC+ app showed especially positive performance, with notable improvements in behavioral regulation, although SymboTalk ® also yielded favorable results, positioning itself as an effective alternative.

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Introducción

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1.1. Planteamiento del problema

La transmisión de señales a través de un código compartido entre un emisor y un receptor se denomina "comunicación", mientras que el sistema arbitrario utilizado para facilitar dicha comunicación entre personas recibe el nombre de "lenguaje" (Romski et al., 2015). La capacidad de comunicarse es innata en el ser humano, pero su desarrollo se produce desde la infancia mediante el contacto y la interacción con otras personas, principalmente padres y cuidadores (Gómez & Strasser, 2021). No obstante, cuando estas interacciones o el proceso comunicativo se ven alterados, pueden surgir dificultades significativas en distintas áreas del desarrollo.

Este aspecto adquiere especial relevancia en el caso de los niños con trastorno del espectro autista (TEA). El TEA se define como una condición de origen neurológico y del desarrollo que se manifiesta desde las primeras etapas de la vida (Lai, 2022; Pan et al., 2021). Se estima que más de 70 millones de personas en todo el mundo han sido diagnosticadas con TEA (Holyfield et al., 2017; WHO, 2023). Asimismo, investigaciones recientes indican que la prevalencia del autismo a nivel global se sitúa entre 65 y 72 casos por cada 10.000 habitantes (Talantseva et al., 2023; Zeidan et al., 2022). Solo en España, afecta a aproximadamente medio millón de personas de todas las edades, con una prevalencia estimada de 15 por cada 1.000 niños en edad preescolar y 10 por cada 1.000 en edad escolar (Morales-Hidalgo et al., 2018; Vidriales-Fernández et al., 2023).

Cerca del 30% de esta población presenta necesidades complejas de comunicación, lo que conlleva limitaciones significativas en su capacidad para expresarse de manera verbal, mediante signos o por escrito (Calleja & Rodríguez, 2018; Gotham et al., 2009; Light & McNaughton, 2012). Estas dificultades pueden persistir a lo largo de su vida, de modo que algunas personas permanecen

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mínimamente verbales incluso en la edad adulta, lo que representa un desafío considerable para su desarrollo social, educativo y personal (Gilhuber et al., 2023; Iacono et al., 2016; Sauer et al., 2021; Tager-Flusberg & Kasari, 2013). Aquellos que logran desarrollar el lenguaje suelen enfrentar importantes dificultades para utilizar las palabras de manera adecuada y mantener conversaciones fluidas. Es común que presenten un vocabulario limitado y que aborden los temas de manera restringida, lo que afecta la calidad y efectividad de sus interacciones verbales (Eigsti et al., 2016). Estas dificultades resultan especialmente desafiantes, ya que la comunicación verbal es uno de los medios fundamentales para la interacción y el establecimiento de relaciones humanas (Romski et al., 2015).

Cuando las habilidades comunicativas de las personas con TEA están afectadas, estas limitaciones pueden manifestarse en una amplia gama de dificultades, incluyendo déficits significativos en el habla, la comunicación no verbal, la capacidad de expandir el vocabulario y la respuesta a estímulos verbales (Boucher, 2012; Marzo-Cordón & Belda-Torrijos, 2021). Estas alteraciones no solo repercuten en la calidad de las interacciones sociales cotidianas, sino que también influyen de manera directa en el comportamiento, dado que las habilidades comunicativas son fundamentales para establecer relaciones interpersonales y responder de forma adecuada a las interacciones sociales (Iacono et al., 2016; Torrens & Ruiz, 2021; Velarde-Incháustegui et al., 2021).

Además, es posible que presenten dificultades significativas en las habilidades receptivas, lo que se traduce en problemas para interpretar información contextual (Chen et al., 2024). Esto incluye no solo la comprensión del significado literal de las palabras escuchadas, sino también el reconocimiento de elementos no verbales como los gestos, las expresiones faciales y el tono de voz, los cuales son esenciales para interpretar correctamente el lenguaje en su contexto (Paredes & Ramos, 2023; Sauer et al., 2021). Estas limitaciones pueden complicar la reciprocidad,

afectando la capacidad de responder adecuadamente a los matices de una conversación o a diferentes situaciones. La ausencia o malinterpretación de estos elementos puede llevar a malentendidos, aumentar la frustración y, en algunos casos, contribuir al desarrollo de conductas inapropiadas o evitativas, complicando aún más las interacciones comunicativas y la autonomía de las personas con TEA (Shen & Piven, 2017; Torrens & Ruiz, 2021).

La investigación en el campo del lenguaje y la comunicación en los casos de TEA es de suma importancia en contextos psicológicos, educativos, clínicos y sociales (Llaneza et al., 2010; Vogindroukas et al., 2022). La necesidad de mejorar la calidad de vida de las personas con dificultades complejas de comunicación ha impulsado el uso de la comunicación aumentativa y alternativa (CAA) en diversas intervenciones y de manera internacional (Cerpa Reyes et al., 2023; Conlon et al., 2024). La CAA comprende un conjunto de herramientas, estrategias, soportes tecnológicos y técnicas diseñadas para apoyar a los usuarios con dificultades o limitaciones en la comunicación, permitiéndoles expresar sus ideas, necesidades y emociones de manera efectiva frente a otros interlocutores. Su objetivo principal es promover una comunicación independiente, facilitar las interacciones sociales y, en última instancia, mejorar la calidad de vida de los usuarios (Crowe et al., 2022).

En los casos de TEA, especialmente niños en edad escolar, estudios recientes han destacado la eficacia de las intervenciones basadas en CAA. Estas estrategias han demostrado aumentar las oportunidades comunicativas al fomentar un flujo dinámico de preguntas y respuestas, lo que contribuye significativamente al desarrollo de habilidades comunicativas y sociales. (Landa, 2018; Lorah et al., 2024; Therrien et al., 2016). Sin embargo, una limitación recurrente en estos procesos es la falta de naturalidad en las interacciones generadas mediante estas estrategias. Esta carencia puede dificultar la generalización de las habilidades

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aprendidas a entornos naturales como el hogar, la escuela o contextos comunitarios, lo que subraya la necesidad de diseñar intervenciones que faciliten su aplicación en situaciones reales (Klopfenstein et al., 2020; Simacek et al., 2018).

En este sentido, entre las estrategias de intervención empleando la CAA destaca la estimulación asistida del lenguaje. Esta metodología, introducida por los pioneros Goossens y Crain (1986), busca proporcionar nuevas oportunidades educativas y sociales a personas con dificultades de comunicación, aprovechando especialmente sus capacidades visoespaciales, como ocurre en el caso del TEA (Cardillo et al., 2020; Therrien et al., 2016). Este enfoque promueve tanto el componente receptivo como el expresivo del lenguaje y se basa en el modelado activo, superando la mera exposición al significado para fomentar el desarrollo de habilidades comunicativas de forma natural. La estimulación asistida del lenguaje implica que el interlocutor utilice símbolos pictográficos (input visual) mientras emplea simultáneamente la producción verbal (input oral). Esta integración permite asociar el significante con el significado, facilitando la creación de nuevas estructuras oracionales y modos de interacción (Drager et al., 2006; O'Neill et al., 2018; Therrien et al., 2016). La estrategia tiene varios objetivos clave: incrementar las emisiones vocales, desarrollar opciones de respuesta, fomentar la interacción mediante el uso de objetos y símbolos, potenciar la intención comunicativa y ampliar las habilidades lingüísticas expresivas y receptivas. Además, busca fortalecer la capacidad de los usuarios para establecer conexiones significativas entre diferentes modalidades comunicativas, optimizando su participación en entornos educativos y sociales de forma natural (Gómez-Taibo & García-Eligio de la Puente, 2016).

Sin embargo, a pesar del creciente interés en este campo de investigación, actualmente no se cuenta con evidencia suficiente respaldada por datos empíricos sólidos (Puig-Pallarols, 2025). Esta situación puede afectar la calidad de las

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intervenciones y limitar la validación de la estrategia de estimulación asistida del lenguaje en niños con TEA con necesidades complejas de comunicación, especialmente en contextos de habla española.

Además, la amplia variedad de recursos de CAA disponibles, tanto en formato impreso como digital, dificulta la toma de decisiones sobre cuál es el soporte más adecuado para las necesidades de cada usuario, lo que representa una limitación importante en las intervenciones. La elección del recurso idóneo se ve condicionada por las características únicas y específicas de cada persona, lo que puede complicar el diseño de estrategias realmente efectivas (Nam et al., 2018). En este sentido, estudios como los de Agius et al. (2024) y Lorah et al. (2022) subrayan la importancia de realizar investigaciones comparativas que analicen distintos tipos de recursos y soportes de CAA, ya que las diferencias en funcionalidad y diseño pueden tener un impacto considerable en los resultados obtenidos. En el caso de los usuarios con TEA, estas diferencias son particularmente críticas, ya que afectan no solo a los componentes receptivo y expresivo del lenguaje, sino también al funcionamiento conductual general y a las habilidades sociales (Brady et al., 2015; Sauer et al., 2021; Velarde-Incháustegui et al., 2021). Por todo ello, comprender cómo estas herramientas pueden influir en la eficacia de la estimulación asistida del lenguaje es prioritario para optimizar su aplicación.

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1.2. Objetivos de la tesis

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El objetivo general de la presente tesis doctoral es comparar la efectividad de la estimulación del lenguaje mediante un enfoque tradicional frente al uso de la TIC en niños con TEA de Grado 3 con necesidades complejas de comunicación, con el fin de determinar qué tipo de enfoque promueve mayores avances en el

desarrollo del lenguaje, contribuyendo así tanto al conocimiento científico como a la aplicación práctica de esta estrategia de intervención.

Para alcanzar dicho objetivo general, la tesis se estructura en torno a tres áreas específicas: a) metodológica, utilizando métodos cuasiexperimentales para evaluar de manera sistemática la implementación de la estrategia de intervención. Esto incluye el uso de instrumentos que permitan cuantificar el impacto de los recursos de CAA en las habilidades evaluadas y su posterior análisis estadístico; b) experimental, examinando las características y resultados específicos derivados del uso de diferentes recursos o soportes de CAA en niños con TEA, identificando patrones de eficacia y analizando las fortalezas y limitaciones asociadas a cada recurso dentro del proceso de intervención; y c) comparativa, analizando la influencia de factores como el diseño del recurso, su funcionalidad y la capacidad de promover el uso adecuado de la estimulación asistida del lenguaje entre el interlocutor y el usuario.

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Con este propósito, las investigaciones que conforman la presente tesis doctoral se diseñaron siguiendo la estrategia PICO. En este marco, la definición del problema o paciente (P) se centró en una muestra de niños diagnosticados con TEA de Grado 3 en edad escolar y con necesidades complejas de comunicación. La intervención analizada (I) consistió en una estrategia basada en la estimulación asistida del lenguaje, mientras que la comparación (C) se realizó con diferentes recursos o soportes de CAA, según correspondiera en cada caso. Los resultados (O) se evaluaron a través de cambios cuantificables en el tiempo en habilidades comunicativas, sociales o conductuales, áreas frecuentemente afectadas en la población con TEA (Velarde-Incháustegui et al., 2021).

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Teniendo en cuenta todos los puntos que se buscaron abarcar, los objetivos específicos fueron los siguientes:

1. Describir un modelo de intervención fundamentado en la estimulación asistida del lenguaje, diseñado desde una perspectiva logopédica y adaptado a un contexto de habla española.
2. Analizar la eficacia de la estimulación asistida para mejorar las habilidades comunicativas en niños con diagnóstico de TEA con necesidades complejas de comunicación. Para ello, se valorará los componentes receptivo, expresivo y de lectoescritura.
3. Evaluar el impacto de las habilidades sociales de los participantes con TEA a partir de la intervención basada en la estimulación asistida del lenguaje. Aquí se incluyen la capacidad para relacionarse con otros (relaciones interpersonales), y jugar y usar el tiempo libre, y la capacidad de adaptarse.
4. Determinar si esta intervención influye en el comportamiento, concretamente en la reducción de conductas disruptivas en los niños con TEA de estas características.
5. Comparar la eficacia de recursos de CAA presentados en formato papel con la de un sistema basado en soporte tecnológico, analizando su impacto en el desarrollo de las habilidades evaluadas. Esta comparación permitirá identificar sus posibles ventajas, limitaciones y aplicaciones en el contexto de la intervención.
6. Analizar la influencia de dos soportes digitales de CAA con características diferenciadas en la efectividad de la estimulación asistida del lenguaje. Del mismo modo, se llevará a cabo una comparación equivalente entre dos recursos de CAA en formato impreso, sin influencia tecnológica.

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1.3. Contexto metodológico

La estratificación de la muestra se llevó a cabo considerando variables clave como la edad (etapa escolar), el nivel de competencia comunicativa —centrándose en niños y niñas con un habla funcional limitada o ausente, quienes suelen depender habitualmente de sistemas de CAA para comunicarse de forma eficaz (Liang et al., 2025)—, la ausencia de experiencia previa con las herramientas o soportes utilizados en los estudios, y la disponibilidad del entorno clínico. Toda la investigación se desarrolló en distintos gabinetes de logopedia de la provincia de Málaga (España), siguiendo una metodología de trabajo y evaluación común, diseñada y supervisada por el autor.

Con el fin de preservar el anonimato de los participantes y cumpliendo estrictamente con los acuerdos de confidencialidad, en este trabajo no se revelan en ningún momento los nombres de las clínicas, centros colaboradores ni de los profesionales implicados. Estos profesionales actuaron como observadores independientes y estaban familiarizados con los participantes, facilitando su implicación durante las sesiones de intervención. El autor estuvo presente en todas ellas, encargándose de la estimulación asistida del lenguaje, así como de la preparación e implementación de los soportes de CAA utilizados en cada estudio.

La evaluación principal se realizó mediante la Escala Vineland-3, completada por la profesional observadora independiente. Esta decisión metodológica respondió a diversas razones: reducir el posible sesgo de deseabilidad social asociado al uso de informantes familiares, aumentar la objetividad del proceso de evaluación mediante observaciones directas, evitar el sesgo del propio autor y garantizar la validez de los datos recogidos. Cabe destacar que la propia escala recomienda ser aplicada por personas que conozcan bien al usuario, como familiares o profesionales que interactúan habitualmente con él.

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Por otro lado, en el marco de esta tesis no se analizaron variables como el sexo o el nivel de escolaridad de los participantes, aunque sí se consideraron a la hora de describir las características generales de los grupos, como es el caso del sexo. Esta decisión se basó en la orientación general del estudio, centrada en evaluar de forma grupal las variables comunicativas, sociales y conductuales con el mayor número de participantes posible. El análisis de estas variables sociodemográficas se plantea como línea de investigación futura.

Todo este planteamiento será desarrollado con mayor detalle en los capítulos siguientes.

1.4. Estructura de la tesis

Con el fin de alcanzar los objetivos planteados en el apartado 1.2, esta tesis se estructura en ocho capítulos principales. El Capítulo 1, en el que nos encontramos actualmente, presenta el tema de estudio, proporciona una visión general del estado de la cuestión y expone los objetivos que guían esta investigación, constituyendo así el marco introductorio sobre el que se articula el conjunto del trabajo. Además, se detalla la información pertinente relativa al marco de desarrollo del estudio, así como los aspectos éticos, incluyendo la aprobación ética obtenida y vigente a lo largo de todo el proceso investigativo.

El Capítulo 2 expone los conceptos y características fundamentales del TEA, incluyendo su evolución teórica a lo largo del último siglo hasta la definición actual establecida en el DSM-5. Posteriormente, se profundiza en los aspectos genéticos y psicológicos más relevantes en estos casos, así como en los principales procesos e instrumentos de evaluación más utilizados. Además, se analizan las estrategias del proceso de intervención más efectivas en el abordaje de esta población. Finalmente, se detallan las particularidades de la comunicación en

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función del grado de TEA, un aspecto clave para el enfoque logopédico de esta tesis.

El Capítulo 3 se basa en la información expuesta en el apartado 2.6 del capítulo anterior para profundizar en la CAA en el contexto de usuarios con TEA, especialmente aquellos con necesidades complejas de comunicación. En este marco, se presentan las características esenciales de la estrategia de intervención denominada estimulación asistida del lenguaje, la metodología principal utilizada a lo largo de esta tesis. Además, se incluyen ejemplos prácticos que ilustran ocho actividades alineadas con esta estrategia y adaptadas a la población objetivo, seleccionadas por su relevancia en la investigación. Estas actividades contribuyen al cumplimiento del objetivo específico 1, definido en el apartado 1.2. Asimismo, se proporcionan los datos necesarios para la implementación de la estimulación asistida del lenguaje en los estudios realizados y para la consecución del resto de los objetivos vinculados a esta estrategia.

El Capítulo 4 recoge una revisión de alcance (*scoping review*), cuyo propósito es proporcionar una base teórica sólida que sustente y justifique tanto las decisiones metodológicas adoptadas como las investigaciones llevadas a cabo en los capítulos siguientes. En este apartado se presentan y analizan investigaciones previas y actuales de relevancia para la tesis, proporcionando un marco teórico y práctico que sustenta los estudios posteriores. La recopilación de datos provenientes de estos estudios permite extraer una serie de conclusiones clave que resaltan la importancia y el potencial de la intervención basada en la estimulación asistida del lenguaje, complementada con la CAA, en usuarios con TEA. Asimismo, se identifican áreas que requieren mayor investigación, entre ellas la necesidad de comparar distintos recursos y soportes de CAA (tanto digitales como no tecnológicos) con el fin de evaluar y confirmar sus efectos en el desarrollo de habilidades comunicativas (receptivas y expresivas), sociales y comportamentales.

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A partir de esta información, la presente tesis busca profundizar en el tema y aportar nuevos datos desde una perspectiva centrada en la población de habla española.

A continuación, se presentan la investigación realizada en el marco experimental, en los que participaron un total de 75 niños y niñas con diagnóstico de TEA de Grado 3 con necesidades complejas de comunicación, distribuidos entre los tres estudios. Estas investigaciones permitieron alcanzar los objetivos específicos 2, 3 y 4, al mismo tiempo que desarrollan el objetivo específico 1 en función del tipo de soporte o recurso de CAA utilizado, exponiendo al mismo tiempo los procesos llevados a cabo y las características del marco de la propia intervención y evaluación. Cada uno de ellos aporta contribuciones científicas significativas, cuyos resultados y conclusiones han sido difundidos a través de publicaciones en revistas de alto impacto, capítulos en obras especializadas y comunicaciones presentadas en congresos internacionales de reconocido prestigio.

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En primer lugar, el Capítulo 5 aborda la implementación de la estimulación asistida del lenguaje utilizando dos tipos de apoyos: por un lado, la aplicación tecnológica y multimodal EC+ y, por otro, pictogramas de ARASAAC impresos en papel. Este capítulo responde al objetivo específico 5 y proporciona información destacable que se integra en los Capítulos 6 y 7. Los procesos descritos en este estudio, así como los recursos de CAA utilizados (EC+ y ARASAAC) y parte de los resultados obtenidos, han sido publicados en la *Revista Comunicar: Revista Científica de Comunicación y Educación* (Appendix G), una publicación indexada en el primer cuartil (Q1) del ranking JCR en su categoría correspondiente para el año 2024.

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El Capítulo 6 se dedica a evaluar los efectos de los recursos de CAA en formato papel sobre las habilidades comunicativas, sociales y conductuales de los

participantes con TEA. Para ello, se comparan dos sistemas: ARASAAC y Mi Estuche de Pictos ®, excluyendo la influencia de dispositivos tecnológicos. Este análisis contribuye a cumplir con parte del objetivo específico 6. Los resultados sugieren que ambos sistemas contribuyen a la mejora de las habilidades evaluadas, aunque ARASAAC parece ofrecer un mayor beneficio para la población analizada. Esta comparación es fundamental para comprender las ventajas y limitaciones de cada material, proporcionando una base sólida para futuras investigaciones que contrasten el uso de herramientas en papel entre ellos o con soportes tecnológicos.

El Capítulo 7 mantiene el enfoque de los estudios previos, pero en esta ocasión compara la eficacia de dos soportes tecnológicos de CAA: EC+ y SymboTalk – AAC Talker ®. La investigación se centra en analizar cómo las diferencias en la presentación de los elementos en una tablet pueden influir en el rendimiento de los participantes. En particular, se examinan dos formatos de estructuración: la lista multimodal y los tableros de comunicación, ya que la disposición de los pictogramas y la forma de acceso a la información pueden impactar en la eficacia del uso de estos soportes. Este estudio resulta especialmente relevante para orientar a profesionales en la selección de herramientas tecnológicas de CAA según las necesidades específicas de cada usuario. Además, proporciona evidencia científica sobre cómo la organización visual y funcionalidad de estos soportes puede optimizar el aprendizaje y la comunicación en los usuarios con TEA. Con esta investigación, se completa el objetivo específico 6 de la tesis. Los resultados de este trabajo han sido publicados en la *Revista de Logopedia, Foniatría y Audiología* (Appendix G), una publicación indexada en el tercer (Q3) y cuarto cuartil (Q4) en la categoría de *Speech and Hearing* y en la de *LPN and LVN*, respectivamente, para el año 2025. Dado el carácter de estudio piloto de dicha publicación, en esta tesis se han añadido datos adicionales para profundizar mejor en ellos y cumplir con los objetivos propuestos.

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El Capítulo 8 presenta un resumen de los principales hallazgos y conclusiones obtenidos a lo largo de la investigación. Asimismo, se plantean futuras líneas de estudio que permitan seguir avanzando en el objetivo general de la tesis: profundizar en la comprensión científica y práctica de la estimulación asistida del lenguaje y de los distintos recursos o soportes de CAA compatibles con esta estrategia de intervención en casos de TEA con necesidades complejas de comunicación.

Tal y como se ha mencionado anteriormente, algunos de los resultados de estos trabajos también han sido publicados en libros científicos de prestigio, como *Avances y desafíos en salud: Progresando desde la investigación*, de la Editorial ASUNIVEP, indexada en el *Spi-Scholarly Publishers Indicators*. Asimismo, se han incluido en: a) *Innovación docente e investigación en salud: Nuevas tendencias para el cambio en la enseñanza superior*; y b) *Investigación y desarrollo de recursos de intervención en contextos clínicos y de la salud*, ambos editados por Dykinson y clasificados en el primer cuartil del ranking *Scholarly Publishers Indicators (SPI)* en su categoría correspondiente para el año 2023 (Appendix G). Por otro lado, los estudios derivados de esta tesis han sido enviados y actualmente se encuentran en proceso de revisión para su publicación en *Disability and Rehabilitation: Assistive Technology*, la *Revista de Investigación en Logopedia* y la revista portuguesa *PSICOLOGIA*.

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1.5. Marco de desarrollo

Esta tesis se desarrolla dentro del programa de Doctorado en Psicología, en la línea de investigación de Necesidades Complejas de Comunicación e Intervención Logopédica basada en Nuevas Tecnologías.

La investigación se ha enmarcado dentro del proyecto "Herramienta digital para evaluar comunicación y lenguaje en personas con necesidades complejas de

comunicación: Comunicación Inclusiva" cuya entidad es el Programa de Ayudas (B.2) para el Fomento de Proyectos de Investigación en Estudios de Género Inclusión y Sostenibilidad Social de la Universidad de Málaga (II Plan Propio) concedido por la Comisión de Investigación y Transferencia de la Universidad de Málaga, de Referencia B2-2022_02.

Además, se han integrado los aportes derivados de dos proyectos clave: a) el Proyecto Red Temática de Investigación: Prácticas eficientes de comunicación inclusiva en poblaciones con enfermedades infrecuentes (COMIN-ENIN), perteneciente al II Plan Propio de Investigación y Transferencia de la Universidad de Málaga (Referencia D5-2022_01); y b) el proyecto Comunicación inclusiva (COMIN) para personas con enfermedades raras y necesidades complejas de comunicación (Referencia B4-2023-18).

Todos los procedimientos realizados en los estudios con participantes se ajustaron a las normas éticas del comité de investigación institucional y nacional y a la Declaración de Helsinki y sus enmiendas posteriores o normas éticas comparables. La tesis y los trabajos relacionados con ella cuentan con la aprobación del Comité Ético de Experimentación de la Universidad de Málaga (Referencia: 19-2023-H).

Por último, cabe destacar que parte del desarrollo del estudio descrito en el Capítulo 6 se llevó a cabo en colaboración con la Faculdade de Psicologia e da Ciências da Educação de la Universidad de Coímbra (Portugal). Esto se hizo durante la estancia de investigación internacional del doctorando y autor principal de la tesis, bajo la supervisión de la Dra. Ana Paula Mendes Correia Couceiro Figueira. Durante esta estancia, se realizaron diversas actividades académicas y científicas, incluyendo el análisis de datos y la recopilación bibliográfica, la participación en seminarios prácticos-teóricos presentando los materiales

utilizados y la colaboración con otros investigadores del área. Este trabajo conjunto permitió fortalecer la dimensión internacional de la investigación, favoreciendo el intercambio de conocimientos y metodologías entre ambas instituciones. Asimismo, los hallazgos obtenidos han servido de base para futuras publicaciones y proyectos de investigación en el ámbito de la logopedia y la psicología del desarrollo.

1.6. Referencias

Agius, M. M., Stansfield, J., & Murray, J. (2024). A comparison of differing organizational formats for teaching requesting skills to children with autism. *Augmentative and Alternative Communication*, 1-12. https://doi.org/10.1080/07434618.2024.2370825

Boucher, J. (2012). Research review: structural language in autistic spectrum disorder–characteristics and causes. *Journal of Child Psychology and Psychiatry*, *53*(3), 219-233. https://doi.org/10.1111/j.1469-7610.2011.02508.x

Brady, N. C., Storkel, H. L., Bushnell, P., Barker, R. M., Saunders, K., Daniels, D., & Fleming, K. (2015). Investigating a multimodal intervention for children with limited expressive vocabularies associated with autism. *American Journal of Speech-Language Pathology*, 24(3), 438-459. https://doi.org/10.1044/2015_AJSLP-14-0093

Calleja Reina, M & Rodríguez, J. M. (2018). La comunicación aumentativa y alternativa para hacer frente a las necesidades complejas de comunicación en usuarios de bajo perfil cognitivo. En Postigo Pinazo, E., Calleja Reina, M., & Gabau Vila, E. (2018). *Disability and Communication. Scientific Analysis, Total Communication and ICT Tools and Case Studies* (pp. 163-174). McGraw Hill Education.

Cardillo, R., Lanfranchi, S., & Mammarella, I. C. (2020). A cross-task comparison on visuospatial processing in autism spectrum disorders. *Autism*, 24(3), 765-779. https://doi.org/10.1177/1362361319888341

UNIVERSIDAD DE MÁLAGA

Cerpa Reyes, C., Jorquera Arellano, L., & Toro Lisboa, J. (2023). Comunicación Aumentativa Alternativa para una Educación Inclusiva: Experiencias y Desafíos. *Revista Latinoamericana de Educación Inclusiva*, 17(1), 95-110. http://dx.doi.org/10.4067/s0718-73782023000100095

Chen, Y., Siles, B., & Tager-Flusberg, H. (2024). Receptive language and receptive-expressive discrepancy in minimally verbal autistic children and adolescents. *Autism Research*, *17*(2), 381-394. https://doi.org/10.1002/aur.3079

Conlon, C., Zupan, B., & Preston, R. (2024). The confidence and competence of speech language pathologists in augmentative and alternative communication: a scoping review. *Augmentative and Alternative Communication*, 1-14. https://doi.org/10.1080/07434618.2024.2333383

Crowe, B., Machalicek, W., Wei, Q., Drew, C., & Ganz, J. (2022). Augmentative and alternative communication for children with intellectual and developmental disability: A mega-review of the literature. *Journal of Developmental and Physical Disabilities*, 1-42. https://doi.org/10.1007/s10882-021-09790-0

Drager, K. D., Postal, V. J., Carrolus, L., Castellano, M., Gagliano, C., & Glynn, J. (2006). The effect of aided language modeling on symbol comprehension and production in 2 preschoolers with autism. *American Journal of Speech-Language Pathology.* https://doi.org/10.1044/1058-0360(2006/012)

Eigsti, I. M., Stevens, M. C., Schultz, R. T., Barton, M., Kelley, E., Naigles, L., ... & Fein, D. A. (2016). Language comprehension and brain function in individuals with an optimal outcome from autism. *NeuroImage: Clinical*, *10*, 182-191. https://doi.org/10.1016/j.nicl.2015.11.014

Gilhuber, C. S., Raulston, T. J., & Galley, K. (2023). Language and communication skills in multilingual children on the autism spectrum: A systematic review. *Autism*, 0(0). https://doi.org/10.1177/13623613221147780

UNIVERSIDAD DE MÁLAGA

Gómez, E., & Strasser, K. (2021). Language and socioemotional development in early childhood: The role of conversational turns. *Developmental Science*, 24(5). https://doi.org/10.1111/desc.13109

Gómez-Taibo, M. L., & García-Eligio de la Puente, M. T. (2016). Una revisión sobre la aplicación de estrategias para aumentar el input de la comunicación aumentativa y alternativa asistida en personas con trastornos del desarrollo. *Revista de Logopedia, Foniatría y Audiología*, 36(1), 23-35. https://dialnet.unirioja.es/servlet/articulo?codigo=5517651

Goossens, C., & Crain, S. (1986). *Establishing multiple communication displays. Augmentative communication: An introduction*, 337-344.

Gotham, K., Pickles, A., & Lord, C. (2009). Standardizing ADOS scores for a measure of severity in autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *39*, 693-705. https://doi.org/10.1007/s10803-008-0674-3

Holyfield, C., Drager, K.D., Kremkow, J., & Light, J. (2017). Systematic review of AAC intervention research for adolescents and adults with autism spectrum disorder. *Augmentative and Alternative Communication*, 33(4), 201–212. https://doi.org/10.1080/07434618.2017.1370495

Iacono, T., Trembath, D., & Erickson, S. (2016). The role of augmentative and alternative communication for children with autism: current status and future trends. *Neuropsychiatric Disease and Treatment*, 2349-2361. https://doi.org/10.2147/NDT.S95967

Klopfenstein, M., Bernard, K., & Heyman, C. (2020). The study of speech naturalness in communication disorders: A systematic review of the literature. *Clinical Linguistics & Phonetics*, 34(4), 327-338. https://doi.org/10.1080/02699206.2019.1652692

UNIVERSIDAD DE MÁLAGA

Lai, M. C. (2022). Clinical reflections on the intersections of autism and personality development. *Autism*, 26(4), 739-742. https://doi.org/10.1177/13623613221088073

Landa R. J. (2018). Efficacy of early interventions for infants and young children with, and at risk for, autism spectrum disorders. *International Review of Psychiatry*, 30(1), 25–39. https://doi.org/10.1080/09540261.2018.1432574

Liang, Z., Chen, Q., & Liang, S. (2025). A literature review of single-case studies utilizing aided augmentative and alternative communication intervention for students on the autism spectrum who have limited speech in elementary school. *International Journal of Developmental Disabilities*, 1-15. https://doi.org/10.1080/20473869.2025.2486431

Light, J., & McNaughton, D. (2012). Supporting the communication, language, and literacy development of children with complex communication needs: State of the science and future research priorities. *Assistive Technology*, *24*(1), 34-44. https://doi.org/10.1080/10400435.2011.648717

Llaneza, D. C., DeLuke, S. V., Batista, M., Crawley, J. N., Christodulu, K. V., & Frye, C. A. (2010). Communication, interventions, and scientific advances in autism: a commentary. *Physiology & Behavior*, 100(3), 268-276. https://doi.org/10.1016/j.physbeh.2010.01.003

Lorah, E. R., Holyfield, C., Griffen, B., & Caldwell, N. (2024). A systematic review of evidence-based instruction for individuals with autism using mobile augmentative and alternative communication technology. *Review Journal of Autism and Developmental Disorders*, 11(1), 210-224. https://doi.org/10.1007/s40489-022-00334-6

Lorah, E. R., Holyfield, C., Miller, J., Griffen, B., & Lindbloom, C. (2022). A systematic review of research comparing mobile technology speech-generating devices to other AAC modes with individuals with autism spectrum disorder. *Journal of*

UNIVERSIDAD DE MÁLAGA

Developmental and Physical Disabilities, 34(2), 187-210. https://doi.org/10.1007/s10882-021-09803-y

Marzo-Cordón, M., & Belda-Torrijos, M. (2021). Trastornos del lenguaje en alumnado con TEA. *International Journal of New Education*, (7) https://doi.org/10.24310/IJNE4.1.2021.12016

Morales-Hidalgo, P., Roigé-Castellví, J., Hernández-Martínez, C., Voltas, N., & Canals, J. (2018). Prevalence and characteristics of Autism Spectrum Disorder among Spanish school-age children. *Journal of Autism and Developmental Disorders*, 48, 3176–3190. https://doi.org/10.1007/s10803-018-3581-2

Nam, S., Kim, J., & Sparks, S. (2018). An Overview of Review Studies on Effectiveness of Major AAC Systems for Individuals with Developmental Disabilities Including Autism. *Journal of Special Education Apprenticeship*, *7*(2), n2.

O'Neill, T., Light, J., & Pope, L. (2018). Effects of Interventions That Include Aided Augmentative and Alternative Communication Input on the Communication of Individuals with Complex Communication Needs: A Meta-Analysis. *Journal of Speech, Language, and Hearing Research: JSLHR*, 61(7), 1743–1765. https://doi.org/10.1044/2018_JSLHR-L-17-0132

Pan, P. Y., Bölte, S., Kaur, P., Jamil, S., & Jonsson, U. (2021). Neurological disorders in autism: A systematic review and meta-analysis. *Autism*, 25(3), 812-830. https://doi.org/10.1177/13623613209513

Paredes, M. S. P., & Ramos, D. C. G. (2023). Perfil sensorial en Autistas. *Ciencia Latina Revista Científica Multidisciplinar*, 7(2), 221-239. https://doi.org/10.37811/cl_rcm.v7i2.5289

Puig-Pallarols, M. C. (2025). Revisión de conceptos, prácticas, paradigmas y evidencias en comunicación aumentativa. *Revista de Logopedia, Foniatría y Audiología*, 45(2), 100523. https://doi.org/10.1016/j.rlfa.2025.100523

UNIVERSIDAD DE MÁLAGA

Romski, M., Sevcik, R. A., Barton-Hulsey, A., & Whitmore, A. S. (2015). Early Intervention and AAC: What a Difference 30 Years Makes. *Augmentative and Alternative Communication*, 31(3), 181–202. https://doi.org/10.3109/07434618.2015.1064163

Sauer, A. K., Stanton, J. E., Hans, S., & Grabrucker, A. M. (2021). Autism Spectrum Disorders: Etiology and Pathology. *Exon Publications*, 1-15. https://doi.org/10.36255/exonpublications.autismspectrumdisorders.2021.etiology

Shen, M. D., & Piven, J. (2017). Brain and behavior development in autism from birth through infancy. *Dialogues in Clinical Neuroscience*, 19(4), 325-333. https://doi.org/10.31887/DCNS.2017.19.4/mshen

Simacek, J., Pennington, B., Reichle, J., & Parker-McGowan, Q. (2018). Aided AAC for people with severe to profound and multiple disabilities: A systematic review of interventions and treatment intensity. *Advances in Neurodevelopmental Disorders*, *2*, 100-115. https://doi.org/10.1007/s41252-017-0050-4

Tager-Flusberg, H., & Kasari, C. (2013). Minimally verbal school-aged children with autism spectrum disorder: The neglected end of the spectrum. *Autism Research*, 6(6), 468–478. https://doi.org/10.1002/aur.1329

Talantseva, O. I., Romanova, R. S., Shurdova, E. M., Dolgorukova, T. A., Sologub, P. S., Titova, O. S., ... & Grigorenko, E. L. (2023). The global prevalence of autism spectrum disorder: A three-level meta-analysis. *Frontiers in Psychiatry*, *14*, 1071181. https://doi.org/10.3389/fpsyt.2023.1071181

Therrien, M. C., Light, J., & Pope, L. (2016). Systematic review of the effects of interventions to promote peer interactions for children who use aided AAC. *Augmentative and Alternative Communication*, 32(2), 81-93. https://doi.org/10.3109/07434618.2016.1146331

UNIVERSIDAD DE MÁLAGA

Torrens, V., & Ruiz, C. (2021). Language and communication in preschool children with autism and other developmental disorders. *Children*, 8(3), 192. https://doi.org/10.3390/children8030192

Velarde-Incháustegui, M., Ignacio-Espíritu, M. E., & Cárdenas-Soza, A. (2021). Diagnóstico de Trastorno del Espectro Autista-TEA, adaptándonos a la nueva realidad, Telesalud. *Revista de Neuro-Psiquiatría*, 84(3), 175-182. http://dx.doi.org/10.20453/rnp.v84i3.4034

Vidriales-Fernández, R., Plaza-Sanz, M., Hernández-Layna, C., Verde-Cagiao, M., Benito-Ruiz, G., & Carvajal-Molina, F. (2023). Characterizing the physical and mental health profile of children, adolescents and adults with autism spectrum disorder in Spain. *Frontiers in Psychiatry*, *14*, 1088727. https://doi.org/10.3389/fpsyt.2023.1088727

Vogindroukas, I., Stankova, M., Chelas, E. N., & Proedrou, A. (2022). Language and speech characteristics in autism. *Neuropsychiatric Disease and Treatment*, 2367-2377. https://doi.org/10.2147/NDT.S331987

World Health Organization (WHO) (2023). *Autism*. https://bit.ly/4dvUOwU

Zeidan, J., Fombonne, E., Scorah, J., Ibrahim, A., Durkin, M. S., Saxena, S., ... & Elsabbagh, M. (2022). Global prevalence of autism: A systematic review update. *Autism Research*, *15*(5), 778-790. https://doi.org/10.1002/aur.2696

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2

Fundamentos teóricos del trastorno del espectro autista

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2.1 El trastorno del espectro autista

El TEA posee un conjunto de condiciones heterogéneas del desarrollo. Por lo tanto, una comprensión profunda y exhaustiva de su concepto y sus características principales resulta fundamental para identificar las variables que intervienen en el desarrollo de las habilidades comunicativas y su influencia como mediadoras en las interacciones sociales y en la regulación del comportamiento.

2.1.1 Evolución del concepto

La conceptualización y denominación del TEA han evolucionado significativamente con el tiempo, reflejando los cambios en el entendimiento científico y social de este trastorno. El término "autismo" tiene raíces etimológicas en la palabra griega *autós*, que significa "propio" o "sí mismo", en contraposición a "otro" (Joon et al., 2021). Este concepto fue introducido por primera vez por el psiquiatra Eugen Bleuler en su obra *Dementia praecox oder Gruppe der Schizophrenien*. Bleuler utilizó el término "autosmo" para describir a un paciente con esquizofrenia grave que manifestaba una desconexión total con el mundo exterior. Esta desconexión se caracterizaba por un repliegue extremo de la vida mental del sujeto hacia sí mismo, lo que daba lugar a la construcción de un mundo cerrado, separado de la realidad externa, y a una notable dificultad o incapacidad para comunicarse con otras personas (Bleuler, 1911).

Entre las décadas de 1930 y 1963, el autismo se interpretaba como un trastorno predominantemente emocional con características severas. Este enfoque se centraba en niños que presentaban alteraciones emocionales, atribuidas a posibles relaciones afectivas anómalas durante la infancia, y que se consideraban potencialmente capaces de alcanzar un desarrollo normal. Por otro lado, autores como Potter (1933), Lutz (1937) y Bleuler (1950) clasificaban el autismo como una forma grave de esquizofrenia. Según estos investigadores, las personas con

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autismo no podían responder a influencias externas, ya que estaban dominadas por el "pensamiento autista", caracterizado por la sustitución de la realidad por alucinaciones y fantasías.

En este contexto, el término "esquizofrenia infantil" ganó aceptación y popularidad, aunque no todos los especialistas aceptaban esta definición ni con el grado de severidad que implicaba. Las aportaciones de Kanner (1943), a través de su artículo *Autistic Disturbances of Affective Contact*, y de Asperger (1944), mediante su informe *Die Autistischen Psychopathen im Kindesalter*, marcaron un punto de inflexión en la comprensión del autismo. Estos trabajos introdujeron un primer concepto y diagnóstico de lo que se denominaría "autismo infantil" o "psicopatía autista", incluyendo tanto casos asociados a lesiones orgánicas como otros que rondaban la normalidad.

Las innovaciones propuestas por Kanner y Asperger influyeron profundamente en la investigación posterior, sentando una base teórica más ampliamente aceptada. Ambos autores coincidieron en identificar en esta población un trastorno caracterizado por dificultades en el contacto afectivo y los instintos, problemas en la comunicación y la adaptación, así como la presencia frecuente de movimientos estereotipados (Artigas-Pallarès & Paula, 2012).

Entre 1963 y 1983, el TEA comenzó a considerarse un trastorno cognitivo. Durante este periodo, el término "síndrome autista" ganó relevancia, siendo formalmente definido por *The National Society for Autism Children* (Ritvo & Freeman, 1977), que proporcionó una descripción clínica detallada y los criterios necesarios para su diagnóstico. Posteriormente, la Organización Mundial de la Salud (OMS) refinó esta definición, destacando que el autismo se manifiesta desde el nacimiento o durante los primeros 30 meses de vida. Entre las características

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destacadas se encontraban respuestas atípicas a estímulos, junto con alteraciones graves en la comprensión y producción del lenguaje.

Estas aportaciones quedaron reflejadas en *Diagnostic and Statistical Manual of Mental Disorders, Third Edition* (DSM-III) (APA, 1983), marcando una evolución natural respecto a versiones anteriores. Este manual adoptó un enfoque descriptivo basado en la evidencia, introduciendo criterios más ajustados a la realidad clínica. En él, el término "psicosis infantil" fue sustituido por "trastorno de inicio en la infancia, niñez y adolescencia", clasificándose dentro de las afecciones generales del desarrollo como un síndrome psiquiátrico específico. Este se caracterizaba por déficits cualitativos en habilidades sociales, comunicación verbal y no verbal, y funciones simbólicas e imaginativas. Además, el autismo infantil fue categorizado según la presencia de un síndrome completo o en estado residual (Rosen et al., 2021).

Wing (1981) fue una de las pioneras en profundizar en el estudio del perfil de las personas con TEA, logrando identificar y definir tres núcleos fundamentales que caracterizan a esta población. Este modelo, conocido como la *tríada de Wing*, incluye:

- Un trastorno cualitativo en las relaciones con otras personas y con el entorno.
- Alteraciones en la comunicación, el lenguaje y el comportamiento.
- Una falta de flexibilidad mental, que se manifiesta en actividades obsesivas y repetitivas.

Además, en algunos casos, pueden observarse otros síntomas asociados, como alteraciones en la alimentación y los ciclos de sueño, dificultades en el desarrollo cognitivo y motor, cambios bruscos en el estado de ánimo, respuestas limitadas

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ante peligros reales y, en el extremo opuesto, miedos intensos a estímulos que no representan una amenaza (Rivière, 2010).

Con la publicación del *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV) (APA, 1994), el autismo pasó a ser considerado una entidad diferenciada de los trastornos generalizados del desarrollo. Este manual descartó clasificaciones anteriores y tuvo en cuenta tanto el nivel de desarrollo mental como la degradación conductual en esta población (Cuxart & Jané, 1998).

Finalmente, revisiones posteriores, como la publicada en el *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5) (APA, 2013), han consolidado la conceptualización actual del TEA como un trastorno del neurodesarrollo. Este marco teórico enfatiza la noción de "espectro" o "continuo autista", lo que pone de relieve la heterogeneidad en las manifestaciones clínicas y en los grados de afectación entre las personas con TEA (Gyawali & Patra, 2019). A continuación, se describen en detalle las principales características que definen esta variabilidad y los grados definidos por el DSM-5.

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2.2 Etiología del autismo

La etiología del TEA se considera multifactorial, destacando el papel de alteraciones neurológicas funcionales y estructurales de origen genético y epigenético (Reynoso et al., 2017; Tager-Flusberg & Joseph, 2003). No presenta diferencias demostrables en cuanto a su prevalencia en diversas culturas, regiones o clases sociales. Sin embargo, se ha establecido que el mayor riesgo de desarrollar este trastorno está asociado principalmente a influencias genéticas heredadas (Bai et al., 2019) y, en menor medida, a factores ambientales. Entre estos últimos, se destacan: a) edad avanzada de los padres en el momento de la concepción; b) complicaciones durante el parto, que pueden afectar el desarrollo neurológico; c) enfermedades inmunológicas experimentadas por la madre durante el embarazo;

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y/o d) exposición a altos niveles de contaminación ambiental, especialmente en el aire (Bhandari et al., 2020; Joon et al., 2021).

Históricamente, se ha visto una mayor incidencia en varones, siendo cuatro veces más frecuente que en mujeres, según lo señalado por autores como Fombonne (2005), Baird et al. (2006) o Bamicha y Drigas (2022) entre otros. Para explicar esta diferencia, se han planteado diversas teorías, como la posible implicación del cromosoma sexual en la etiología del TEA o el impacto de las influencias hormonales durante la gestación. No obstante, estas hipótesis aún carecen de confirmación definitiva. En la actualidad, las diferencias de prevalencia entre sexos parecen estar disminuyendo. Estudios recientes indican que las niñas suelen presentar un perfil más cercano al neurotípico en comparación con los niños, lo que puede llevar a errores diagnósticos o incluso a la ausencia de su detección en numerosos casos (Bourson & Prevost, 2024; Parish-Morris et al., 2017; Song et al., 2021).

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2.2.1 Fundamentos genéticos

Los avances en las tecnologías y métodos de estudio de variantes genéticas en el ser humano, como la hibridación in situ fluorescente (FISH), la tecnología de microarrays para cromosomas (CMA) o las resonancias magnéticas, han permitido identificar múltiples mutaciones genéticas asociadas al TEA. Estas incluyen tanto variaciones en pares de bases individuales, conocidas como variantes de un solo nucleótido (SNV), como alteraciones que afectan a numerosos pares de bases, denominadas variantes en el número de copias (CNV). Estas mutaciones contribuyen no solo a la aparición del TEA, sino también a otras enfermedades relacionadas con el fenotipo (Vorstman et al., 2017).

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Aunque está ampliamente reconocida la implicación de factores neurobiológicos en el desarrollo del TEA, aún no se ha logrado identificar una

etiopatogenia única y definitiva que explique su origen ni la amplia variabilidad clínica observada entre los casos. La evidencia acumulada sugiere que el TEA resulta de una compleja interacción entre factores genéticos y ambientales, con un fuerte peso del componente hereditario. No obstante, esta herencia es poligénica y heterogénea, lo que complica su comprensión y diagnóstico (Lord et al., 2020; Yuen et al., 2017).

En este contexto, múltiples estudios han identificado alteraciones en genes que desempeñan funciones críticas en el neurodesarrollo, la plasticidad sináptica y la organización cerebral. Chaste y Leboyer (2012), así como investigaciones más recientes como la de Benabdallah et al. (2022), han señalado mutaciones o disfunciones en varios genes clave

- MET: Este gen codifica una tirosina quinasa receptora involucrada en procesos de señalización intracelular, proliferación neuronal y supervivencia celular. Alteraciones en MET se han asociado con una disminución de la conectividad funcional en regiones cerebrales sociales como la corteza prefrontal medial.
- RELN: Codifica la reelina, una glicoproteína fundamental para la migración y la disposición adecuada de las neuronas durante la corticogénesis. Una disfunción en este gen puede afectar el patrón de organización laminar del cerebro.
- PTEN: Este gen actúa como regulador de la proliferación celular y la supervivencia neuronal. Mutaciones en PTEN han sido asociadas a macrocefalia, un rasgo físico frecuente en subtipos de TEA, así como a trastornos en la mielinización y en la organización cortical.
- SLC6A4: Responsable del transporte de serotonina, este gen regula la disponibilidad del neurotransmisor en la sinapsis. Alteraciones en el

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mismo se han relacionado con diferencias en la reactividad emocional y en los patrones de interacción social en personas con TEA.

- TSC1 y TSC2: Estos genes codifican las proteínas hamartina y tuberina, que regulan el crecimiento celular a través de la vía mTOR. Mutaciones en estos genes se asocian al complejo de esclerosis tuberosa, un trastorno con alta comorbilidad con el TEA.
- Genes reguladores de neuroliginas y neurexinas (NLGN, NRXN, SHANK): Estos genes juegan un papel crucial en la formación, mantenimiento y especificidad de las sinapsis excitadoras e inhibitorias. Su disfunción puede producir desequilibrios en la neurotransmisión, afectando directamente a los mecanismos de comunicación neuronal esenciales para las habilidades sociales y comunicativas.

Dentro de la búsqueda por comprender los mecanismos neurobiológicos subyacentes al TEA, dos teorías han adquirido especial relevancia en los últimos años: la teoría del sistema de las neuronas espejo y la teoría de la infraconectividad. Ambas aportan perspectivas complementarias sobre las posibles causas de las alteraciones en la cognición social, el lenguaje y la integración sensorial que caracterizan este trastorno del neurodesarrollo.

La teoría del sistema de neuronas espejo sostiene que una disfunción en este sistema cerebral podría ser clave para explicar las dificultades que presentan las personas con TEA en el área de la empatía, la imitación y la comprensión de las intenciones ajenas. Las neuronas espejo se activan tanto cuando una persona realiza una acción como cuando observa a otra ejecutarla, lo que sugiere un mecanismo neurofisiológico para la comprensión intuitiva de las acciones, emociones y estados mentales de los demás (Rizzolatti & Craighero, 2004).

Estudios neuroimagenológicos han mostrado que las personas con TEA presentan una activación reducida en regiones asociadas a este sistema, como la corteza premotora, el área de Broca y la corteza parietal inferior (Dapretto et al., 2006; Rizzolatti & Fabbri-Destro, 2010). Según esta hipótesis, el mal funcionamiento del sistema de neuronas espejo afectaría significativamente la capacidad de "leer" las emociones o intenciones en las expresiones faciales o corporales de los demás, dificultando el desarrollo de habilidades de reciprocidad social (Nguyen et al., 2021; Zhao et al., 2023). Este déficit también se ha vinculado con la alteración en la imitación motora y vocal, procesos esenciales en el desarrollo del lenguaje y el aprendizaje social durante la infancia (Ruggieri, 2013; Oberman & Ramachandran, 2007).

Por otro lado, la teoría de la infraconectividad plantea que muchas de las dificultades observadas en el TEA pueden deberse a una conectividad cerebral atípica, especialmente entre regiones distantes de la corteza cerebral. A diferencia de los modelos tradicionales basados en lesiones o disfunciones localizadas, esta teoría sugiere que el TEA se caracteriza por una hiperconectividad local y una hipoconectividad funcional entre redes corticales de largo alcance, lo cual compromete la integración global de la información (Just et al., 2004; Assaf et al., 2010).

A nivel estructural, se ha observado que los niños y niñas con TEA pueden presentar un exceso de volumen cerebral en etapas tempranas del desarrollo, así como una densidad inusualmente alta de espinas dendríticas en la corteza prefrontal, lo que podría dificultar la poda sináptica eficiente durante la maduración cerebral (Courchesne et al., 2011). Asimismo, se han reportado anomalías en la migración neuronal y en la mielinización de ciertas vías cerebrales, lo que impactaría directamente en la velocidad y eficacia de la comunicación entre

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distintas áreas corticales (Jurado & Bernal, 2011; Llorens Romea & Gabás Fajarnés, 2022).

Estas alteraciones no solo afectan a los procesos cognitivos superiores, como el lenguaje, la atención o la memoria de trabajo, sino también a la autorregulación emocional, la percepción multisensorial y la interpretación de los estados mentales propios y ajenos. La infraconectividad funcional puede, por tanto, contribuir a una visión fragmentada del mundo, dificultando la capacidad de atribuir significado a las experiencias y limitar la espontaneidad en la interacción comunicativa.

Cabe destacar que ambos modelos, el de las neuronas espejo y el de la infraconectividad, no son excluyentes, sino que podrían ser complementarios. Algunos investigadores plantean que la disfunción en el sistema de neuronas espejo podría estar mediada, en parte, por la conectividad atípica entre regiones cerebrales implicadas en el procesamiento social, lo que refuerza la hipótesis de una alteración de la integración de información entre regiones frontotemporales en personas con TEA (O'Reilly et al., 2017; Yerys et al., 2017).

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2.2.2 Fundamentos psicológicos

El estudio de las funciones ejecutivas resulta crucial para comprender los fundamentos psicológicos del TEA, ya que estas habilidades cognitivas de alto nivel son esenciales para regular el comportamiento, planificar, resolver problemas y adaptarse a nuevas situaciones. En las personas con TEA, las alteraciones en las funciones ejecutivas afectan áreas clave como la memoria de trabajo, la flexibilidad cognitiva, la inhibición de respuestas, la anticipación y la organización (Cristofori et al., 2019; Miyake et al., 2000; Pellicano, 2012). Dichas deficiencias contribuyen significativamente a los patrones conductuales característicos del TEA, como la rigidez en los intereses, las conductas repetitivas y las dificultades

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para adaptarse a entornos cambiantes. Además, estas alteraciones tienen un impacto directo en la capacidad para gestionar las demandas sociales y académicas, así como en la autonomía personal (Demetriou et al., 2019; Pérez-Pichardo et al., 2018).

Asimismo, diversas teorías psicológicas han sido desarrolladas para comprender los fundamentos del TEA, proporcionando un marco conceptual integral que permite abordar sus características cognitivas, emocionales y conductuales. Entre estas, destacan cuatro hipótesis fundamentales que siguen siendo de gran relevancia en la actualidad y que también contribuyen al diseño de intervenciones que aborden de manera específica las necesidades de esta población:

- Teoría de la Mente (Baron-Cohen et al., 1985).

La Teoría de la Mente (ToM, por sus siglas en inglés) hace referencia a la capacidad cognitiva que permite atribuir estados mentales —tales como creencias, deseos, intenciones y emociones— a uno mismo y a los demás. Esta habilidad resulta fundamental para comprender que los pensamientos de otras personas pueden diferir de los propios y, por tanto, para predecir y explicar su comportamiento. En personas con desarrollo típico, esta capacidad emerge en los primeros años de vida, alrededor de los 4 años de edad, y constituye un pilar para la socialización y el desarrollo del lenguaje pragmático (Wellman et al., 2001).

En el caso del TEA, múltiples investigaciones han documentado una alteración significativa en el desarrollo de la ToM. Los estudios pioneros de Baron-Cohen et al. (1985) demostraron que los niños con TEA presentaban dificultades notables para superar tareas clásicas de falsa creencia, lo que evidenciaba una limitación en su capacidad para entender que otras personas pueden tener creencias distintas, e incluso erróneas, sobre una situación. Esta limitación tiene

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consecuencias relevantes no solo en el plano cognitivo, sino también en el afectivo y social. Las personas con TEA pueden mostrar dificultades para interpretar ironías, comprender bromas o seguir el hilo de una conversación cuando esta requiere inferencias sobre estados mentales no explícitos (Tager-Flusberg, 2007).

El déficit en la ToM incide de forma directa en las habilidades socio-comunicativas. La dificultad para comprender y anticipar las intenciones y emociones ajenas limita la capacidad para participar en interacciones recíprocas, mantener la atención conjunta o adaptar el lenguaje al contexto social. Estas limitaciones se manifiestan desde edades tempranas y son especialmente visibles en entornos escolares o familiares, donde se espera que el niño sea capaz de compartir experiencias, entender normas implícitas o interpretar las emociones de quienes le rodean (Bamicha & Drigas, 2022).

Además, diversos autores han señalado que la ToM no debe entenderse como una habilidad unitaria, sino como un constructo complejo que incluye diferentes niveles de procesamiento: desde la ToM de primer orden (atribuir creencias simples) hasta la de segundo orden (atribuir creencias sobre creencias ajenas). Los niños con TEA suelen tener mayores dificultades a medida que se incrementa la complejidad de las tareas de atribución mental (Ozonoff et al., 1991). Asimismo, investigaciones recientes han propuesto que estas dificultades podrían no deberse únicamente a una alteración en el módulo cognitivo de la ToM, sino también a factores vinculados a la motivación social, el procesamiento ejecutivo o la integración multisensorial (Burnside et al., 2017; Chevallier et al., 2012).

Cabe destacar que no toda la población con TEA presenta el mismo grado de afectación en esta habilidad. En los últimos años, se ha evidenciado una gran variabilidad interindividual, con algunos perfiles que muestran un desarrollo parcial o compensado de la ToM, especialmente en personas con niveles altos de

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funcionamiento o con apoyos adecuados (Livingston et al., 2019). Esta variabilidad apoya la conceptualización del TEA como un espectro y refuerza la necesidad de intervenciones individualizadas que tengan en cuenta tanto los puntos fuertes como las áreas de dificultad de cada persona.

- Teoría de la intersubjetividad y alteraciones en la atención conjunta (Trevarthen, 1990).

La teoría de la intersubjetividad plantea que el desarrollo social y comunicativo temprano se sustenta en una capacidad innata para compartir estados afectivos, intenciones y experiencias con otras personas. Este proceso de sintonía emocional y cognitiva permite que los seres humanos establezcan relaciones significativas desde los primeros meses de vida, incluso antes del desarrollo del lenguaje verbal. La intersubjetividad implica la capacidad de establecer vínculos recíprocos mediante miradas, expresiones faciales, gestos y vocalizaciones, y constituye el fundamento sobre el cual se construyen competencias socioemocionales más complejas (Trevarthen & Aitken, 2001).

En el caso del TEA, diversos estudios han mostrado que este tipo de interacciones preverbales se encuentran profundamente afectadas. Desde edades tempranas, los niños con TEA manifiestan dificultades para participar en episodios de atención conjunta, es decir, para coordinar su foco atencional con otra persona hacia un objeto o evento de interés mutuo. Este tipo de atención compartida es crucial para el desarrollo del lenguaje, la regulación emocional y la comprensión de los estados mentales ajenos (Mundy & Newell, 2007). La ausencia o disminución de estos intercambios afectivos iniciales puede limitar la exposición a experiencias de aprendizaje social, lo que repercute en la adquisición de habilidades comunicativas tanto verbales como no verbales.

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La intersubjetividad se divide en dos niveles: la intersubjetividad primaria, que hace referencia a la interacción cara a cara entre el infante y el cuidador (presente desde los primeros meses de vida), y la intersubjetividad secundaria, que implica una relación triádica entre el niño, otra persona y un objeto o evento externo (Stern, 2018). Las personas con TEA presentan alteraciones significativas en ambos niveles, lo que sugiere un patrón de desarrollo atípico que va más allá de las dificultades lingüísticas. Estas limitaciones afectan su capacidad para establecer vínculos sociales profundos, interpretar las emociones de los demás de manera espontánea y participar en contextos comunicativos (Coronado, 2019; Hobson, 2004).

Otras investigaciones han asociado estas dificultades con diferencias en la conectividad de redes cerebrales implicadas en el procesamiento social, como la red de la teoría de la mente y el sistema de neuronas espejo, que estaría relacionado con la imitación y la empatía (Uddin et al., 2013). Estos hallazgos refuerzan la idea de que el TEA no se limita a un déficit cognitivo aislado, sino que implica una alteración en los procesos básicos que permiten la conexión interpersonal desde los primeros momentos del desarrollo. Además, la alteración en la atención conjunta no solo tiene implicaciones en la adquisición del lenguaje, sino también en la construcción del sentido del "otro" como agente independiente. La incapacidad para compartir experiencias de manera fluida y espontánea limita el desarrollo de habilidades metacognitivas y la comprensión de normas sociales, aspectos fundamentales para la adaptación al entorno escolar, familiar y comunitario (Bruner, 1995; Adamson et al., 2019).

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- Teoría de la coherencia central débil (Happé & Frith, 2006).

Esta teoría sostiene que las personas con TEA presentan un estilo cognitivo caracterizado por una tendencia a centrarse en los detalles locales de la

información, en detrimento de la integración global o gestáltica de los estímulos. En otras palabras, este enfoque cognitivo se manifiesta como una debilidad para procesar la información de manera holística, lo que puede dificultar la comprensión del contexto general, las intenciones subyacentes en la comunicación o el sentido amplio de una situación social.

Este sesgo hacia el procesamiento de detalles específicos tiene implicaciones en diversas áreas del funcionamiento cognitivo. Por ejemplo, en tareas perceptivas o visoespaciales, como la figura de bloques del WISC (Wechsler, 2015) o la prueba de la figura oculta, las personas con TEA suelen obtener rendimientos superiores a la media, precisamente porque no se ven influenciadas por la percepción global del estímulo y pueden identificar más fácilmente los elementos individuales que lo componen (Shah & Frith, 1983; Mottron et al., 2006). No obstante, esta habilidad se convierte en una limitación cuando se requiere la comprensión de situaciones sociales complejas, la interpretación del discurso implícito o el reconocimiento de patrones contextuales en la vida cotidiana.

La coherencia central puede entenderse como una predisposición natural del sistema cognitivo humano a organizar la información entrante de forma coherente, integrando múltiples fuentes de datos en una representación unificada y significativa. Esta capacidad permite interpretar el lenguaje más allá de su significado literal, captar ironías, comprender narraciones o identificar emociones sutiles en una conversación (Happé & Frith, 2006). La debilidad en este proceso integrador en las personas con TEA podría explicar muchas de sus dificultades pragmáticas y sociales, así como su preferencia por entornos estructurados y predecibles. No obstante, lejos de interpretarse únicamente como un déficit, esta teoría también ha contribuido a una visión más equilibrada del perfil cognitivo del TEA, destacando sus fortalezas en tareas que requieren atención al detalle, pensamiento sistemático o memoria visual (Baron-Cohen et al., 2009).

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Algunos estudios han cuestionado la universalidad del modelo, señalando que no todas las personas con TEA muestran una coherencia central débil, y que esta puede variar según el nivel cognitivo, el perfil clínico o el contexto de evaluación (Van der Hallen et al., 2015). En este sentido, se plantea que esta característica cognitiva debe considerarse como un continuo dimensional, más que como un rasgo categórico, lo que se alinea con los enfoques actuales del espectro como una condición heterogénea.

- Teoría de la disfunción ejecutiva (Ozonoff et al., 2000).

La teoría de la disfunción ejecutiva ha sido una de las propuestas más influyentes para explicar algunas de las características nucleares del TEA, especialmente aquellas relacionadas con los comportamientos repetitivos, la rigidez cognitiva y las dificultades para adaptarse a entornos cambiantes (Ozonoff et al., 2000). Este enfoque sostiene que muchas de las manifestaciones observadas en las personas con TEA pueden entenderse como resultado de alteraciones en las funciones ejecutivas, lo que repercute de manera directa en su desempeño cotidiano. Por ejemplo, la dificultad para inhibir respuestas puede traducirse en comportamientos impulsivos o repetitivos; la rigidez mental, en resistencia a los cambios; y las limitaciones en la planificación, en problemas para organizar tareas complejas o anticipar consecuencias (Paula Pérez & Martos, 2011).

Una de las características más destacadas del TEA, la presencia de patrones de conducta estereotipados y repetitivos, ha sido interpretada dentro de este marco teórico como una manifestación de una pobre flexibilidad cognitiva (Hill, 2004). Esta dificultad se traduce en una tendencia a mantener rutinas estrictas, a perseverar en temas de interés restringido o a presentar malestar significativo ante situaciones nuevas o inesperadas. Del mismo modo, las dificultades en memoria de trabajo pueden afectar la comprensión de instrucciones largas o el

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seguimiento de conversaciones complejas, interfiriendo tanto en el rendimiento académico como en las interacciones sociales (Russell, 1997).

Estudios neuropsicológicos han respaldado esta teoría al identificar disfunciones en los circuitos frontoestriatales del cerebro, especialmente en la corteza prefrontal dorsolateral, una región estrechamente vinculada a la ejecución de tareas que requieren control voluntario del comportamiento (Schmitz et al., 2006). Estas evidencias sugieren que el TEA no solo implica alteraciones en el procesamiento social, sino también en los mecanismos de regulación cognitiva interna, lo que podría explicar la coexistencia frecuente de este trastorno con otras condiciones como la ansiedad o la hiperactividad.

Aunque la teoría de la disfunción ejecutiva ha ofrecido una perspectiva útil y bien fundamentada para comprender muchas de las dificultades asociadas al TEA, no explica por sí sola la totalidad del perfil. De hecho, se ha señalado que este tipo de alteraciones también puede observarse en otras condiciones neuropsicológicas, lo que pone en cuestión su especificidad diagnóstica (Pennington & Ozonoff, 1996). Además, existe una notable variabilidad en la manifestación de estos déficits dentro del propio espectro, lo que sugiere la necesidad de integrar esta teoría con otros modelos explicativos, como la teoría de la mente o la coherencia central débil, para lograr una comprensión más completa del TEA.

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2.3 Síntomas durante el desarrollo

La sintomatología del TEA presenta un patrón evolutivo caracterizado por su variabilidad, lo que impide establecer un modelo de conducta universal y fijo. En este contexto, Uclés (2015) sugiere una diferenciación en tres estadios específicos del desarrollo durante los primeros 18 meses de vida, los cuales representan hitos clave en el progreso evolutivo temprano (Tabla 1).

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Tabla 1

Estadios del desarrollo temprano y patrones asociados al TEA

Estadio	Edad	Características principales	Indicadores relevantes
Primario	0-9 meses	Desarrollo de la intersubjetividad primaria mediante interacción cara a cara e imitación.	Ausencia de conductas comunicativas intencionadas; tranquilidad expresiva o llantos sin motivo aparente.
Secundario	9-18 meses	Transición hacia la intersubjetividad secundaria con interés por objetos y sucesos del entorno, promoviendo interacción tríadica y acciones conjuntas.	Carencia o limitación de conductas protodeclarativas, dificultades en la teoría de la mente. Ausencia de habilidades como señalar para dirigir la atención, alternar la mirada entre un objeto y una persona, y seguir gestos indicativos.
Terciario	A partir de 18 meses	Evidencias más claras de alteraciones en los patrones normales de desarrollo, incluyendo comunicación, lenguaje y relaciones sociales.	Alejamiento de las relaciones sociales, falta de intencionalidad, ignorar a iguales, alteración del lenguaje expresivo (pobreza, ecolalia) y receptivo (sordera aparente). Ausencia de juego funcional o simbólico, contacto ocular limitado, y dificultades de simbolización.

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Los primeros signos de alerta suelen manifestarse con mayor magnitud en los niños y niñas a partir de los 9 meses de edad, cuando se observa una falta de iniciativa en las relaciones interpersonales y en las respuestas sociales. Estas

señales se hacen más evidentes hacia los 18 meses, momento en el que pueden aparecer ausencia o limitaciones significativas en el lenguaje y la comunicación.

De hecho, uno de los síntomas más comunes en el TEA son los problemas asociados con la integración del lenguaje verbal y no verbal (Alcalá & Ochoa, 2022). Las habilidades lingüísticas en las primeras etapas del desarrollo se consideran un predictor clave del desempeño social, el rendimiento académico y los resultados psiquiátricos tanto en la infancia tardía como en la adultez (Paul & Cohen, 1984; Vogindroukas et al., 2022).

En este sentido, las dificultades en el desarrollo temprano del habla suelen ser una de las primeras inquietudes expresadas por los padres y representan una de las causas más habituales de derivación a servicios clínicos (Durrleman et al., 2015; Short & Schopler, 1988; Yeganeh & Kamari, 2020). Sin embargo, en muchos casos, los adultos no identifican estos indicadores tempranos debido a la falta de conciencia sobre el TEA, lo que conlleva retrasos en su detección y, en consecuencia, en la intervención adecuada. Por lo general, el diagnóstico se realiza a partir del segundo año de vida, cuando emergen síntomas más evidentes que afectan de forma significativa a la vida cotidiana del niño en diversos contextos (Shen & Piven, 2017).

Entre los 18 meses y los 5 años, las limitaciones propias del TEA tienden a desarrollarse con mayor claridad. En esta etapa, es frecuente la aparición de las primeras estereotipias, un aislamiento generalizado, y dificultades marcadas en las interacciones relacionadas con el juego y la comunicación. Desde los 5 años hasta la adolescencia y la edad adulta, la evolución de las personas con TEA presenta una marcada heterogeneidad (Hobson & Petty, 2021; Wang et al., 2023). Este desarrollo desigual depende, en gran medida, de las intervenciones recibidas, así como de la influencia de las rutinas y los comportamientos propios del

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individuo. Además, durante estas etapas, es común la aparición de comorbilidades como la epilepsia, la depresión y la hiperactividad, las cuales pueden impactar de manera significativa en su calidad de vida (Lai, 2022).

Las discrepancias entre el nivel de lenguaje alcanzado y el grado de comunicación funcional varían entre las personas con TEA. Estas limitaciones se hacen evidentes en contextos que demandan habilidades sociales o interactivas, donde esta población enfrenta importantes dificultades para cumplir con las expectativas comunicativas. Es posible afirmar que, concretamente, los niños con TEA tienden a mostrar un patrón disarmónico en el desarrollo del lenguaje, caracterizado por contrastes significativos en los diferentes niveles de forma, contenido y uso. Los déficits lingüísticos más destacados durante el periodo crítico del desarrollo se evidencian en varias etapas clave: las habilidades prelingüísticas (11-14 meses), la expansión del vocabulario (a partir de los 18 meses), la construcción de frases productivas (18-20 meses), la adquisición del lenguaje de referencia mental, la capacidad para ajustar el lenguaje a diferentes situaciones y contribuir activamente a la conversación, la comprensión del uso no literal del lenguaje y la función autorreguladora del lenguaje (3-4 años) (Backes et al., 2017).

2.4 Abordaje del TEA

2.4.1 Proceso de evaluación

La identificación temprana del TEA es fundamental para garantizar que los niños puedan acceder a intervenciones especializadas que les permitan mejorar su calidad de vida. Detectar el trastorno a edades tempranas posibilita no solo una intervención más eficaz, sino también la identificación de posibles comorbilidades, lo que resulta fundamental para implementar un tratamiento integral. Sin embargo, el TEA constituye un diagnóstico complejo que requiere un proceso de evaluación continuo, caracterizado por un enfoque prescriptivo y multiaxial

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(Mukherjee, 2017). En España, es poco frecuente que los niños con sospecha de TEA sean derivados a servicios especializados antes de los tres años. Diversos estudios indican que existe un intervalo de tiempo considerable, entre 13 y 60 meses, entre las primeras sospechas de los padres y la obtención de un diagnóstico definitivo. Aunque estas sospechas suelen manifestarse entre los 12 y 23 meses de edad, el diagnóstico específico no suele realizarse hasta los 52-60 meses (Cortez Bellotti de Oliveira & Contrera, 2007; Sevilla et al., 2014).

Este proceso se basa en la observación sistemática de carencias conductuales en tres áreas clave: la interacción social, las habilidades comunicativas y el rango de actividades e intereses, que suelen ser los signos de alarma más evidentes en los primeros meses de vida (Huerta & Lord, 2012). El procedimiento de evaluación se desarrolla generalmente en dos etapas principales. La primera consiste en una monitorización constante del desarrollo del niño, realizada por profesionales como pediatras, psicólogos especializados o expertos en salud infantil, quienes identifican posibles irregularidades. La segunda etapa implica una evaluación más exhaustiva por parte de un equipo multidisciplinar de especialistas, cuyo objetivo es emitir un diagnóstico diferencial (Braiden et al., 2010; González-Mercado et al., 2016).

Para esta población, se recomienda emplear un enfoque cualitativo en la evaluación, utilizando observaciones directas y registros sistemáticos que permitan determinar y controlar el nivel de desarrollo y progreso de la persona con TEA. Esto facilita la identificación de las áreas afectadas y orienta el diseño de las intervenciones necesarias. Paralelamente, también es posible complementar el análisis con un enfoque cuantitativo, utilizando técnicas e instrumentos específicos que evalúan el rendimiento de la persona y permiten realizar comparaciones intraindividuo. Sin embargo, este enfoque cuantitativo por sí solo no resulta suficiente para obtener una valoración completa (Calderón, 2001).

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La evaluación final se basa en la integración de los resultados obtenidos durante el proceso de monitorización continua, que proporciona una visión precisa de la situación real de la persona con TEA. Para ello, se emplean diversas herramientas como escalas de cribado, entrevistas estructuradas y pruebas centradas en el desarrollo general. Entre estas herramientas destacan las siguientes: Escala de comportamiento adaptativo

- Escala de Comportamiento Adaptativo Víneland-3 (Sparrow et al., 2016): Evalúa la conducta adaptativa desde el nacimiento hasta la edad adulta a través de cinco dominios: comunicación, habilidades de la vida diaria, socialización, habilidades motoras, y conducta adaptativa
- Inventario IDEA (Rivière, 2002): Mide la severidad de los rasgos del TEA, ayudando en el diagnóstico y el diseño de estrategias de tratamiento, evaluando dimensiones como la socialización, la comunicación, la flexibilidad y la simbolización.
- Test de Inteligencia No Verbal, TONI-4 (Brown et al., 2019): Evalúa la inteligencia no verbal, especialmente en contextos no verbales, a través de pruebas de razonamiento y resolución de problemas.
- Cuestionario M-CHAT (Robins et al., 2009): Dirigido a padres o tutores de niños de 16 a 30 meses, con el objetivo de detectar signos tempranos del TEA, especialmente en la comunicación no verbal y el uso de la mirada.
- Escala ADOS-2 (Lord et al., 2015): Herramienta observacional semiestructurada que evalúa la comunicación, interacción social y juego imaginativo en niños desde los 12 meses hasta adultos.
- Escala CARS (Schopler et al., 1988): Mide 15 ítems del comportamiento del TEA, tales como la relación social, la imitación,

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el uso del cuerpo y los objetos, la comunicación, la respuesta a cambios y estímulos, y la ansiedad.

- Cuestionario SCQ (Rutter et al., 2019): Cuestionario de screening breve para padres, que evalúa la comunicación social y las conductas restringidas y repetitivas, dirigido a niños a partir de los 4 años.
- Test ADI-R (Rutter et al., 2011): Entrevista clínica para padres o tutores que explora áreas como el lenguaje, las interacciones sociales y las conductas repetitivas, útil para el diagnóstico y evaluación del TEA (Frigaux et al., 2019).

2.4.1.1 Comorbilidades asociadas

La evaluación y el diagnóstico diferencial en el TEA se enfrenta a importantes desafíos debido a la alta prevalencia de trastornos concurrentes, que pueden compartir síntomas y dificultar una evaluación precisa. Estas comorbilidades suelen influir en la presentación clínica del TEA, aumentando su complejidad y, en ocasiones, enmascarando características propias del trastorno (Brentani et al., 2013; Casanova et al., 2020; Lordan et al., 2021; Maenner, 2021). Entre las comorbilidades más frecuentes se encuentran:

- Trastorno por déficit de atención e hiperactividad (TDAH).

El TDAH es un trastorno del neurodesarrollo de origen multifactorial y diagnóstico clínico, el cual se caracteriza por déficits en la atención, hiperactividad e impulsividad. Las funciones ejecutivas se encuentran alteradas en el TDAH, lo que genera dificultades para planificar, organizar y reflexionar sobre tareas o conductas específicas. Esta afectación de las funciones ejecutivas comparte similitudes con algunas características del TEA, lo que complica el diagnóstico diferencial (Rusca-Jordán & Cortez-Vergara, 2020).

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- Discapacidad intelectual (DI) o discapacidad de aprendizaje.

La DI, originada por alteraciones en el neurodesarrollo, es una condición permanente que impacta el comportamiento, las habilidades sociales y la comunicación, dependiendo del grado de afectación cognitiva (Chiurazzi et al., 2020). Se calcula que más de un tercio de las personas con TEA también presentan DI, lo que hace imprescindible un diagnóstico exhaustivo y detallado, el cual está estrechamente vinculado a la disponibilidad de recursos y a factores sociodemográficos (Katusic et al., 2021; Shenouda et al., 2023). La DI también se la conoce como "discapacidad de aprendizaje" (en inglés: "*learning disability*"), un término que en la actualidad se considera más adecuado y con una connotación más positiva (Cluley, 2018).

- Trastorno bipolar.

Este trastorno del estado de ánimo tiene un impacto significativo en la calidad de vida de la persona y su entorno. Se caracteriza por episodios alternantes de estados depresivos y maníacos, junto con altos niveles de ansiedad, temor o alegría esporádica, entre otras manifestaciones (Borue et al., 2016).

- Trastorno obsesivo compulsivo (TOC).

El TOC se define por la presencia de impulsos o pensamientos obsesivos recurrentes e indeseados. Su diagnóstico diferencial en personas con TEA es especialmente complicado, ya que los patrones de comportamiento, actividades e intereses restringidos y estereotipados del TEA pueden confundirse con los síntomas obsesivo-compulsivos característicos del TOC (Paula-Pérez, 2013).

- Dispraxia.

Esta alteración psicomotriz, que se origina en la infancia, causa lentitud en los movimientos y falta de coordinación entre diferentes grupos musculares. La

dispraxia afecta tanto a la motricidad fina como a la gruesa, impactando significativamente en actividades de la vida cotidiana e interfiriendo en el desarrollo del lenguaje, así como en otras habilidades sociales, conductuales y motoras. Estos efectos sugieren que la dispraxia podría constituir un elemento central del TEA o bien actuar como un marcador de las anomalías neurológicas subyacentes al mismo (Dziuk et al., 2007; MacNeil & Mostofsky, 2012).

- Trastorno gastrointestinal.

Las alteraciones gastrointestinales en el TEA pueden ser resultado de diferentes factores, como el uso excesivo de antibióticos que afectan el microbiota intestinal, o pueden estar relacionadas con la rigidez cognitiva, las dificultades en la coherencia central y las alteraciones emocionales y sociales. Estas complicaciones reflejan la interacción entre aspectos biológicos y conductuales en el TEA (Gallego Vicente, 2019).

2.4.2 Proceso de intervención

El proceso de intervención en personas con TEA debe ser cuidadosamente elaborado, variado y altamente estructurado, considerando la amplia diversidad de síntomas que pueden manifestar. Entre los métodos de intervención más destacados se encuentra el Análisis Conductual Aplicado (ABA), que facilita el aprendizaje de nuevas habilidades y la reducción de comportamientos no deseados a partir de la influencia del entorno de la persona (Eckes et al., 2023). Asimismo, el uso de historias sociales resulta especialmente útil para proporcionar guiones visuales que ayuden a la persona a comprender cómo actuar en diferentes situaciones y a desenvolverse adecuadamente en su entorno natural (Sanz et al., 2018). Las estrategias de intervención (Tabla 2) deben centrarse en abordar los síntomas más afectados, organizándose en tres grandes enfoques: Psicodinámico, biomédico y psicoeducativo (Mulas et al., 2010; Sala, 2016).

Tabla 2

Principales enfoques de intervención en el TEA

Enfoque	Descripción	Áreas de intervención
Psicodinámico	Aborda las bases emocionales y cognitivas afectadas en las personas con TEA.	- Teoría de la Mente: Comprensión de creencias, deseos y sentimientos ajenos. - Funciones ejecutivas: Autocontrol, planificación, memoria de trabajo, flexibilidad cognitiva. - Coherencia central: Integración e interpretación social.
Biomédico	Trata síntomas asociados al TEA, como epilepsia, alteraciones del sueño o problemas conductuales.	- Epilepsia. - Alteraciones del sueño. - Conductas oposicionistas, rabietas o agresividad. - Dificultades en la adaptación al cambio o a nuevas tareas.
Psicoeducativo	Se centra en intervenciones conductuales y evolutivas, adaptadas a las necesidades específicas de la persona.	- Intervenciones basadas en la familia. - Terapias orientadas al desarrollo de la comunicación. - Actividades para mejorar habilidades sensoriomotoras.

Nota. TEA: Trastorno del espectro autista.

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2.5 Características principales según el DSM-5

El DSM-5 (APA, 2013), actualmente el manual más actualizado y utilizado para el diagnóstico de trastornos mentales, especifica que las personas con TEA se caracterizan por mostrar un desarrollo marcadamente anómalo o deficitario en la interacción social y la comunicación, acompañado de un repertorio muy restringido de actividades e intereses (Rosen et al., 2021). Dicho manual clasifica

el TEA dentro de los trastornos del neurodesarrollo e incluye los siguientes criterios diagnósticos:

- Déficits persistentes en la comunicación y la interacción social en diversos contextos, que se manifiestan en: a) deficiencias en la reciprocidad socioemocional, como acercamientos sociales inadecuados y conversaciones erráticas; b) anomalías en las conductas comunicativas no verbales, como el contacto visual atípico o problemas en el lenguaje corporal; c) dificultades para comprender y mantener relaciones sociales, como la falta de interés hacia otras personas; y d) incapacidad para adaptar el comportamiento a diferentes contextos sociales.
- Patrones repetitivos y restrictivos de comportamiento, actividades o intereses, que pueden incluir: a) movimientos repetitivos o estereotipados, como gestos repetitivos o uso ritualizado del habla; b) uso repetitivo de objetos o fijaciones en rutinas inflexibles; c) intereses altamente restringidos o apego excesivo a objetos específicos; d) reacciones sensoriales inusuales, como hiper o hiposensibilidad a estímulos.
- Inicio temprano de los síntomas, presentes en las primeras etapas del desarrollo. Sin embargo, estos pueden no ser evidentes hasta que las demandas sociales superan las capacidades de la persona.
- Impacto clínicamente significativo en las áreas social, escolar y/o laboral, con limitaciones y alteraciones funcionales.
- Ausencia de explicaciones alternativas más adecuadas, como una discapacidad intelectual o un retraso global del desarrollo.

Dado que las características de la población con TEA pueden variar significativamente entre personas, en el pasado se podía utilizar una clasificación

en dos grandes grupos para facilitar la evaluación: TEA de bajo funcionamiento (TEA-BF) y TEA de alto funcionamiento (TEA-AF): El TEA-BF se caracterizaba por un coeficiente intelectual inferior a 70, estereotipias motoras frecuentes, una notable reducción en la capacidad de imitación social y comprensión del lenguaje, problemas sensoriales y un retraso adaptativo generalizado. El TEA-AF se refería a personas con un coeficiente intelectual verbal y no verbal superior a 70. Presentaban dificultades en la prosodia y la conciencia pragmática, así como una insistencia en conductas perseverativas (O'Brien & Pearson, 2004; Venter et al., 1992). No obstante, esta clasificación es actualmente considerada poco exacta y ha sido excluida del DSM-5, entre otras cuestiones, por la falta de consenso sobre la diferenciación clara entre las dos categorías (Lord et al., 2018; Volkmar et al., 2012).

El DSM-5 propone un modelo basado en tres niveles de gravedad, que evalúan el grado de apoyo requerido y se alinean con las necesidades específicas de cada persona (APA, 2013): Grado 3: "Necesita ayuda muy notable" (*Level 3: "Requiring very substantial support"*); Grado 2: "Necesita ayuda notable" (*Level 2: "Requiring substantial support"*); y Grado 1: "Necesita ayuda" (*Level 1: "Requiring support"*) (Tabla 3).

En relación con las actualizaciones más recientes del DSM-5, este manual incluye al síndrome de Asperger dentro de la categoría del TEA. El síndrome de Asperger se define como un trastorno del desarrollo que provoca alteraciones en la interacción social recíproca, en la comunicación verbal y no verbal, en la flexibilidad del pensamiento y en la capacidad para aceptar cambios o intereses alternativos (Motlani et al., 2022). Sin embargo, las alteraciones cognitivas asociadas dependerán del grado de afectación, permitiendo en algunos casos la presencia de habilidades comunicativas avanzadas y un nivel elevado de vocabulario (Parraga et al., 2019).

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Tabla 3

Clasificación del TEA según niveles de gravedad del DSM-5

Gravedad	Descripción
Grado 3: Necesita ayuda muy notable	Se observan deficiencias graves en la comunicación verbal y no verbal, con interacciones sociales muy limitadas y respuestas mínimas ante otros. Las interacciones sociales suelen estar restringidas a satisfacer necesidades inmediatas o en situaciones muy específicas. El lenguaje puede ser reducido y contener pocas palabras inteligibles. A nivel conductual, se evidencia una marcada inflexibilidad, gran dificultad para adaptarse a los cambios, y rutinas restringidas o repetitivas que limitan significativamente el funcionamiento diario.
Grado 2: Necesita ayuda notable	Existen deficiencias notables en la comunicación verbal y no verbal, lo que ocasiona dificultades en el inicio de interacciones sociales y respuestas limitadas o atípicas. El lenguaje utilizado suele consistir en frases simples. Conductualmente, se observan dificultades considerables para enfrentar cambios, con patrones de comportamiento restringidos o repetitivos que interfieren en diferentes contextos sociales y personales.
Grado 1: Necesita ayuda	Se presentan diferencias en la comunicación social que dificultan el inicio de interacciones y provocan que las respuestas sean atípicas o insatisfactorias. Aunque el lenguaje está compuesto por frases completas, pueden ocurrir errores durante las conversaciones. El comportamiento se caracteriza por cierta inflexibilidad, dificultad para alternar entre actividades y problemas de planificación, lo que afecta a la autonomía personal.

Además, otras patologías incluidas en la clasificación de TEA según el DSM-5 son las siguientes:

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- Trastorno Desintegrativo Infantil o Síndrome de Heller.

Este trastorno se caracteriza por una pérdida drástica y tardía del funcionamiento conductual y del desarrollo (Hidalgo Vicario & Rodríguez Hernández, 2013). Generalmente, se manifiesta como una regresión repentina en el desarrollo que ocurre alrededor de los dos años, acompañada por la aparición de síntomas típicos del TEA (Pírez et al., 2019).

- Trastorno Generalizado del Desarrollo no Especificado (TGD).

Este término hace referencia a niños que presentan alteraciones en el desarrollo social y en sus intereses, así como la presencia de estereotipias y conductas inadecuadas que suelen manifestarse antes del tercer año de vida. No obstante, estos casos no cumplen con todos los criterios diagnósticos de los trastornos previamente mencionados (Sandoval et al., 2012).

- Síndrome de Rett.

Se trata de un trastorno neurológico que afecta de manera predominante al cromosoma X, razón por la cual se presenta principalmente en niñas. Este síndrome provoca un deterioro progresivo en el desarrollo del lenguaje y las habilidades motoras (Ramírez et al., 2021).

2.6 Comunicación y TEA

El lenguaje constituye la forma de expresión más común en un idioma, y los recién nacidos tienen la capacidad de reconocerlo desde lo que escuchan a su alrededor para adquirirlo progresivamente, utilizando como herramienta principal la alfabetización. La efectividad de los intercambios comunicativos dependerá, por tanto, de la comprensión del mensaje, su retención y la capacidad de compartirlo mediante su producción (Goodman, 1992). Los niños con un desarrollo normotípico son capaces de participar de manera activa en interacciones sociales,

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adquiriendo un amplio vocabulario que formará su léxico durante su desarrollo. Además, emplean espontáneamente oraciones complejas, amplían su conciencia fonológica y dominan los símbolos sonoros, habilidades esenciales para aprender a leer y escribir (Gleason & Ratner, 2010).

Las dificultades en el lenguaje y la comunicación varían significativamente en función del grado de severidad del TEA, como se puede apreciar en el Grado 2 y Grado 1 (Tabla 4). En los casos de Grado 1, donde las personas pueden desarrollar un lenguaje oral funcional, suelen presentar alteraciones significativas, especialmente a nivel semántico-pragmático, tanto en la comprensión como en el uso literal del lenguaje. Estas dificultades incluyen problemas para iniciar interacciones, comprender reglas y turnos conversacionales, proporcionar retroalimentación al interlocutor, utilizar referencias no compartidas, el uso de emisiones o frases estereotipadas y emplear gestos comunicativos de manera efectiva (Kelley et al., 2006; Logan et al., 2017).

Además, su desarrollo fonológico, morfosintáctico y semántico tiende a ser lento, tardío y relativamente simple, mientras que el desarrollo pragmático presenta limitaciones en la capacidad auto-reflexiva, espontaneidad y respeto de turnos y normas socio-comunicativas, así como alteraciones en el tono, ritmo y acento del habla, dificultando aún más la interacción social (Carrero Barril, 2025; Eigsti et al., 2016; Fein et al., 2013; Muñoz Burillo, 2020).

A medida que aumenta la severidad del TEA, estas dificultades se acentúan, dando lugar a un mayor deterioro en la comunicación. En los casos de Grado 2, las alteraciones pragmáticas se combinan con un uso más restringido del lenguaje, mayor presencia de ecolalia y dificultades significativas en la comprensión del lenguaje figurado y en la expresión mediante gestos y expresiones faciales (APA, 2013).

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Tabla 4

Características lingüísticas y comunicativas del TEA de Grado 2 y Grado 1

Grado de severidad	Características
Grado 2	- Vocabulario limitado basado en representaciones simbólicas simples. - Presencia de ecolalias funcionales, utilizadas con un propósito comunicativo claro (por ejemplo: responder preguntas, hacer solicitudes o comentar). - Comprensión limitada a palabras aisladas y órdenes simples, con escasas habilidades para interpretar enunciados más complejos. - Predominio de una comunicación de tipo imperativo, caracterizada por solicitudes y mandatos, con ausencia de interacciones de tipo protodeclarativo.
Grado 1	- Iniciativa comunicativa escasa y poca fluidez en las interacciones. - Uso limitado de funciones comunicativas, frecuentemente mediante ecolalias compuestas por frases memorizadas. - Morfosintaxis con desarrollo parcial, pero sin uso de conceptos abstractos ni verbos mentalistas (por ejemplo: “pensar” o “creer”). - Dificultades para diferenciar entre información relevante e irrelevante en contextos comunicativos. - Comprensión literal del lenguaje, con problemas para interpretar figuras retóricas, metáforas o ironías. - Ineficacia conversacional y alteraciones pragmáticas. - Ausencia de habilidades de engaño, lo que resulta en una comunicación excesivamente sincera e ingenua, incluso en temas sociales o sensibles.

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Cuando las habilidades comunicativas se encuentran completamente afectadas, pueden derivar en limitaciones severas, especialmente en aquellos casos clasificados como TEA de Grado 3 con necesidades complejas de comunicación (Tabla 5). En estas situaciones se evidencian déficits significativos en el habla, la comunicación no verbal, la ampliación del vocabulario y la capacidad de responder correctamente a las interacciones con uno o varios interlocutores. Estas dificultades no solo repercuten de manera negativa en las habilidades sociales durante las situaciones cotidianas, sino que también pueden influir directamente en el comportamiento de la persona y sus efectos pueden extenderse a lo largo de todas las fases del desarrollo (Iacono et al., 2016; Torrens & Ruiz, 2021; Velarde-Incháustegui et al., 2021; Wang et al., 2023). La correcta percepción de la información contextual que reciben estas personas también se encuentra alterada, lo que afecta su capacidad para procesar gestos, expresiones faciales y tono de voz. Estos elementos son fundamentales para la comprensión del lenguaje y para establecer una interacción recíproca efectiva (Shen & Piven, 2017).

En línea con lo expuesto anteriormente, las alteraciones graves del habla o su ausencia total suelen ir acompañadas de una intención comunicativa baja o inexistente, lo que dificulta significativamente la enseñanza de estrategias de comunicación. Estas dificultades ocasionan respuestas inexactas a retroalimentaciones que se basan exclusivamente en palabras habladas, generando intercambios comunicativos con errores, poca receptividad y frecuentes malentendidos. Esto, a su vez, afecta negativamente a elementos fundamentales para la interacción, como la motivación, el interés o la iniciativa para comunicarse, debido a la falta de refuerzos naturales y espontáneos (Holyfield et al., 2017). Como consecuencia, los vínculos sociales y los procesos de aprendizaje se ven comprometidos, lo que ralentiza la expansión de las capacidades cognitivas y

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puede conducir a limitaciones en la interacción dentro de la sociedad (Drager et al., 2010).

Tabla 5

Características lingüísticas y comunicativas del TEA de Grado 3

Grado de severidad	Características
Grado 3	- Mutismo o uso predominante de ecolalias no comunicativas. - Dificultades severas en la comprensión del lenguaje, incluso en contextos altamente estructurados. - Requiere la implementación de sistemas de comunicación aumentativa o alternativa (CAA) para posibilitar el intercambio comunicativo básico. - Respuesta mínima o nula a intentos comunicativos iniciados por otros, con escasa capacidad para mantener contacto visual durante las interacciones. - Falta de reciprocidad comunicativa. - Poca o nula capacidad para interpretar gestos, expresiones faciales o señales no verbales de los interlocutores. - Predominio de conductas repetitivas o ritualizadas como medio de expresión o de manejo de frustraciones, que interfieren en el desarrollo del lenguaje funcional. - Ausencia de intencionalidad comunicativa espontánea, limitándose a emitir sonidos o gestos únicamente como respuesta a necesidades básicas.

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Dichas características ocasionan respuestas inexactas a retroalimentaciones que se basan exclusivamente en palabras habladas, generando intercambios comunicativos con errores, poca receptividad y frecuentes malentendidos. Esto, a su vez, afecta negativamente a elementos fundamentales para la interacción, como

la motivación, el interés o la iniciativa para comunicarse, debido a la falta de refuerzos naturales y espontáneos (Holyfield et al., 2017). Como consecuencia, los vínculos sociales y los procesos de aprendizaje se ven comprometidos, lo que ralentiza la expansión de las capacidades cognitivas y puede conducir a limitaciones en la interacción dentro de la sociedad (Drager et al., 2010).

A pesar de estas dificultades, estudios recientes sugieren que el nivel de comprensión del lenguaje en esta población tiende a ser superior al nivel de expresión, aunque esta ventaja no suele desarrollarse adecuadamente de manera autónoma (Plesa Skwerer et al., 2016). Asimismo, se ha evidenciado que las habilidades lingüísticas (vocabulario, sintaxis y pragmática) están estrechamente relacionadas con las funciones ejecutivas (memoria de trabajo, flexibilidad cognitiva e inhibición), lo que implica que ambas áreas suelen estar afectadas de manera simultánea. Por ello, constituyen objetivos prioritarios en las intervenciones diseñadas para esta población (Friedman & Sterling, 2019), justificando el uso de sistemas y estrategias que incluyan CAA especialmente en los casos con mayores niveles de afectación.

UNIVERSIDAD DE MÁLAGA

2.7 Referencias

Adamson, L. B., Bakeman, R., Deckner, D. F., & Nelson, P. B. (2014). From interactions to conversations: The development of joint engagement during early childhood. *Child Development*, *85*(3), 941-955. https://doi.org/10.1111/cdev.12189

Alcalá, G., & Ochoa, M.G. (2022). Trastorno del espectro autista (TEA). *Revista de la Facultad de Medicina (México)*, 65(1), 7-20. https://doi.org/10.22201/fm.24484865e.2022.65.1.02

American Psychiatric Association (APA) (1983) Diagnostic and Statistical Manual of Mental Disorders. 3th ed. *Washington, DC*: *American Psychiatric Publishing*

UNIVERSIDAD DE MÁLAGA

American Psychiatric Association (APA) (1994) Diagnostic and Statistical Manual of Mental Disorders. 4th ed. *Washington, DC*: *American Psychiatric Publishing*

American Psychiatric Association (APA) (2013). Diagnostic and statistical manual of mental disorders (5th ed.). *Washington, DC: American Psychiatric Publishing*. https://doi.org/10.1176/appi.books.9780890425596

Artigas-Pallarès, J., & Paula, I. (2012). El autismo 70 años después de Leo Kanner y Hans Asperger. *Revista de la Asociación Española de Neuropsiquiatría*, 32(115), 567-587. https://dx.doi.org/10.4321/S0211-57352012000300008

Asperger, H. (1944). Die Autistischen Psychopathen im Kindesalter. *Archiv für Psychiatrie und Nervenkrankheiten*, 117(1), 76-136.

Assaf, M., Jagannathan, K., Calhoun, V. D., Miller, L., Stevens, M. C., Sahl, R., ... & Pearlson, G. D. (2010). Abnormal functional connectivity of default mode sub-networks in autism spectrum disorder patients. *Neuroimage*, *53*(1), 247-256. https://doi.org/10.1016/j.neuroimage.2010.05.067

Backes, B., Zanon, R. B., & Bosa, C. A. (2017). Language regression in autism spectrum disorder: a systematic review. *Psicologia: Teoria e Prática*, *19*(2), 215-241. https://doi.org/10.5935/1980-6906/psicologia.v19n2p210-236

Bai, D., Yip, B. H. K., Windham, G. C., Sourander, A., Francis, R., Yoffe, R. & Sandin, S. (2019). Association of Genetic and Environmental Factors with Autism in a 5-Country Cohort. *JAMA Psychiatry*, 76(10), 1035-1043. https://doi.org/10.1001/jamapsychiatry.2019.1411

Baird, G., Simonoff, E., Pickles, A., Chandler, S., Loucas, T., Meldrum, D., & Charman, T. (2006). Prevalence of disorders of the autism spectrum in a population cohort of children in South Thames: the Special Needs and Autism Project (SNAP). *The Lancet*, *368*(9531), 210-215. https://doi.org/10.1016/S0140-6736(06)69041-7

Bamicha, V., & Drigas, A. (2022). ToM & ASD: The interconnection of Theory of Mind with the social-emotional, cognitive development of children with Autism

UNIVERSIDAD DE MÁLAGA

Spectrum Disorder. The use of ICTs as an alternative form of intervention in ASD. *Technium Social Sciences Journal*, *33*, 42-72. https://doi.org/10.47577/tssj.v33i1.6845

Baron-Cohen, S., Ashwin, E., Ashwin, C., Tavassoli, T., & Chakrabarti, B. (2009). Talent in autism: hyper-systemizing, hyper-attention to detail and sensory hypersensitivity. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1522), 1377-1383. https://doi.org/10.1098/rstb.2008.0337

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"?. *Cognition*, 21(1), 37-46. https://doi.org/10.1016/0010-0277(85)90022-8

Benabdallah, F. Z., Drissi El Maliani, A., Lotfi, D., Jennane, R., & El Hassouni, M. (2022). An autism spectrum disorder adaptive identification based on the Elimination of brain connections: a proof of long-range underconnectivity. *Soft Computing*, *26*(10), 4701-4711. https://doi.org/10.1007/s00500-022-06890-7

Bhandari, R., Paliwal, J. K., & Kuhad, A. (2020). Neuropsychopathology of autism spectrum disorder: complex interplay of genetic, epigenetic, and environmental factors. *Personalized Food Intervention and Therapy for Autism Spectrum Disorder Management*, 97-141. https://doi.org/10.1007/978-3-030-30402-7_4

Bleuler, E. (1911). Dementia præcox, oder die Gruppe der Schizophrenien. *Handbuch der Psychiatrie. Spezieller Teil*, *4*.

Bleuler, E. (1950). *Dementia Praecoxx or the Group of Schizophrenics*. Nueva York: International Universities Press.

Borue, X., Mazefsky, C., Rooks, B. T., Strober, M., Keller, M. B., Hower, H., ... & Birmaher, B. (2016). Longitudinal course of bipolar disorder in youth with high-functioning autism spectrum disorder. *Journal of the American Academy of Child & Adolescent Psychiatry*, *55*(12), 1064-1072. https://doi.org/10.1016/j.jaac.2016.08.011

UNIVERSIDAD DE MÁLAGA

Bourson, L., & Prevost, C. (2024). Characteristics of restricted interests in girls with ASD compared to boys: A systematic review of the literature. *European Child & Adolescent Psychiatry*, *33*(4), 987-1004. https://doi.org/10.1007/s00787-022-01998-5

Braiden, H. J., Bothwell, J., & Duffy, J. (2010). Parents' experience of the diagnostic process for autistic spectrum disorders. *Child Care in Practice*, *16*(4), 377-389. https://doi.org/10.1080/13575279.2010.498415

Brentani, H., Paula, C. S. D., Bordini, D., Rolim, D., Sato, F., Portolese, J., ... & McCracken, J. T. (2013). Autism spectrum disorders: an overview on diagnosis and treatment. *Brazilian Journal of Psychiatry*, *35*, S62-S72. https://doi.org/10.1590/1516-4446-2013-S104

Brown, L., Sherbenou, R. J., & Johnsen, S. K. (2019). Test of Nonverbal Intelligence (TONI-4). *Encyclopedia of Autism Spectrum Disorders*, 2021. https://doi.org/10.1007/978-3-319-91280-6

Bruner, J. (1995). *From joint attention to the meeting of minds: Communication and cognition*. In C. Moore & P. J. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp. 1–14). Lawrence Erlbaum.

Burnside, K., Wright, K., & Poulin-Dubois, D. (2017). Social motivation and implicit theory of mind in children with autism spectrum disorder. *Autism Research*, 10(11), 1834-1844. https://doi.org/10.1002/aur.1836

C Yuen, R. K., Merico, D., Bookman, M., L Howe, J., Thiruvahindrapuram, B., Patel, R. V., ... & Scherer, S. W. (2017). Whole genome sequencing resource identifies 18 new candidate genes for autism spectrum disorder. *Nature Neuroscience*, *20*(4), 602-611. https://doi.org/10.1038/nn.4524

Calderón, R. S. (2001). La evaluación de las personas con autismo. *Revista Educación*, 25(1), 103-110.

UNIVERSIDAD DE MÁLAGA

Camarata, S. (2014). Early identification and early intervention in autism spectrum disorders: Accurate and effective?. *International Journal of Speech-Language Pathology*, *16*(1), 1-10. https://doi.org/10.3109/17549507.2013.858773

Carrero Barril, F. J. (2025). *Trastorno del espectro autista de grado 1.* Editorial Síntesis.

Casanova, M. F., Frye, R. E., Gillberg, C., & Casanova, E. L. (2020). Comorbidity and autism spectrum disorder. *Frontiers in Psychiatry*, *11*, 617395. https://doi.org/10.3389/fpsyt.2020.617395

Chaste, P., & Leboyer, M. (2012). Autism risk factors: genes, environment, and gene-environment interactions. *Dialogues in Clinical Neuroscience*. https://doi.org/10.31887/DCNS.2012.14.3/pchaste

Chevallier, C., Kohls, G., Troiani, V., Brodkin, E. S., & Schultz, R. T. (2012). The social motivation theory of autism. *Trends in Cognitive Sciences*, 16(4), 231-239. https://doi.org/10.1016/j.tics.2012.02.007

Chiurazzi, P., Kiani, A. K., Miertus, J., Paolacci, S., Barati, S., Manara, E., Stuppia, L., Gurrieri, F., & Bertelli, M. (2020). Genetic analysis of intellectual disability and autism. *Acta Bio-Medica: Atenei Parmensis*, 91(13). https://doi.org/10.23750/abm.v91i13-S.10684

Cluley, V. (2018). From "Learning disability to intellectual disability"—Perceptions of the increasing use of the term "intellectual disability" in learning disability policy, research and practice. *British Journal of Learning Disabilities*, 46(1), 24-32. https://doi.org/10.1111/bld.12209

Coronado, R. C. (2019). La intervención en el trastorno del espectro autista en las alteraciones en intersubjetividad y la teoría de la mente. *Educación*, *25*(1), 67-78. https://doi.org/10.33539/educacion.2019.v25n1.1771

Cortez Bellotti de Oliveira, M., & Contreras, M. M. (2007). Diagnóstico precoz de los trastornos del espectro autista en edad temprana (18-36 meses). *Archivos Argentinos de Pediatría*, *105*(5), 418-426.

UNIVERSIDAD DE MÁLAGA

Courchesne, E., Mouton, P. R., Calhoun, M. E., Semendeferi, K., Ahrens-Barbeau, C., Hallet, M. J., ... & Pierce, K. (2011). Neuron number and size in prefrontal cortex of children with autism. *Jama*, *306*(18), 2001-2010. https://doi.org/10.1001/jama.2011.1638

Cristofori, I., Cohen-Zimerman, S. & Grafman, J. (2019). Executive Functions. *Handbook of Clinical Neurology*, 163, 197-219. https://doi.org/10.1016/B978-0-12-804281-6.00011-2

Cuxart, F., & Jané i Ballabriga, M. D. C. (1998). Evolución conceptual del término 'autismo': una perspectiva histórica. *Revista de Historia de la Psicología*, 19(2-3), 0369-389.

Dapretto, M., Davies, M. S., Pfeifer, J. H., Scott, A. A., Sigman, M., Bookheimer, S. Y., & Iacoboni, M. (2006). Understanding emotions in others: mirror neuron dysfunction in children with autism spectrum disorders. *Nature Neuroscience*, *9*(1), 28-30. https://doi.org/10.1038/nn1611

Demetriou, E. A., DeMayo, M. M., & Guastella, A. J. (2019). Executive function in autism spectrum disorder: history, theoretical models, empirical findings, and potential as an endophenotype. *Frontiers in Psychiatry*, *10*, 753. https://doi.org/10.3389/fpsyt.2019.00753

Drager, K., Light, J., & McNaughton, D. (2010). Effects of AAC interventions on communication and language for young children with complex communication needs. *Journal of Pediatric Rehabilitation Medicine*, *3*(4), 303-310. https://doi.org/10.3233/PRM-2010-0141

Durrleman, S., Hippolyte, L., Zufferey, S., Iglesias, K., & Hadjikhani, N. (2015). Complex syntax in autism spectrum disorders: A study of relative clauses. *International Journal of Language & Communication Disorders*, *50*(2), 260-267. https://doi.org/10.1111/1460-6984.12130

UNIVERSIDAD DE MÁLAGA

Dziuk, M. A., Larson, J. G., Apostu, A., Mahone, E. M., Denckla, M. B., & Mostofsky, S. H. (2007). Dyspraxia in autism: association with motor, social, and communicative deficits. *Developmental Medicine & Child Neurology*, *49*(10), 734-739. https://doi.org/10.1111/j.1469-8749.2007.00734.x

Eckes, T., Buhlmann, U., Holling, H. D., & Möllmann, A. (2023). Comprehensive ABA-based interventions in the treatment of children with autism spectrum disorder–a meta-analysis. *BMC Psychiatry*, *23*(1), 133. https://doi.org/10.1186/s12888-022-04412-1

Eigsti, I. M., Stevens, M. C., Schultz, R. T., Barton, M., Kelley, E., Naigles, L., ... & Fein, D. A. (2016). Language comprehension and brain function in individuals with an optimal outcome from autism. *NeuroImage: Clinical*, *10*, 182-191. https://doi.org/10.1016/j.nicl.2015.11.014

Fein, D., Barton, M., Eigsti, I. M., Kelley, E., Naigles, L., Schultz, R. T., ... & Tyson, K. (2013). Optimal outcome in individuals with a history of autism. *Journal of Child Psychology and Psychiatry*, *54*(2), 195-205. https://doi.org/10.1111/jcpp.12037

Fombonne, E. (2005). Epidemiology of autistic disorder and other pervasive developmental disorders. *Journal of Clinical Psychiatry*, *66*, 3.

Friedman, L., & Sterling, A. (2019). A review of language, executive function, and intervention in autism spectrum disorder. In Seminars in speech and language. *Thieme Medical Publishers*, 40(4), 291-304. https://doi.org/10.1055/s-0039-1692964

Frigaux, A., Evrard, R., & Lighezzolo-Alnot, J. (2019). ADI-R and ADOS and the differential diagnosis of autism spectrum disorders: Interests, limits and openings. *L'encephale*, 45(5), 441-448. https://doi.org/10.1016/j.encep.2019.07.002

Gallego Vicente, P. (2019). *Microbiota intestinal y/o problemas gastrointestinales relacionados con el trastorno autista*. Revisión bibliográfica.

UNIVERSIDAD DE MÁLAGA

Gleason, J. B., & Ratner, N. B. (2010). El desarrollo del lenguaje. *Pearson Educacion*.

González-Mercado, Y. M., Rivera-Martínez, L. B., & Domínguez-González, M. G. (2016). Autismo y evaluación. *Ra Ximhai*, 12(6), 525-533. https://doi.org/10.35197/rx.12.01.e3.2016.33.yg

Goodman, K. (1992). Lenguaje total: la manera natural del desarrollo del lenguaje. *Cero en Conducta*, 7(29), 17-23.

Gyawali, S., & Patra, B. N. (2019). Trends in concept and nosology of autism spectrum disorder: A review. *Asian Journal of Psychiatry*, *40*, 92-99. https://doi.org/10.1016/j.ajp.2019.01.021

Happé, F., & Frith, U. (2006). The weak coherence account: detail-focused cognitive style in autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 36(1), 5-25. https://doi.org/10.1007/s10803-005-0039-0

Hidalgo Vicario, M. H., & Rodríguez Hernández, P. R. (2013). *DSM-5. manual diagnóstico y estadístico de los trastornos mentales. últimas novedades*. Pediatría integral, 17(7), 461-462.

Hill, E. L. (2004). Executive dysfunction in autism. *Trends in Cognitive Sciences*, *8*(1), 26-32. https://doi.org/10.1016/j.tics.2003.11.003

Hobson, H., & Petty, S. (2021). Moving forwards not backwards: heterogeneity in autism spectrum disorders. *Molecular Psychiatry*, *26*(12), 7100-7101. https://doi.org/10.1038/s41380-021-01226-7

Hobson, P. (2004). *The cradle of thought: Exploring the origins of thinking*. Pan Macmillan.

Holyfield, C., Drager, K.D., Kremkow, J., & Light, J. (2017). Systematic review of AAC intervention research for adolescents and adults with autism spectrum disorder. *Augmentative and Alternative Communication*, 33(4), 201–212. https://doi.org/10.1080/07434618.2017.1370495

UNIVERSIDAD DE MÁLAGA

Huerta, M., & Lord, C. (2012). Diagnostic evaluation of autism spectrum disorders. *Pediatric Clinics of North America*, *59*(1), 103. https://doi.org/10.1016/j.pcl.2011.10.018

Iacono, T., Trembath, D., & Erickson, S. (2016). The role of augmentative and alternative communication for children with autism: current status and future trends. *Neuropsychiatric Disease and Treatment*, 2349-2361. https://doi.org/10.2147/NDT.S95967

Joon, P., Kumar, A., & Parle, M. (2021). What is autism?. *Pharmacological Reports*, *73*(5), 1255-1264. https://doi.org/10.1007/s43440-021-00244-0

Jurado, P., & Bernal T., D. (2011). El alumno afectado con síndrome de Asperger en el aula ordinaria: análisis de caso. *Revista de Educación Inclusiva*, 4(2), 29-46.

Just, M. A., Cherkassky, V. L., Keller, T. A., & Minshew, N. J. (2004). Cortical activation and synchronization during sentence comprehension in high-functioning autism: evidence of underconnectivity. *Brain*, *127*(8), 1811-1821. https://doi.org/10.1093/brain/awh199

Kanner, L. (1943). Autistic Disturbances of Affective Contact. *Revista Española de Discapacidad Intelectual Siglo Cero*, 36.

Katusic, M. Z., Myers, S. M., Weaver, A. L., & Voigt, R. G. (2021). IQ in autism spectrum disorder: a population-based birth cohort study. *Pediatrics*, 148(6). https://doi.org/10.1542/peds.2020-049899

Kelley, E., Paul, J. J., Fein, D., & Naigles, L. R. (2006). Residual language deficits in optimal outcome children with a history of autism. *Journal of Autism and Developmental Disorders*, *36*, 807-828. https://doi.org/10.1007/s10803-006-0111-4

Lai, M. C. (2022). Clinical reflections on the intersections of autism and personality development. *Autism*, 26(4), 739-742. https://doi.org/10.1177/13623613221088073

UNIVERSIDAD DE MÁLAGA

Livingston, L. A., Carr, B., & Shah, P. (2019). Recent advances and new directions in measuring theory of mind in autistic adults. *Journal of Autism and Developmental Disorders*, 49, 1738-1744. https://doi.org/10.1007/s10803-018-3823-3

Llorens Romea, M., & Gabás Fajarnés, E. M. (2022). *Creación de un cuaderno de comunicación para trabajar la asamblea con una niña TEA*. Universidad de Zaragoza, FCHE.

Logan, K., Iacono, T. & Trembath, D. (2017). A systematic review of research into aided AAC to increase social-communication functions in children with autism spectrum disorder. *Augmentative and Alternative Communication*, 33(1), 51-64. https://doi.org/10.1080/07434618.2016.1267795

López, B., & Leekam, S. R. (2007). Teoría de la coherencia central: una revisión de los supuestos teóricos. *Infancia y Aprendizaje*, *30*(3), 439-457. https://doi.org/10.1174/021037007781787462

Lord, C., Elsabbagh, M., Baird, G., & Veenstra-Vanderweele, J. (2018). Autism spectrum disorder. *The Lancet*, *392*(10146), 508-520.

Lord, C., Elsabbagh, M., Baird, G., & Veenstra-VanderWeele, J. (2018). Autism spectrum disorder. The Lancet, 392(10146), 508–520. https://doi.org/10.1016/S0140-6736(18)31129-2

Lord, C., Rutter, M., DiLavore, P. C., Risi, S., Gotham, K. y Bishop, S. L. (2015). ADOS-2. *Escala de Observación para el Diagnóstico del Autismo*, *2*.

Lordan, R., Storni, C., & De Benedictis, C. A. (2021). *Autism Spectrum Disorders: Diagnosis and Treatment*. Exon Publications, Brisbane (AU).

Lutz, J. (1937). Autisme infantile et psychoses infantiles precoces. *Clinique des Síndromes Autistiques*, 11-17.

MacNeil, L. K., & Mostofsky, S. H. (2012). Specificity of dyspraxia in children with autism. *Neuropsychology*, *26*(2), 165. https://doi.org/10.1037/a0026955

UNIVERSIDAD DE MÁLAGA

Maenner, M. J. (2021). Prevalence and characteristics of autism spectrum disorder among children aged 8 years—autism and developmental disabilities monitoring network, 11 sites, United States, 2018. *MMWR. Surveillance Summaries*, *70*. http://dx.doi.org/10.15585/mmwr.ss7011a1

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49-100. https://doi.org/10.1006/cogp.1999.0734

Motlani, V., Motlani, G., & Thool, A. (2022). Asperger syndrome (AS): a review article. *Cureus*, *14*(11). https://doi.org/10.7759/cureus.31395

Mottron, L., Dawson, M., Soulières, I., Hubert, B., & Burack, J. (2006). Enhanced perceptual functioning in autism: An update, and eight principles of autistic perception. *Journal of Autism and Developmental Disorders*, *36*, 27-43. https://doi.org/10.1007/s10803-005-0040-7

Mukherjee, S. B. (2017). Autism spectrum disorders—diagnosis and management. *The Indian Journal of Pediatrics*, *84*(4), 307-314. https://doi.org/10.1007/s12098-016-2272-2

Mulas, F., Ros-Cervera, G., Millá, M. G., Etchepareborda, M. C., Abad, L., & Téllez de Meneses, M. (2010). Modelos de intervención en niños con autismo. *Revista de Neurología*, 50(3), 77-84.

Mundy, P., & Newell, L. (2007). Attention, joint attention, and social cognition. *Current Directions in Psychological Science*, *16*(5), 269-274. https://doi.org/10.1111/j.1467-8721.2007.00518.x

Muñoz Burillo, L. (2020). Conciencia pragmática en niños con síndrome de asperger. In *Congreso Internacional de Investigación e innovación en educación infantil y primaria*.

UNIVERSIDAD DE MÁLAGA

Nguyen, T., Miguel, H. O., Condy, E. E., Park, S., & Gandjbakhche, A. (2021). Using functional connectivity to examine the correlation between mirror neuron network and autistic traits in a typically developing sample: A fNIRS study. *Brain Sciences*, *11*(3), 397. https://doi.org/10.3390/brainsci11030397

O'Brien, G., & Pearson, J. (2004). Autism and learning disability. *Autism*, 8(2), 125-140. https://doi.org/10.1177/1362361304042718

O'Reilly, C., Lewis, J. D., & Elsabbagh, M. (2017). Is functional brain connectivity atypical in autism? A systematic review of EEG and MEG studies. *PloS One*, *12*(5), e0175870. https://doi.org/10.1371/journal.pone.0175870

Oberman, L. M., & Ramachandran, V. S. (2007). The simulating social mind: the role of the mirror neuron system and simulation in the social and communicative deficits of autism spectrum disorders. *Psychological Bulletin*, *133*(2), 310. https://doi.org/10.1037/0033-2909.133.2.310

Ozonoff, S., Pennington, B. F., & Rogers, S. J. (1991). Executive function deficits in high-functioning autistic individuals: relationship to theory of mind. *Journal of child Psychology and Psychiatry*, 32(7), 1081-1105. https://doi.org/10.1111/j.1469-7610.1991.tb00351.x

Ozonoff, S., South, M., & Provencal, S. (2005). Handbook of autism and pervasive developmental disorders. *New Jersey: John Wiley and Sons*, 606- 627.

Parish-Morris, J., Liberman, M. Y., Cieri, C., Herrington, J. D., Yerys, B. E., Bateman, L., ... & Schultz, R. T. (2017). Linguistic camouflage in girls with autism spectrum disorder. *Molecular Autism*, *8*, 1-12. https://doi.org/10.1186/s13229-017-0164-6

Parraga, G. C. V., Rodríguez, J. D. C., Moyano, D. M. C., & Guaycha, A. G. L. (2019). Síndrome de Asperger. *RECIMUNDO: Revista Científica de la Investigación y el Conocimiento*, 3(4), 416-433.

UNIVERSIDAD DE MÁLAGA

Paul, R., & Cohen, D. J. (1984). Outcomes of severe disorders of language acquisition. *Journal of Autism and Developmental Disorders*, *14*(4), 405-421. https://doi.org/10.1007/BF02409831

Paula Pérez, I., & Martos, J. M. P. (2011). Una aproximación a las funciones ejecutivas en el trastorno del espectro autista. *Revista de Neurologia, 52(1),* 147-153. https://doi.org/10.33588/rn.52S01.2010816

Paula-Pérez, I. (2013). Diagnóstico diferencial entre el trastorno obsesivo compulsivo y los patrones de comportamiento, actividades e intereses restringidos y repetitivos en los trastornos del espectro autista. *Revista de Psiquiatría y Salud Mental*, *6*(4), 178-186. https://doi.org/10.1016/j.rpsm.2012.07.005

Pellicano, E. (2012). The development of executive function in autism. *Autism Research and Treatment*, *2012*(1), 146132. https://doi.org/10.1155/2012/146132

Pennington, B. F., & Ozonoff, S. (1996). Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry*, *37*(1), 51-87. https://doi.org/10.1111/j.1469-7610.1996.tb01380.x

Pérez-Pichardo, M. F., Ruz-Sahrur, A., Barrera-Morales, K., & Moo-Estrella, J. (2018). Medidas directas e indirectas de las funciones ejecutivas en niños con trastorno de espectro autista. *Acta Pediátrica de México*, *39*(1), 13-22. https://doi.org/10.18233/apm1no1pp13-221536

Pírez, G. M, Alemán, C. S, Vega, D. D., Cabrera, C. V., & Sáiz, L. C. (2019). Trastorno desintegrativo infantil: a propósito de un caso. *Revista de Psiquiatría Infarto-Juvenil*, 36(2), 106.

Plesa Skwerer, D., Jordan, S. E., Brukilacchio, B. H., & Tager-Flusberg, H. (2016). Comparing methods for assessing receptive language skills in minimally verbal children and adolescents with autism spectrum disorders. *Autism*, 20(5), 591-604. https://doi.org/10.1177/1362361315600146

UNIVERSIDAD DE MÁLAGA

Potter, H. W. (1933). Schizophrenia in children. *American Journal of Psychiatry*, 89(6), 1253-1270.

Ramírez, D. C., Elu, A. B., Pulgar, S. J., Nieto, L. P., & Nieto, V. P. (2021). Síndrome de Rett. *Revista Sanitaria de Investigación*, 2(3), 91.

Reynoso, C., Rangel, M. J., & Melgar, V. (2017). Autism spectrum disorder: Etiological, diagnostic and therapeutic aspects. *Revista Médica del Instituto Mexicano del Seguro Social*, 55(2), 214-222.

Ritvo, E. R., & Freeman, B. J. (1977). National Society for Autistic Children definition of the syndrome of autism. *Journal of Pediatric Psychology*, *2*(4), 146-148. https://doi.org/10.1093/jpepsy/2.4.146

Rivière, Á. (2002). *IDEA: Inventario de espectro autista*. Fundación para el desarrollo de los estudios cognitivos.

Rivière, Á. (2010). Autismo. Orientaciones para la intervención educativa. *Madrid: Trotta*. Available from: https://dialnet.unirioja.es/servlet/libro?codigo=111863

Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Annu. Rev. Neurosci.*, 27(1), 169-192. https://doi.org/10.1146/annurev.neuro.27.070203.144230

Rizzolatti, G., & Fabbri-Destro, M. (2010). Mirror neurons: from discovery to autism. *Experimental Brain Research*, *200*(3), 223-237. https://doi.org/10.1007/s00221-009-2002-3

Robins, D., Fein, D., & Barton, M. (2009). Cuestionario M-Chat Revisado de Detección del Autismo en niños pequeños con entrevista de seguimiento (M-CHATR/F). *Grupo Estudio MCHAT España*.

Rosen, N. E., Lord, C., & Volkmar, F. R. (2021). The diagnosis of autism: From Kanner to DSM-III to DSM-5 and beyond. *Journal of Autism and Developmental Disorders*, *51*, 4253-4270. https://doi.org/10.1007/s10803-021-04904-1

UNIVERSIDAD DE MÁLAGA

Ruggieri, V. L. (2013). Empatía, cognición social y trastornos del espectro autista. *Revista de Neurología*, 56(1), 13-21.

Rusca-Jordán, F., & Cortez-Vergara, C. (2020). Trastorno por déficit de atención con hiperactividad (TDAH) en niños y adolescentes. *Revista de Neuro-Psiquiatría*, 83(3), 148-156. https://dx.doi.og/10.20453/rnp.v83i3.3794

Russell, J. E. (1997). *Autism as an executive disorder*. Oxford University Press.

Rutter, M., Bailey, A. & Lord, C. (2019). SCQ. *Cuestionario de Comunicación Social* (J. Pereña y P. Santamaría, adaptados). Madrid: TEA Ediciones.

Rutter, M., Le Couteur, A., & Lord, C. (2011). *ADI-R. Autism diagnostic interview revised. Manual*. Los Angeles: Western Psychological Services.

Sala, G. L. (2016). *Propuesta didáctica para la mejora de la comunicación en alumnado con Trastorno del Espectro Autista* (Bachelor's thesis).

Sandoval, A., Moyano, A., & Barrera, P. (2012). Trastorno generalizado del desarrollo no especificado: Una reflexión sobre este diagnóstico. *Revista Chilena de Neuro-Psiquiatría*, 50(3), 202-203. http://dx.doi.org/10.4067/S0717-92272012000300010

Sanz, P., Tárraga, R., & Lacruz, I. (2018). Prácticas psicoeducativas basadas en la evidencia para trabajar con alumnos con TEA. *Quaderns Digitals*, 87, 152-161.

Schmitz, N., Rubia, K., Daly, E., Smith, A., Williams, S., & Murphy, D. G. (2006). Neural correlates of executive function in autistic spectrum disorders. *Biological Psychiatry*, *59*(1), 7-16. https://doi.org/10.1016/j.biopsych.2005.06.007

Schopler, E., Reichler, R. J., & Renner, B. R. (1988). *The Childhood Autism Rating Scale (CARS)*. Western Psychological Services.

Sevilla, M. D. S. F., Bermúdez, M. O. E., & Sánchez, J. J. C. (2014). Nuevas formas de abordaje del proceso diagnóstico del TEA después del DSM-5. *Revista INFAD de Psicología. International Journal of Developmental and Educational Psychology.*, *1*(1), 243-250. https://doi.org/10.17060/ijodaep.2014.n1.v1.367

UNIVERSIDAD DE MÁLAGA

Shah, A., & Frith, U. (1983). An islet of ability in autistic children: A research note. *Journal of child Psychology and Psychiatry*, *24*(4), 613-620. https://doi.org/10.1111/j.1469-7610.1983.tb00137.x

Shen, M. D., & Piven, J. (2017). Brain and behavior development in autism from birth through infancy. *Dialogues in Clinical Neuroscience*, 19(4), 325-333. https://doi.org/10.31887/DCNS.2017.19.4/mshen

Shenouda, J., Barrett, E., Davidow, A. L., Sidwell, K., Lescott, C., Halperin, W., ... & Zahorodny, W. (2023). Prevalence and disparities in the detection of autism without intellectual disability. *Pediatrics*, 151(2). https://doi.org/10.1542/peds.2022-056594

Short, A. B., & Schopler, E. (1988). Factors relating to age of onset in autism. *Journal of Autism and Developmental Disorders*, *18*(2), 207-216. https://doi.org/10.1007/BF02211947

Song, A., Cola, M., Plate, S., Petrulla, V., Yankowitz, L., Pandey, J., ... & Parish-Morris, J. (2021). Natural language markers of social phenotype in girls with autism. *Journal of Child Psychology and Psychiatry*, *62*(8), 949-960. https://doi.org/10.1111/jcpp.13348

Sparrow, S. S., Cicchetti, D. V. & Saulnier, C.A. (2016). Vineland Adaptive Behavior Scales, Third Edition (Vineland-3). *San Antonio, TX: Pearson.* https://doi.org/10.1177/0829573517733845Suárez

Stern, D. N. (2018). *The interpersonal world of the infant: A view from psychoanalysis and developmental psychology*. Routledge.

Tager-Flusberg, H. (2007). Evaluating the theory-of-mind hypothesis of autism. *Current Directions in Psychological Science*, 16(6), 311-315. https://doi.org/10.1111/j.1467-8721.2007.00527.x

UNIVERSIDAD DE MÁLAGA

Tager-Flusberg, H., & Joseph, R. M. (2003). Identifying neurocognitive phenotypes in autism. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, *358*(1430), 303-314. https://doi.org/10.1098/rstb.2002.1198

Torrens, V., & Ruiz, C. (2021). Language and communication in preschool children with autism and other developmental disorders. *Children*, 8(3), 192. https://doi.org/10.3390/children8030192

Trevarthen, C. (1990). Growth and education in the hemispheres. Brain circuits and functions of the mind: Essays in honour of Roger W. Sperry. *Cambridge: Cambridge University Press*, 334-363.

Trevarthen, C., & Aitken, K. J. (2001). Infant intersubjectivity: Research, theory, and clinical applications. *The Journal of Child Psychology and Psychiatry and Allied Disciplines*, *42*(1), 3-48. https://doi.org/10.1111/1469-7610.00701

Uclés, S. V. (2015). Aspectos diferenciales en el desarrollo comunicativo de las personas con autismo. *Revista Internacional de Apoyo a la Inclusión, Logopedia, Sociedad y Multiculturalidad*, *1*(2).

Uddin, L. Q., Supekar, K., & Menon, V. (2013). Reconceptualizing functional brain connectivity in autism from a developmental perspective. *Frontiers in Human Neuroscience*, *7*, 458. https://doi.org/10.3389/fnhum.2013.00458

Van der Hallen, R., Evers, K., Brewaeys, K., Van den Noortgate, W., & Wagemans, J. (2015). Global processing takes time: A meta-analysis on local–global visual processing in ASD. *Psychological Bulletin*, *141*(3), 549. https://doi.org/10.1037/bul0000004

Velarde-Incháustegui, M., Ignacio-Espíritu, M. E., & Cárdenas-Soza, A. (2021). Diagnóstico de Trastorno del Espectro Autista-TEA, adaptándonos a la nueva realidad, Telesalud. *Revista de Neuro-Psiquiatría*, 84(3), 175-182. http://dx.doi.org/10.20453/rnp.v84i3.4034

UNIVERSIDAD DE MÁLAGA

Venter, A., Lord, C., & Schopler, E. (1992). A follow-up study of high-functioning autistic children. *Journal of Child Psychology and Psychiatry*, *33*(3), 489-597. https://doi.org/10.1111/j.1469-7610.1992.tb00887.x

Vogindroukas, I., Stankova, M., Chelas, E. N., & Proedrou, A. (2022). Language and speech characteristics in autism. *Neuropsychiatric Disease and Treatment*, 2367-2377. https://doi.org/10.2147/NDT.S331987

Volkmar, F. R., Reichow, B., & McPartland, J. (2012). Classification of autism and related conditions: progress, challenges, and opportunities. Dialogues in Clinical Neuroscience, 14(3), 229-237. https://doi.org/10.31887/DCNS.2012.14.3/fvolkmar

Vorstman, J. A., Parr, J. R., Moreno-De-Luca, D., Anney, R. J., Nurnberger Jr, J. I., & Hallmayer, J. F. (2017). Autism genetics: opportunities and challenges for clinical translation. *Nature Reviews Genetics*, 18(6), 362-376. https://doi.org/10.1038/nrg.2017.4

Wang, L., Wang, B., Wu, C., Wang, J., & Sun, M. (2023). Autism spectrum disorder: neurodevelopmental risk factors, biological mechanism, and precision therapy. *International Journal of Molecular Sciences*, 24(3), 1819. https://doi.org/10.3390/ijms24031819

Wechsler, D. (2015). *WISC-V. Escala de inteligencia de Wechsler para niños-V.* Madrid: Pearson (Edición original, 2014).

Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-analysis of theory-of-mind development: The truth about false belief. *Child Development*, 72(3), 655-684. https://doi.org/10.1111/1467-8624.00304

Wing, L. (1981). Sex ratios in early childhood autism and related conditions. *Psychiatry Research*, 5(2), 129-137. https://doi.org/10.1016/0165-1781(81)90043-3

Yeganeh, M. T., & Kamari, E. (2020). Investigating mean length of utterance (MLU) in monolingual Persian speaking children with autism spectrum disorder

UNIVERSIDAD DE MÁLAGA

(ASD). *International Journal of Health Studies*. https://doi.org/10.22100/ijhs.v6i2.743

Yerys, B. E., Herrington, J. D., Satterthwaite, T. D., Guy, L., Schultz, R. T., & Bassett, D. S. (2017). Globally weaker and topologically different: resting-state connectivity in youth with autism. *Molecular Autism*, *8*, 1-11. https://doi.org/10.1186/s13229-017-0156-6

Zhao, W., Liu, Q., Zhang, X., Song, X., Zhang, Z., Qing, P., ... & Kendrick, K. M. (2023). Differential responses in the mirror neuron system during imitation of individual emotional facial expressions and association with autistic traits. *NeuroImage*, *277*, 120263. https://doi.org/10.1016/j.neuroimage.2023.120263

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3

Concepto teórico y práctico de la CAA y la estimulación asistida del lenguaje

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3.1 La comunicación aumentativa y alternativa

Las habilidades visuoespaciales observadas en personas con TEA (Cardillo et al., 2020; Di Mascio et al., 2019) han llevado a la implementación de estrategias de CAA en esta población cuando son necesarias. Estas comprenden todas las modalidades de comunicación que facilitan al usuario la expresión de pensamientos, necesidades, deseos e ideas. Estas herramientas actúan como recursos complementarios o sustitutivos, ya sea para compensar trastornos temporales durante el proceso de recuperación del habla o para abordar trastornos persistentes de la comunicación que están limitados o no han llegado a desarrollarse plenamente (Casado et al., 2013; Chazin et al., 2018; García et al., 2009; Suárez Gómez, 2013).

La CAA utiliza signos que relacionan un significante perceptible con un significado mental. Estos signos pueden ser íconos, señales, pistas y símbolos gráficos, y muchas veces van acompañados de palabras escritas (Calleja Reina & Sotillo Méndez, 2023). Sin embargo, la capacidad de comprender estos signos no es innata, por lo que su nivel de iconicidad es crucial para representar conceptos tanto específicos como abstractos si se pretende aumentar las oportunidades comunicativas de las personas con TEA (Pereira et al., 2020).

Los sistemas de CAA suelen integrar símbolos visuales organizados dentro de un espacio definido, como un panel físico en el caso de los pictogramas impresos, o una pantalla interactiva en los sistemas presentados en formato digital. Esta disposición estructurada facilita el acceso y la localización de los símbolos por parte del usuario, optimizando la interacción con el sistema (Jagaroo & Wilkinson, 2008). Las estrategias con estos elementos abarcan una amplia variedad de metodologías orientadas a mejorar las habilidades comunicativas con su implementación desde edades tempranas y que permiten la adaptación a nuevos

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recursos y soportes (Crowe et al., 2022; Sevcik et al., 2008), incluyendo las tecnologías de la información y la comunicación (TIC). Las TIC engloban herramientas, dispositivos y recursos digitales utilizados para recopilar, almacenar, procesar, transmitir y compartir información en un contexto de enseñanza y aprendizaje multidisciplinar. Esto abarca ordenadores, aplicaciones (App), software, redes de comunicación, Internet, dispositivos móviles y tecnologías relacionadas compatibles como soportes de CAA (Martínez Abella, 2023; Gavilán, 2022; Ghanouni et al., 2020).

Investigaciones recientes han demostrado los beneficios de implementar CAA en niños con TEA, especialmente cuando estos sistemas se integran de manera natural con estímulos familiares y adecuados para la edad del usuario (Agius et al., 2024; Aspiranti et al., 2020; Esposito et al., 2017; Logan et al., 2017; Pereira et al., 2020; Scarcella et al., 2023; Valencia et al., 2019). Esto respalda la importancia de usar este tipo de recursos, especialmente en casos de TEA clasificados como Grado 3 con necesidades complejas de comunicación. Las particularidades asociadas a este grado han sido abordadas en detalle en el capítulo anterior.

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3.1.1 Clasificación de los sistemas de CAA

Tradicionalmente, los sistemas de CAA se han clasificado en dos categorías: "con asistencia" (CAA+a) y "sin asistencia" (CAA-a), dependiendo del nivel tecnológico requerido, ya sea alto o bajo (Calleja Reina & Rodríguez, 2018). Esta clasificación, aunque útil, ha evolucionado con el tiempo gracias a los criterios más actualizados de la *American Speech-Language-Hearing Association* (ASHA).

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En la actualidad, los sistemas de CAA+a se describen como soportes tecnológicos o dispositivos electrónicos diseñados para facilitar la comunicación. Estos dispositivos, como comunicadores dinámicos o estáticos, permiten mostrar

de manera simultánea letras, palabras, símbolos y frases, posibilitando la construcción de mensajes complejos, ya sea con salida de voz sintética o sin ella. Algunos ejemplos incluyen aplicaciones específicas para dispositivos móviles, software adaptado y equipos electrónicos portátiles, que pueden personalizarse según las necesidades individuales de cada usuario. Por otro lado, los sistemas de CAA-a se caracterizan por no depender de tecnologías electrónicas y se centran en recursos que utilizan el cuerpo y materiales físicos para la comunicación. Esto incluye el uso de gestos naturales, lenguaje corporal, lengua de signos, tableros de comunicación, tarjetas con pictogramas y otros soportes visuales que no requieren energía eléctrica ni dispositivos tecnológicos. Estos sistemas suelen ser más accesibles en términos de coste y disponibilidad (ASHA, 2024).

Existen estudios que destacan la eficacia de ambos tipos de sistemas cuando se integran adecuadamente en las rutinas diarias de las personas con necesidades complejas de comunicación. Mientras que los sistemas de CAA+a son altamente efectivos para usuarios con capacidades motoras suficientes para manejar dispositivos electrónicos, los sistemas de CAA-a ofrecen una alternativa para aquellos con limitaciones tecnológicas o que viven en entornos donde el uso de dispositivos electrónicos no es viable (Logan et al., 2017; Scarcella et al., 2023). Esta dualidad permite a los profesionales seleccionar los recursos más adecuados según el perfil del usuario y sus contextos de interacción.

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3.1.2 Procesos implicados

El uso de los sistemas de CAA+a y CAA-a está influido por una interacción compleja de factores, entre los que destaca el procesamiento cognitivo. Este procesamiento, determinado por elementos exógenos (externos) y endógenos (propios de la persona), desempeña un papel fundamental en habilidades como la atención y el reconocimiento de los estímulos presentados.

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Entre los elementos exógenos que influyen en el uso de la CAA se encuentran factores relacionados tanto con el diseño del sistema como con las características del entorno. Por ejemplo, la organización de los pictogramas en categorías lógicas y visualmente accesibles facilita la identificación de los estímulos relevantes, mientras que un entorno bien iluminado y libre de ruido ambiental favorece la atención del usuario al interactuar con el sistema. Por otro lado, el apoyo del interlocutor, como un cuidador que proporcione retroalimentación constante, constituye un elemento exógeno clave para garantizar el éxito en la comunicación.

En este sentido, características del diseño como el color, el movimiento, el tamaño y la novedad son determinantes para atraer la atención hacia los recursos de CAA (Light et al., 2004; Schlosser & Sigafoos, 2002). Autores como Jagaroo y Wilkinson (2008) destacan que los estímulos en movimiento tienden a captar más atención que los estáticos, aunque un exceso puede generar sobrecarga o habituación. Además, la novedad y el significado del estímulo también juegan un papel importante, al igual que el tamaño, ya que los objetos más grandes suelen ser más llamativos (Wilkinson & Light, 2014).

En cuanto a los elementos endógenos, estos comprenden las capacidades cognitivas, sensoriales y emocionales del usuario. Procesos como la memoria visual, la memoria de trabajo, el procesamiento visual, espacial y auditivo son fundamentales para la interacción efectiva con los sistemas de CAA. La memoria visual, en particular, permite identificar pictogramas o símbolos que ya se han presentado previamente (Semino et al., 2021). Por ejemplo, un usuario debe recordar que el símbolo de un “bocadillo” en una página de “comida” representa un elemento específico del almuerzo que desea solicitar. Esta capacidad de memoria puede verse sobrecargada si el sistema está mal diseñado, si las categorías no son intuitivas o si el interlocutor no lo presenta correctamente. La memoria de trabajo por otra parte permite mantener y manipular información temporalmente,

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como recordar los elementos seleccionados mientras se busca un nuevo símbolo (Thistle & Wilkinson, 2013). Por ejemplo, entender frases requiere mantener en la mente las palabras ya escuchadas mientras se asocia los pictogramas correspondientes.

Los avances en el estudio de la cognición visual han permitido comprender en mayor profundidad cómo se procesan los estímulos visuales y cómo estos afectan a procesos clave como la percepción, identificación, clasificación y al posterior recuerdo. Este conocimiento resulta especialmente relevante en el ámbito de la CAA, donde el diseño de soportes o materiales depende en gran medida de estos procesos cognitivos. Investigaciones recientes han explorado cómo optimizar el diseño y la funcionalidad de estos sistemas para mejorar su accesibilidad y eficacia, destacando la interacción entre los estímulos visuales y las capacidades cognitivas de los usuarios (Light et al., 2019; Liang & Wilkinson, 2018; Thiessen et al., 2017).

Tal y como concluyen Jagaroo y Wilkinson (2008), estos procesos son especialmente críticos para los usuarios de sistemas de CAA, donde se requieren que el usuario no solo reconozca los códigos de las palabras (como códigos icónicos o numéricos), sino también que localice con precisión el lugar donde están almacenados los mensajes dentro de una matriz (soporte electrónico o tablero), identificarlos correctamente, interpretar su significado y recordarlos para futuras interacciones. Por ejemplo, un niño con TEA que utiliza un tablero de comunicación deberá identificar en qué sección se encuentra el pictograma que representa “jugar”, lo que implica tanto habilidad es de memoria visual como atención sostenida y el procesamiento visual. El nivel de activación fisiológica o arousal, también afectan al procesamiento atencional, reflejando la receptividad o responsividad que muestra una persona ante los estímulos (García Sevilla, 1997).

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Los sistemas actuales de CAA suelen imponer demandas cognitivas significativas, especialmente en términos de memoria y atención (Thistle & Wilkinson, 2012). Para mitigar estas demandas, es importante que las estrategias y técnicas de CAA se adapten a las características específicas de cada usuario. Esto incluye valorar a partir de procedimientos informales, no estandarizados, las necesidades individuales, la agudeza visual, la percepción sensorial y la capacidad de acceso físico al sistema (Gómez-Taibo & García-Eligio de la Puente, 2018).

Además, dado que gran parte del uso de la CAA se basa en un canal predominantemente visual para la entrada y salida de información, se debe considerar integrar estos sistemas con apoyo auditivo (input oral) para optimizar la transmisión del mensaje. Este enfoque multimodal no solo podría mejorar la comprensión, sino que también reduciría la carga cognitiva asociada al procesamiento visual, facilitando una comunicación más efectiva, tal y como ocurre con la estimulación asistida del lenguaje (Gómez-Taibo & García-Eligio de la Puente, 2016; Muttiah et al., 2022).

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3.1.3 Intervención con CAA

La implementación temprana de sistemas de CAA puede generar beneficios significativos de manera progresiva, siempre y cuando se integren estímulos familiares y adaptados a la edad y a las características del usuario (Landa, 2018). Además, la efectividad de estas intervenciones se potencia mediante un elevado número de oportunidades de práctica comunicativa, basadas en un flujo continuo de preguntas y respuestas. Este enfoque interactivo, que no siempre es el más recomendable de usar dado a la carga cognitiva que supone, no solo podría reforzar las habilidades relacionadas con el lenguaje y la comunicación, sino que también es capaz de promover la motivación y el interés del usuario por participar activamente en su entorno (Lang et al., 2016).

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Los sistemas de CAA, cuando se implementan de forma óptima, también pueden contribuir al desarrollo de habilidades sociales y comportamentales, al permitir que los usuarios expresen sus necesidades y pensamientos de manera más efectiva. Esto reduce las barreras comunicativas y facilita una integración más fluida en entornos educativos y familiares, mejorando así su calidad de vida y fomentando su autonomía a largo plazo (Crowe et al., 2022).

Uno de los métodos de intervención con CAA más empleados en casos de TEA es el Sistema de Comunicación por Intercambio de Imágenes (PECS), desarrollado por Frost y Bondy (1985). Este programa estructurado en seis fases progresivas tiene como objetivo enseñar a niños a utilizar un sistema de comunicación funcional basado en el intercambio de pictogramas entre el propio usuario y un adulto responsable. Dicho sistema se centra en desarrollar habilidades de comunicación funcional más que en el habla, priorizando un output lingüístico adecuado para expresar y cumplir solicitudes (Flippin et al., 2010; Santos et al., 2021). Asimismo, dentro de las intervenciones con CAA también se encuentra la estrategia de estimulación asistida del lenguaje, la cual presenta diferencias significativas con respecto al sistema PECS tanto en su implementación como en sus objetivos (Tabla 6).

Dentro de este marco de intervención, la logopedia cumple un rol fundamental junto al resto del equipo multidisciplinar. Esta área suele ser la encargada principal de la implementación y optimización de los sistemas de CAA+a y CAA-a, ya que diseñan y personalizan estrategias que potencian las habilidades comunicativas del usuario (Lund et al., 2017). Los logopedas no solo evalúan las necesidades individuales de cada persona, sino que también facilitan la integración natural de estos sistemas en la vida diaria. Además, fomentan un aprendizaje gradual mediante prácticas comunicativas constantes y significativas,

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promoviendo la interacción, la autonomía y el desarrollo integral del usuario en todas las etapas de su vida (Dietz et al., 2012).

3.2 La estrategia de estimulación asistida del lenguaje

La estimulación asistida del lenguaje es una estrategia de intervención con CAA que se define como un enfoque que promueve tanto el componente expresivo como la comprensión, utilizando estímulos visuales proporcionados por el interlocutor. Esta estrategia va más allá del modelado del lenguaje, al ofrecer una vía para el uso de símbolos gráficos como una forma viable de comunicación. Se enfoca en trabajar el input lingüístico en cualquier situación comunicativa, como interacciones cotidianas, la creación de rutinas o la transmisión de instrucciones dentro del contexto de la terapia (O'Neill et al., 2018).

Para que este proceso sea efectivo, es fundamental habilitar el entorno social del usuario, proporcionando un input oral por parte de los interlocutores, de manera que las experiencias lingüísticas del usuario se asemejen a las de aquellos con un desarrollo considerado normo-típico. Este enfoque combina el canal oral con el visual, enriqueciéndolo con mayor nivel de detalle y de forma natural durante conversaciones o actividades instruccionales. En otras palabras, los interlocutores modelan el uso de la CAA en interacciones dinámicas y continuas (Beck et al., 2009; Chazin et al., 2021; Muttiah et al., 2022; Sennott et al., 2016). El objetivo principal es ofrecer a los usuarios más oportunidades comunicativas, sociales y educativas, potenciando el aprovechamiento de sus capacidades existentes y promoviendo el desarrollo de aquellas habilidades que puedan estar comprometidas, con el fin de alcanzar un comportamiento comunicativo específico.

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Tabla 6

Diferencias principales entre la estimulación asistida y el Sistema PECS

	Estimulación asistida del lenguaje	**Sistema de Comunicación por el Intercambio de Imágenes (PECS)**
Características principales	Método de intervención centrado en aumentar el input lingüístico, favoreciendo la comprensión, la retención del mensaje y la expansión del vocabulario mediante un modelo de lenguaje expresivo funcional.	Programa manual que utiliza estrategias de ayuda y refuerzo para favorecer la comunicación, haciendo énfasis en la iniciación y espontaneidad desde el inicio sin recurrir a ayudas verbales.
Objetivos	Compensar la asimetría en el desarrollo del lenguaje usando el lenguaje hablado como input principal, junto con la CAA (imágenes o símbolos pictográficos) como vía de expresión.	Enseñar a los usuarios a usar un sistema de comunicación basado en el intercambio de pictogramas con un adulto responsable.
Técnica trabajada	Input lingüístico.	Output lingüístico.
Procedimiento	Se utiliza los elementos de CAA por parte del interlocutor mientras interactúa con el usuario, utilizando el lenguaje hablado y señalando los símbolos visuales correspondientes para que el sujeto asocie el símbolo con el modelo verbal correspondiente.	Se divide en seis fases: • Fase I: Cómo comunicarse. • Fase II: Distancia y persistencia. • Fase III: Discriminación de imágenes. • Fase IV: Estructura de la oración. • Fase V: Peticiones en respuesta. • Fase VI: Comentario.

Nota. CAA: Comunicación aumentativa y alternativa.

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Los principales objetivos específicos de la estimulación asistida del lenguaje (Gómez-Taibo & García-Eligio de la Puente, 2016) son:

- Incrementar las emisiones vocálicas y mejorar la retención del mensaje, fortaleciendo así la comunicación funcional.
- Establecer la correspondencia entre las emisiones orales y los símbolos, favoreciendo el desarrollo de la intención comunicativa.
- Fomentar la generación de respuestas mediante el uso de objetos y símbolos, cuyas representaciones visuales, como pictogramas o fotografías, reflejan la realidad de manera no arbitraria.

Esta estrategia de intervención no se organiza en fases específicas, sino que se basa en la presentación continua de estímulos adaptados a cada usuario. El proceso se lleva a cabo mediante un intercambio comunicativo que involucra recursos multimodales, permitiendo una interacción conjunta a nivel auditivo y visual.

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Para ello, el interlocutor —que puede ser un profesional como el logopeda, el profesorado o incluso los propios familiares— debe señalar los símbolos pictográficos mientras estimula el lenguaje oral pronunciando en voz alta la palabra correspondiente. Esta acción puede ir acompañada de extensiones, comentarios o ejemplos, con el objetivo de favorecer una asociación natural y significativa entre las representaciones visuales (Figura 1). Este emparejamiento entre símbolos gráficos y modelos verbales es crucial para permitir la formación de nuevas frases y formas de interacción (Acheson et al., 2006).

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La estrategia de estimulación asistida del lenguaje fue inicialmente desarrollada por Goossens y Crain (1986), quienes establecieron las bases para su posterior implementación y evolución. Aunque en la actualidad no existe una abundante evidencia sobre el uso de este enfoque en personas con TEA con

necesidades complejas de comunicación, algunos estudios muestran que esta modalidad de intervención puede mejorar la comprensión simbólica y, en algunos casos, incluso la producción (Beck et al., 2009).

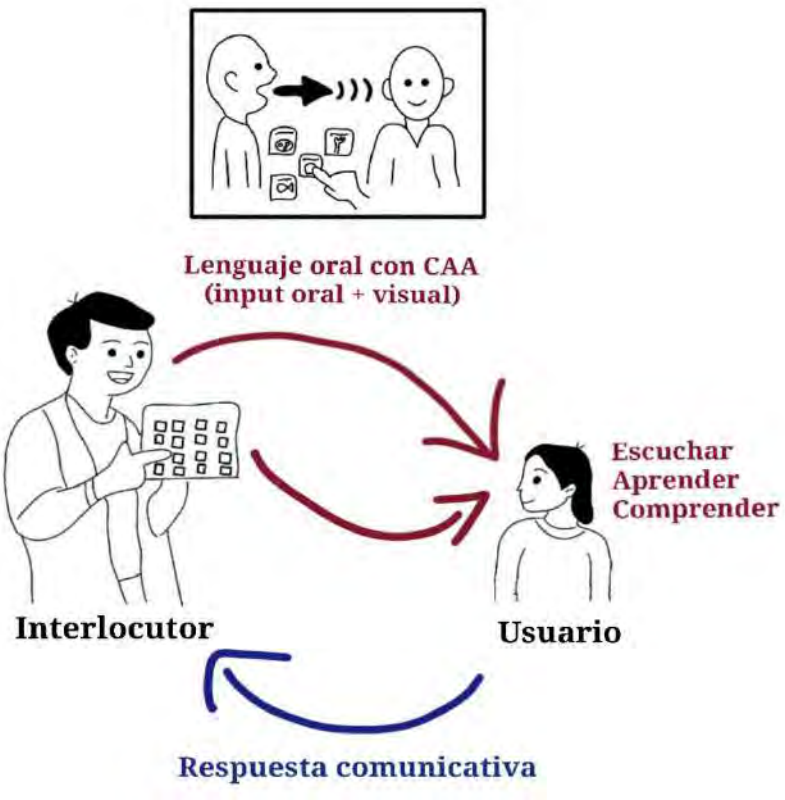


Figura 1: Representación visual de la estimulación asistida del lenguaje

Las ventajas principales de esta técnica incluyen el aprovechamiento de habilidades visoespaciales y la naturalidad del input lingüístico en el contexto, lo que promueve un aumento significativo en las interacciones con el interlocutor, así como en el vocabulario receptivo y expresivo. Además, se han observado efectos adicionales, como una posible mejora en la conducta y la atención sostenida, además de las ya mencionadas habilidades sociales (Pereira et al., 2020). Varios estudios refuerzan estas afirmaciones, entre ellos:

- Cafiero (2001) realizó una investigación con un niño de 13 años con TEA, sin lenguaje y con alteraciones conductuales. La intervención basada en la

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estimulación asistida del lenguaje, realizada en la escuela durante 22 meses, incluyó este tipo de estrategia junto a conversaciones naturales. El niño comenzó usando un tablero de comunicación con 4 palabras y, al final del proceso, incrementó su vocabulario a 29 palabras, mejorando tanto su vocabulario expresivo como receptivo, además de su comportamiento.

- Drager et al. (2006) realizaron un estudio con dos niños en edad preescolar con TEA, cuyos lenguajes funcionales consistían en 30 palabras, con una comprensión menor de 60. Durante 5 meses, implementaron la estimulación asistida del lenguaje a través de tres juegos de acción conjunta, señalando objetos y sus símbolos gráficos, y vocalizando los nombres. Los resultados mostraron un aumento en los símbolos producidos y en la comprensión de ambos niños.
- Hall (2014) llevó a cabo un estudio con un niño de 7 años con TEA mínimamente verbal en un entorno clínico. Utilizando tableros de comunicación basados en temas de interés para el niño durante 18 sesiones, se observó un aumento en la producción de combinaciones de símbolos gráficos y palabras, aunque el efecto sobre la producción de palabras habladas aisladas fue menor.

La intervención basada en la estimulación asistida del lenguaje también ha sido aplicada en diversas patologías, como la afasia (Puig-Pallarols & Basil Almirall, 2013) y la parálisis cerebral (Viera & Reali, 2020), mencionada en este caso como un "andamiaje verbal creado por el interlocutor", mostrando resultados positivos en el área de la comunicación y el lenguaje de los usuarios. En un estudio de Laher y Dada (2023), se evaluó el efecto de la estimulación asistida del lenguaje en la adquisición de vocabulario en seis niños con necesidades complejas de comunicación y discapacidad intelectual grave. Los resultados indicaron que esta

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intervención favorece la adquisición efectiva de vocabulario receptivo durante el periodo de 35 días en el que se llevó a cabo el estudio.

3.2.1 Conceptos y terminología

El término "estimulación asistida del lenguaje" utilizado en España está generando cierta confusión terminológica que merece ser abordada. La traducción literal al inglés sería "*assisted natural language*"; sin embargo, este término no corresponde a un marco, disciplina, modelo ni método de enseñanza de CAA con base en evidencia científica sólida. Más bien, se trata de una de las posibles formas de implementar el modelo de estimulación asistida del lenguaje.

A nivel internacional, se utiliza "*assisted language*" para hacer referencia principalmente al uso de sistemas basados en símbolos gráficos, y "*aided AAC modeling*" o "*augmented input*" para designar las estrategias empleadas en este tipo de intervención (Biggs et al., 2018). Los términos "*assisted natural language*" o "*aided natural language*" son más comunes en contextos relacionados con programación, informática y áreas afines. La estimulación asistida del lenguaje por lo tanto cuenta con respaldo científico, y existen diversas maneras de implementarla.

La modalidad que se aborda en la presente tesis doctoral es la denominada en inglés como "*natural aided language stimulation"* o "*aided augmented input"*, términos que se ajustan a la definición de la estrategia de intervención planteada. Esta estrategia consiste en que los interlocutores modelen el uso de sistemas CAA durante interacciones naturales con el objetivo de fomentar un comportamiento comunicativo específico en el usuario (Acheson et al., 2006; Wandin et al., 2023). En las investigaciones que complementan la tesis y en los estudios de carácter internacional, se ha empleado preferentemente el término "*aided augmented input"* al referirse a la estrategia de intervención.

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3.2.2 Ejemplos de actividades

Existen diversas actividades y enfoques que son compatibles con la estimulación asistida del lenguaje, usando tanto elementos tradicionales en papel (CAA-a) como soportes TIC (CAA+a), para todos los usuarios que requieran este tipo de intervención. Sin embargo, cuando se trabaja con niños con TEA de Grado 3 con necesidades complejas de comunicación, es fundamental que estas actividades se presenten de manera simple, asegurando que los intentos comunicativos sean claros y fácilmente comprensibles.

A continuación, se describen diversas actividades desarrolladas en el marco de esta investigación, orientadas a la estimulación asistida del lenguaje. Estas actividades se caracterizan por su compatibilidad tanto con recursos de CAA-a como con sistemas CAA+a. En este último caso, las ilustraciones utilizadas han sido elaboradas tomando como referencia la aplicación EC+, cuyas especificaciones se detallan en los capítulos posteriores. Además, se incluyen ejemplos visuales para facilitar su comprensión y aplicación práctica.

- Actividad 1: Conciencia del entorno.

Se realiza un juego de acción conjunta basado en contextos reales o en láminas que representen un entorno relacionado con el hogar (Figura 2). El interlocutor debe señalar con el dedo índice un objeto o lugar específico dentro de una habitación, y de forma secuencial, mostrar el símbolo gráfico correspondiente, pronunciando también su nombre de forma clara. Esta actividad tiene como objetivo trabajar la atención selectiva del niño, ayudándole a diferenciar los elementos solicitados mediante su mirada, señalando el objeto nombrado o pronunciando la palabra de manera exacta o aproximada. Una alternativa para este ejercicio podría ser centrarse en la conciencia del propio cuerpo. En este caso, el profesional señalará un pictograma que represente una parte del cuerpo y el

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niño aprenderá a identificar y localizar esa zona, desarrollando una imagen mental de sí mismo como ser físico.

Los pictogramas seleccionados estarán relacionados con el campo semántico de "objetos y lugares de la casa", utilizando imágenes representativas como "ventana", "mesa", "silla", "sofá", "cama", "puerta", "reloj", "móvil", "luz", "escoba", "baño", "suelo", "botella", entre otros. En el caso de la conciencia corporal, se utilizarán pictogramas como "boca", "nariz", "ojos", "cabeza", "manos" o "pies". Estos recursos pueden ser presentados en formato impreso o a través de soportes TIC específicas para este fin.

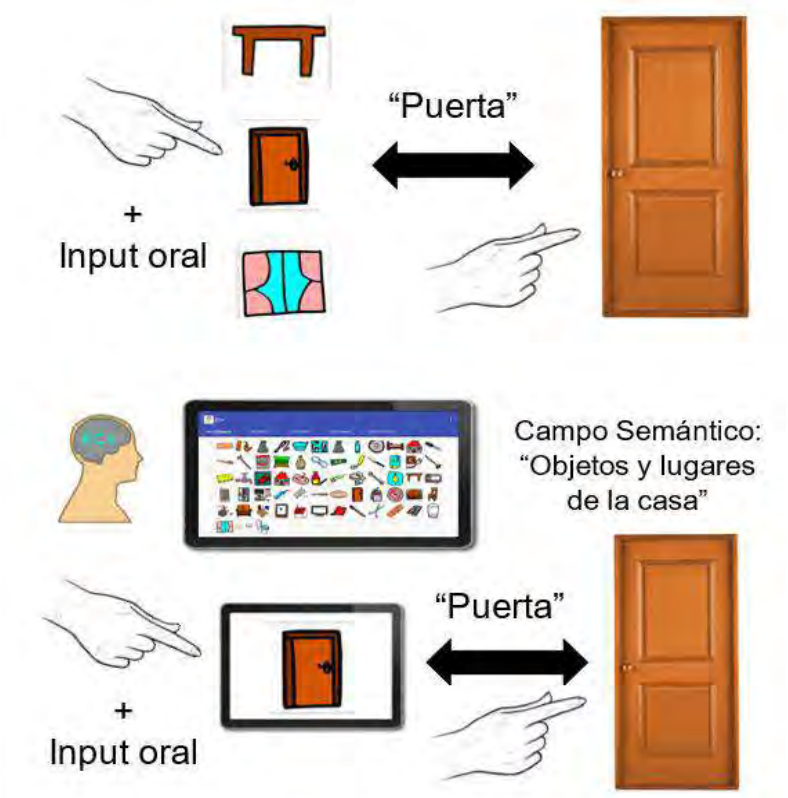


Figura 2: Ilustración del proceso llevado a cabo para la conciencia del entorno

- Actividad 2: Reconocimiento e imitación de emociones.

Esta actividad tiene como objetivo desarrollar la capacidad del niño para reconocer y comprender el comportamiento emocional de los demás, al mismo

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tiempo que se trabaja en su propia conducta. Se utiliza un ejercicio de estimulación asistida del lenguaje en el que el interlocutor señala la imagen que representa la emoción a trabajar y, de manera secuencial, presenta el símbolo gráfico correspondiente, pronunciándola en voz alta (Figura 3). Como alternativa, se podría seguir un proceso similar, pero en lugar de usar imágenes, el propio interlocutor expresa la emoción con su rostro o mediante un juguete adecuado. Después, el niño debe imitar la expresión emocional frente a un espejo, lo que facilita la generalización de esta habilidad y aumenta el impacto del input visual.

Se requiere de pictogramas de emociones como "contento", "triste", "enfadado" o "asustado", entre otras. Los recursos pueden ser presentados en formato impreso o a través de soportes TIC.

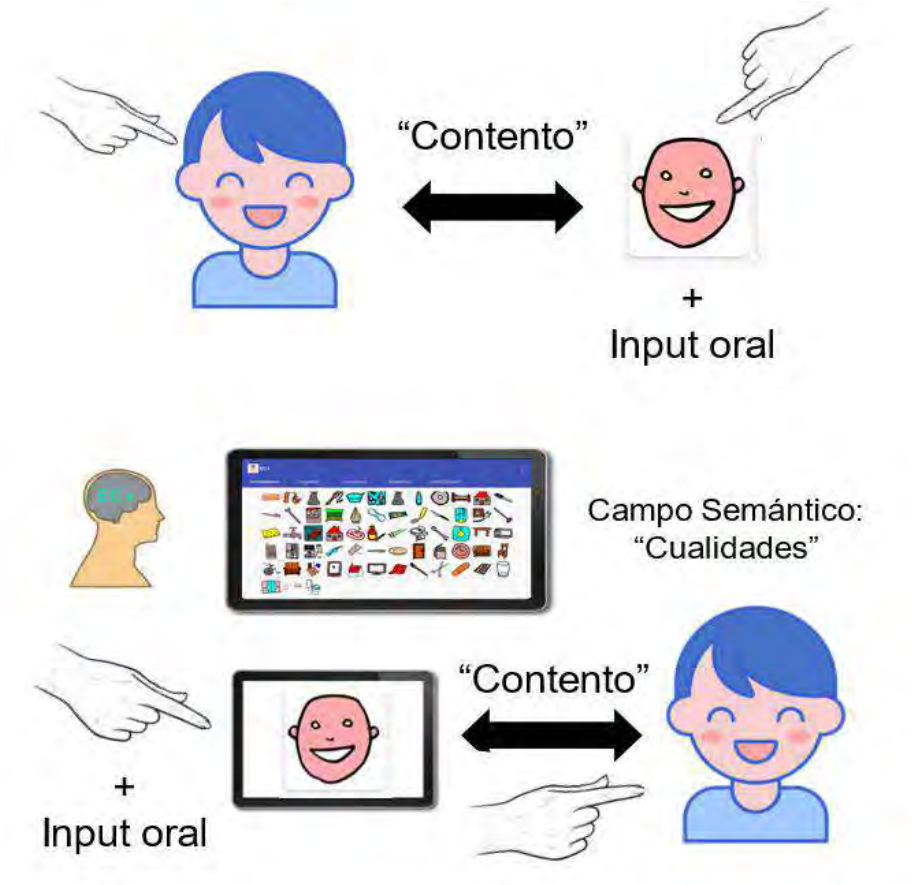


Figura 3: Ilustración del proceso llevado a cabo para el reconocimiento e imitación de emociones

- Actividad 3: Ejercicio de categorías.

Esta actividad utiliza la metodología de la estimulación asistida del lenguaje para ampliar el vocabulario del usuario mediante el trabajo con diferentes campos semánticos, como "alimentos y bebidas", "animales", "ropa" o "vehículos". El objetivo principal es que el niño clasifique un ítem, ya sea en formato de pictograma, fotografía u objeto real, dentro de su categoría correspondiente.

El interlocutor señala un ítem y pronuncia su nombre de forma simultánea (Figura 4). Posteriormente, el niño deberá imitar este procedimiento y clasificar el ítem en su categoría correspondiente. Para facilitar este paso, se pueden usar apoyos visuales como recipientes diferenciados para cada campo semántico o láminas que representen un contexto relacionado con la categoría (por ejemplo, un armario para "ropa" o una nevera para "alimentos y bebidas"). Otra alternativa consiste en presentar al niño todos los ítems de un mismo campo semántico al mismo tiempo; el interlocutor los señala uno a uno, los nombra de manera natural, y al final, el niño debe identificar la categoría común a todos, descartando posibles opciones erróneas.

En este tipo de actividad, se necesitan pictogramas pertenecientes a un mismo campo semántico, junto con láminas o imágenes representativas de ese grupo. Por ejemplo, para "ropa" se puede usar una lámina con un armario; para "alimentos y bebidas", una nevera; para "animales", un bosque o una granja; y para "vehículos", un escenario urbano. Los materiales pueden estar en formato impreso o integrados en soportes digitales.

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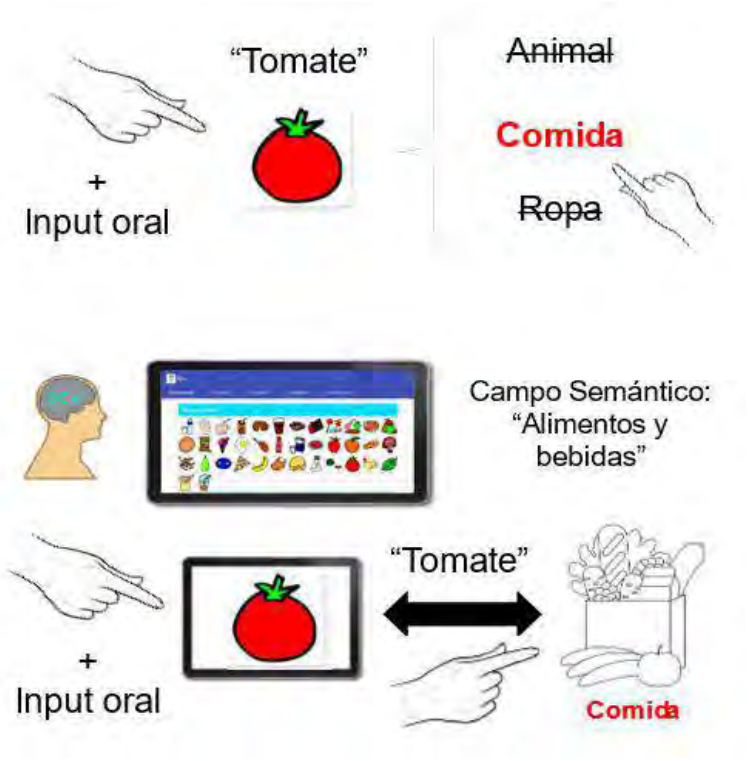


Figura 4: Ilustración del proceso llevado a cabo para el ejercicio de categorías

- Actividad 4: Discriminación de objetos.

Esta actividad tiene como objetivo que el niño aprenda a discriminar un objeto de refuerzo entre otros elementos distractores, basándose en las instrucciones proporcionadas por el interlocutor. Se busca fomentar la comprensión y la respuesta adecuada ante estímulos específicos. Para ello, sobre una superficie despejada se colocan dos objetos diferentes, claramente distinguibles, como un coche y unos bloques de juguete. El interlocutor emite una instrucción sencilla, por ejemplo, "mira el... coche" o "dame los... bloques", mientras señala el pictograma correspondiente y vocaliza el nombre del objeto clave de forma simultánea (Figura 5).

A medida que el niño avanza en su habilidad, el ejercicio puede complicarse incorporando más objetos a la superficie, trabajando con elementos del mismo campo semántico pero con diferencias más sutiles. También se pueden añadir

variantes en las instrucciones, como pedir al niño que nombre el objeto, lo alcance o lo coloque en un lugar determinado.

Se usarán pictogramas relacionados con diferentes campos semánticos, junto con objetos o juguetes reales para favorecer la interacción física y visual, así como la motivación. Los materiales pueden presentarse en formato impreso o mediante soportes TIC.



Figura 5: Ilustración del proceso llevado a cabo para la discriminación de objetos

- Actividad 5: Juego de asociaciones.

Esta actividad consiste en que el niño asocie un ítem con otro que tenga una relación lógica o funcional. Por ejemplo, en el campo semántico de "ropa" y "partes del cuerpo", deberá identificar qué prenda corresponde a cada zona corporal. El objetivo es fomentar el razonamiento lógico, la asociación y el

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enriquecimiento del vocabulario. El interlocutor comienza señalando la imagen de una "mano" y pronunciando su nombre en voz alta. A continuación, señala el pictograma de un "guante" y espera a que el niño lo asocie colocándolo junto a la imagen de la mano (Figura 6).

Siguiendo esta dinámica, se pueden realizar otras asociaciones como "cabeza" con "gorro", "pies" con "zapatos", y "cuello" con "bufanda". Además, la actividad puede ampliarse para incluir otras asociaciones lógicas, como clasificar por tamaño, color, o identificar si un alimento es sólido o líquido. En todos los casos, se empleará la estimulación asistida del lenguaje para reforzar las asociaciones y ofrecer feedback continuo. Se necesitan láminas y pictogramas diseñados para facilitar la asociación entre distintos elementos.

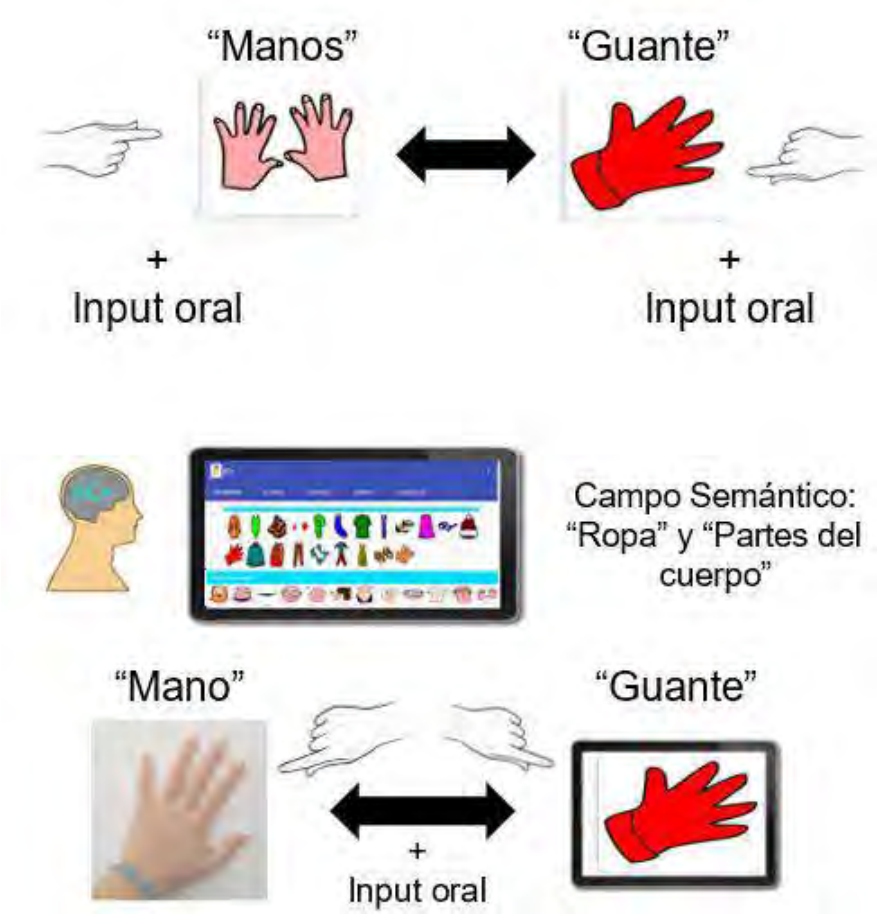


Figura 6: Ilustración del proceso llevado a cabo para juego de asociaciones

- Actividad 6: Creación de frases.

Esta actividad tiene como objetivo fomentar el desarrollo del lenguaje y sus componentes básicos mediante la construcción de frases simples. Se trabajará con una estructura inicial compuesta por un artículo, un sustantivo y un adjetivo para describir objetos de forma clara y accesible.

Cada elemento de la frase se representará con un pictograma correspondiente que el interlocutor irá señalando secuencialmente, en consonancia con el enfoque de la estimulación asistida del lenguaje (Figura 7). Los componentes de la frase se presentarán de manera individual y progresiva, permitiendo al niño procesar cada parte antes de integrar el conjunto completo.

La actividad es altamente adaptable, de modo que, en caso de que el usuario desarrolle nuevas habilidades lingüísticas, se podrán incorporar elementos adicionales a las frases, como verbos, complementos, otros determinantes o sujetos múltiples, favoreciendo la complejidad progresiva.

Se requieren pictogramas que representen los artículos, sustantivos y adjetivos necesarios para construir las frases, pudiendo complementarlos con la palabra escrita para fomentar habilidades de lectoescritura. No obstante, esta no se considera una actividad sencilla, ya que requiere una planificación cuidadosa y la selección precisa de los elementos visuales. Por este motivo, su implementación estará limitada a complementar las oraciones del interlocutor, asegurando que su uso esté debidamente justificado dentro del contexto comunicativo.

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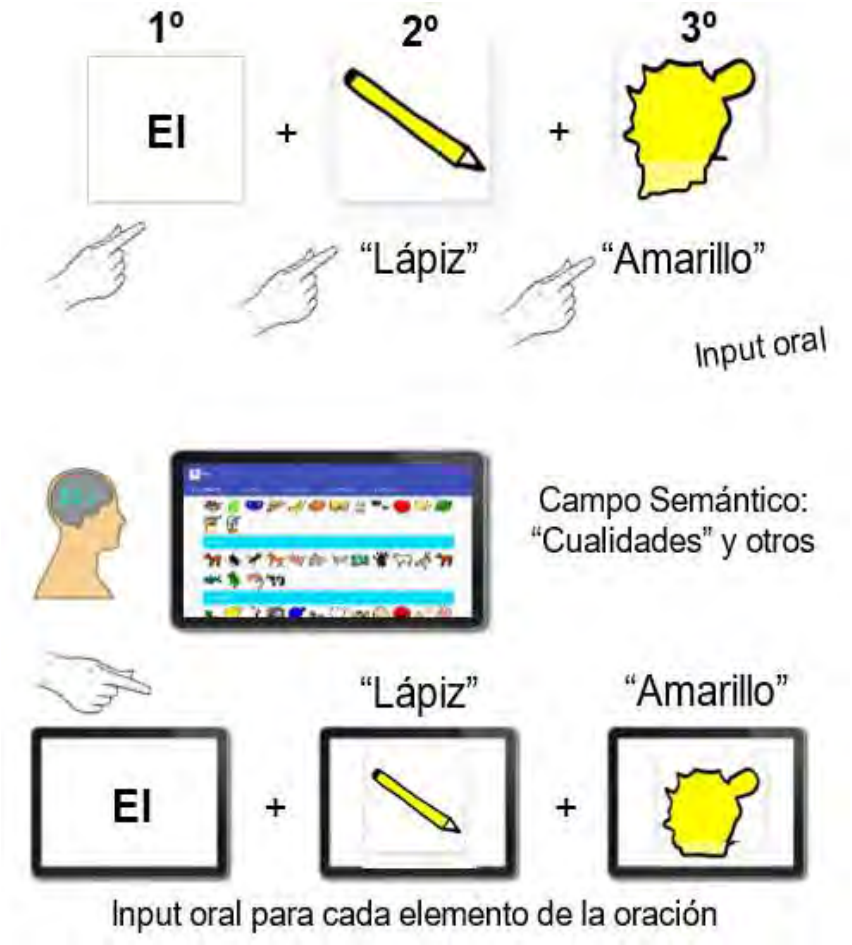


Figura 7: Ilustración del proceso llevado a cabo para creación de frases

- Actividad 7: Juego de las posiciones.

Esta actividad está diseñada para trabajar la preposiciones y locativos. A través de la estimulación asistida del lenguaje, el niño aprenderá a identificar y expresar la posición de un objeto específico en el espacio. Además, desarrollará su capacidad para manipular el entorno, colocando el objeto en posiciones distintas según las indicaciones proporcionadas.

El interlocutor seleccionará un punto estático previamente definido, como una caja o un juguete, y usará un objeto móvil que será colocado en distintas posiciones en relación con ese punto. De acuerdo con la estrategia de la estimulación asistida del lenguaje, señalará el pictograma correspondiente a la preposición y vocalizará el término en voz alta. Ejemplos de posiciones trabajadas

incluyen “arriba”, “abajo”, “delante” y “detrás” (Figura 8). La actividad puede repetirse en diferentes contextos para reforzar el aprendizaje.

Se necesitan pictogramas representativos de preposiciones y locativos, ya sea en formato impreso o mediante soportes TIC. Además, se emplearán objetos cotidianos y llamativos como cajas o juguetes que permitan realizar las actividades de manipulación y colocación en el espacio.

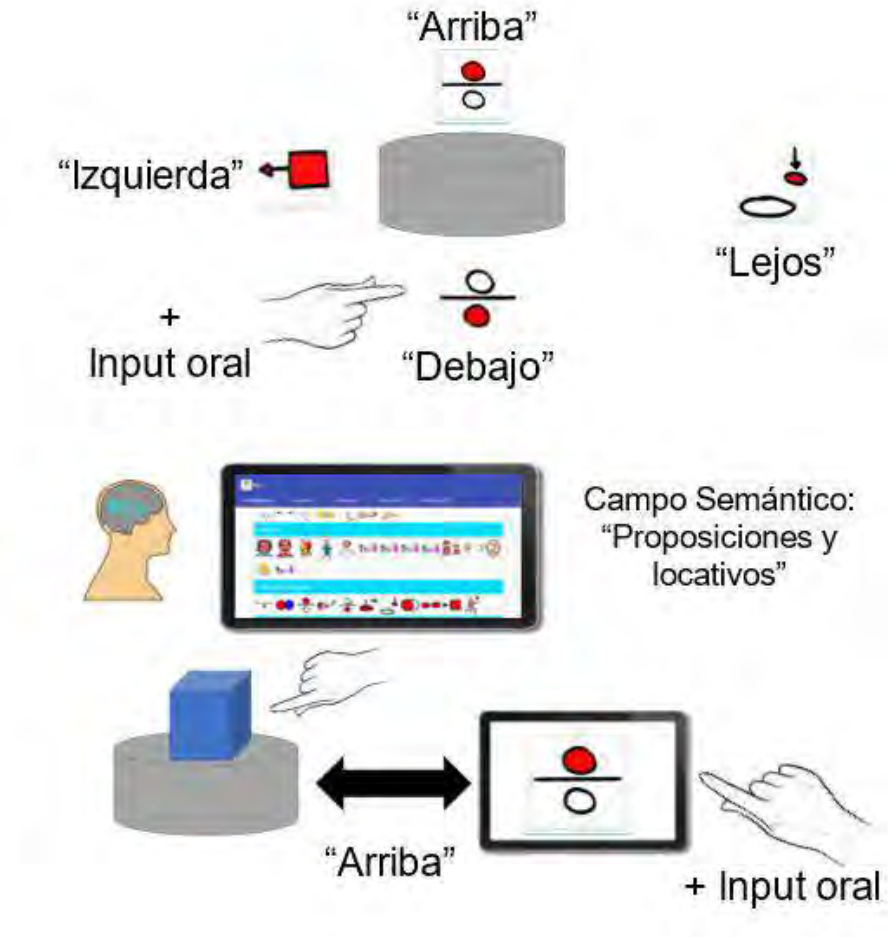


Figura 8: Ilustración del proceso llevado a cabo para juego de las posiciones

- Actividad 8: Ejercicio de bien y mal.

Esta actividad está diseñada para trabajar el reconocimiento y manejo de historias sociales de forma accesible, con un enfoque en el autocontrol y en la comprensión de diferentes situaciones hipotéticas. El objetivo principal es que el

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usuario sea capaz de identificar si un comportamiento observado es adecuado o inapropiado (Figura 9).

Se presentará una lámina que ilustre una situación específica y se deberá decidir si lo que ocurre está "bien" o "mal". El interlocutor empleará la estimulación asistida del lenguaje señalando el pictograma correspondiente y pronunciando en voz alta "bien" cuando se trate de un acto positivo (por ejemplo, abrazar a alguien o lavarse las manos) o "mal" para una acción negativa (como arañar a otra persona o romper algo en un estado de enfado).

Este ejercicio permite fomentar la reflexión sobre conductas y desarrollar habilidades sociales de manera progresiva. Además, si ocurre algún tipo de conducta negativa o positiva durante la sesión, se pueden implementar estos elementos como reforzadores.

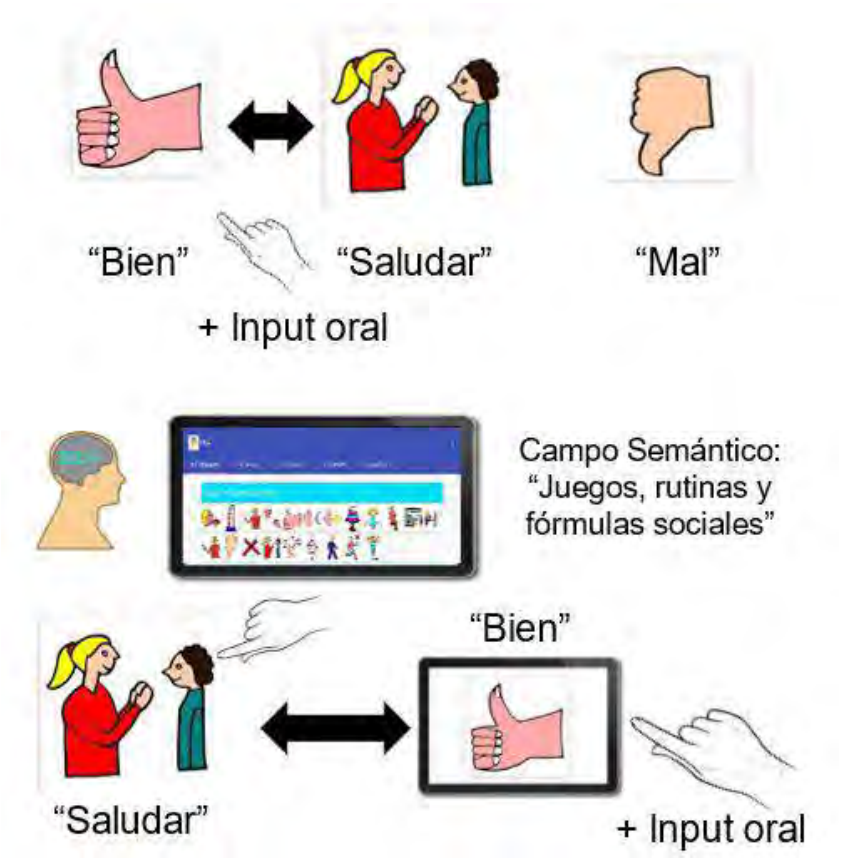


Figura 9: Ilustración del proceso llevado a cabo para ejercicio de bien y mal

Estos ocho ejemplos de actividades compatibles con la estimulación asistida del lenguaje se proponen como recomendaciones para su implementación en la intervención con niños con TEA de Grado 3. No obstante, es fundamental tener en cuenta su carácter orientativo y flexible, evitando interpretarlos como un modelo cerrado. El objetivo es ofrecer un marco de trabajo común para los participantes de los estudios posteriores, pero permitiendo modificaciones según las necesidades específicas.

En este sentido, las actividades pueden adaptarse alternando su orden o modificando los elementos, además de incluir otros ejercicios y juegos que aprovechen las características de la estrategia de intervención. Asimismo, es importante descartar aquellas actividades que resulten excesivamente complejas para el usuario y que puedan dificultar su comprensión o participación. Se sugiere también aprovechar recursos no contemplados en los ejemplos presentados, como tableros de comunicación u otras herramientas relevantes.

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La clave radica en personalizar las actividades a las características individuales de cada niño, optimizando su diseño y aplicación para maximizar los beneficios de la intervención. En este sentido resulta fundamental reflexionar sobre la cantidad de símbolos que se utilizarán, las características específicas de los pictogramas seleccionados y el tipo de vocabulario incluido en el soporte empleado (Jonsson et al., 2011). Este análisis será relevante tanto para los usuarios como para los interlocutores, ya que permitirá evaluar las reacciones de los niños al señalar el símbolo correspondiente mientras se verbaliza. El objetivo principal es identificar indicadores que confirmen si el sistema de pictogramas elegido es adecuado, contribuyendo a un aumento en la comprensión y facilitando el desarrollo de habilidades para generar una comunicación expresiva en aquellas

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personas que no dispongan de un habla funcional (González, 2018), como ocurre con las necesidades complejas de comunicación.

3.3. Factores que influyen en los interlocutores

Tal como se ha evidenciado en la definición de la estimulación asistida del lenguaje y en los ejemplos previamente expuestos, el papel del interlocutor resulta clave para garantizar una implementación adecuada de esta estrategia de intervención basada en la CAA. De hecho, la eficacia de la CAA en personas con necesidades complejas de comunicación no depende únicamente de la tecnología empleada, los soportes disponibles o los sistemas simbólicos seleccionados, sino que está profundamente influida por la implicación, el conocimiento y las habilidades de sus interlocutores. En esta línea, Hanley et al. (2024) identifican diversos factores que inciden en la efectividad comunicativa de los interlocutores (o "*communication partners*", en la literatura anglosajona). Para que su participación en el proceso comunicativo resulte óptima, es necesario que se cumplan una serie de condiciones que han sido consideradas de forma constante a lo largo del desarrollo de la presente tesis y las investigaciones que la conforman. Estos factores pueden agruparse en cuatro dimensiones principales:

- Conocimiento y competencia sobre la CAA.

Uno de los principales factores identificados es el nivel de conocimiento que poseen los interlocutores sobre la CAA, incluyendo su formación previa y su experiencia práctica. Se ha observado que un conocimiento insuficiente de estos sistemas puede derivar en un uso inconsistente o inadecuado, limitando las oportunidades de comunicación de los usuarios (Hanley et al., 2023). En este sentido, autores como Beukelman y Light (2020) subrayan la importancia de una formación estructurada y continua que permita a los interlocutores desarrollar

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competencias técnicas y relacionales en el uso de la CAA, adaptadas a las necesidades comunicativas de cada usuario.

Asimismo, Brady et al. (2016) sostienen que una evaluación adecuada de las capacidades comunicativas de la persona es fundamental para guiar intervenciones eficaces. Sin este conocimiento, los interlocutores pueden subestimar el potencial comunicativo de la persona y, en consecuencia, limitar sus oportunidades de participación dentro y fuera de las sesiones de intervención.

- Actitudes hacia la CAA y expectativas de comunicación.

Las actitudes de los interlocutores —que abarcan creencias, valores y expectativas sobre la comunicación del usuario— influyen considerablemente en la manera en que se implementan los sistemas de CAA. Hanley et al. (2023) destacan que incluso cuando los interlocutores tienen conocimientos sobre la CAA, si no creen en su efectividad o consideran que la persona no tiene intención comunicativa, su uso será restringido. Esto se relaciona con lo señalado por otros autores (Chua & Gorgon, 2019; Conlon & Zupan, 2024; Wormnæs & Abdel Malek, 2004), quienes encontraron que las actitudes negativas o escépticas hacia la CAA constituyen una de las principales barreras para su implementación en contextos clínicos y educativos

Además, existe una tendencia a que los interlocutores asuman que, por conocer bien al usuario, no es necesario utilizar apoyos comunicativos formales. Sin embargo, esta suposición puede invisibilizar necesidades comunicativas reales, limitando el desarrollo de interacciones más ricas y significativas (Goldbart et al., 2014).

- Compromiso compartido y dinámica colaborativa.

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Otro factor clave identificado es el nivel de compromiso y coordinación entre los diferentes interlocutores implicados en el entorno de la persona usuaria de CAA. La falta de claridad en los roles y responsabilidades, así como la ausencia de colaboración interprofesional y familiar, pueden dificultar la continuidad del uso de la CAA en distintos contextos.

Este compromiso compartido no solo implica una disposición individual, sino también la creación de condiciones organizativas que faciliten el trabajo conjunto, como tiempos específicos para planificar y revisar las estrategias comunicativas, como es el caso de la estimulación asistida del lenguaje. Lund y Light (2007) argumentan que los resultados a largo plazo en el uso de la CAA están significativamente asociados con entornos que promueven una responsabilidad compartida entre profesionales, familiares y cuidadores.

- Adecuación del sistema de CAA a las necesidades individuales.

Por último, la adecuación del sistema de CAA utilizado —ya sea mediante objetos de referencia, tableros pictográficos o soportes electrónicos— debe responder a las características sensoriales, cognitivas y relacionales del usuario. Una selección no ajustada puede generar frustración tanto en esta persona como en sus interlocutores, reduciendo la frecuencia y calidad de las interacciones (Hanley et al., 2023).

Rombouts et al. (2017) analizan cómo el comportamiento de los interlocutores puede facilitar o inhibir el uso de CAA, dependiendo de cómo se ajusten las estrategias comunicativas al contexto y a la persona. En muchos casos, la selección y uso adecuados del sistema requieren un proceso de ensayo y error guiado por la observación y la reflexión compartida entre los miembros del equipo de apoyo, especialmente en casos de TEA severo.

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Por todo lo anterior, en el desarrollo de los estudios que soportan el aspecto experimental de esta tesis, han participado logopedas —incluido el propio autor de este trabajo— con formación específica en el uso de la CAA, así como con experiencia práctica en su aplicación. Estos profesionales reúnen las condiciones necesarias para garantizar la correcta implementación de la estimulación asistida del lenguaje, cumpliendo con los factores clave descritos. Gracias a ello, ha sido posible optimizar la intervención y favorecer resultados sostenibles y significativos a lo largo del tiempo.

3.4 Referencias

Acheson, M. J., Zins, J. E., Feldis, D. & Grether, S. M. (2006). *The effect of natural aided language stimulation on requesting desired objects or actions in children with autism spectrum disorder* [Doctoral dissertation, University of Cincinnati]. ProQuest Dissertations Publishing. https://www.proquest.com/docview/305361843?pqorigsite=gscholar&fromopenview=true

Agius, M. M., Stansfield, J., & Murray, J. (2024). A comparison of differing organizational formats for teaching requesting skills to children with autism. *Augmentative and Alternative Communication*, 1-12. https://doi.org/10.1080/07434618.2024.2370825

ASHA (American Speech-Language-Hearing Association) (2024). *Augmentative and Alternative Communication Systems.* https://www.asha.org/public/speech/spanish/los-sistemas-aumentativos-y-alternativos-de-comunicacion/

Aspiranti, K. B., Larwin, K. H., & Schade, B. P. (2020). iPads/tablets and students with autism: A meta-analysis of academic effects. *Assistive Technology, 32*(1), 23–30. https://doi.org/10.1080/10400435.2018.1463575

Beck, A. R., Stoner, J. B., & Dennis, M. L. (2009). An investigation of aided language stimulation: Does it increase AAC use with adults with developmental disabilities

and complex communication needs?. *Augmentative and Alternative Communication*, *25*(1), 42-54. https://doi.org/10.1080/07434610802131059

Beukelman, D. R., & Light, J. C. (2020). *Augmentative & Alternative Communication: Supporting Children and Adults with Complex Communication Needs* (5th ed.). Paul H. Brookes Publishing.

Biggs, E. E., Carter, E. W., & Gilson, C. B. (2018). Systematic review of interventions involving aided AAC modeling for children with complex communication needs. *American Journal on Intellectual and Developmental Disabilities*, *123*(5), 443-473. https://doi.org/10.1352/1944-7558-123.5.443

Brady, N. C., Bruce, S., Goldman, A., Erickson, K., Mineo, B., Ogletree, B. T., ... & Wilkinson, K. (2016). Communication services and supports for individuals with severe disabilities: Guidance for assessment and intervention. *American Journal on Intellectual and Developmental Disabilities*, *121*(2), 121-138. https://doi.org/10.1352/1944-7558-121.2.121

Cafiero, J. M. (2001). The effect of an augmentative communication intervention on the communication, behavior, and academic program of an adolescent with autism. *Focus on Autism and Other Developmental Disabilities*, 16(3), 179-189. https://doi.org/10.1177/108835760101600306

Calleja Reina, M & Rodríguez, J. M. (2018). *La comunicación aumentativa y alternativa para hacer frente a las necesidades complejas de comunicación en usuarios de bajo perfil cognitivo*. In Postigo Pinazo, E., Calleja Reina, M., & Gabau Vila, E. (2018). Disability and Communication. Scientific Analysis, Total Communication and ICT Tools and Case Studies (pp. 163-174). McGraw Hill Education.

Calleja Reina, M., & Sotillo Méndez, M. (2023). *Comunicación Aumentativa y Alternativa: 40 años de Desarrollo en España y Retos Futuros*. Peter Lang.

Cardillo, R., Lanfranchi, S., & Mammarella, I. C. (2020). A cross-task comparison on visuospatial processing in autism spectrum disorders. *Autism*, 24(3), 765–779. https://doi.org/10.1177/1362361319888341

UNIVERSIDAD DE MÁLAGA

Casado, S., Inmaculada, J., & Merino, J. M. B. (2013). Comunicación Alternativa Aumentativa (CAA): Análisis de este nuevo escenario inclusivo. *International Journal of Developmental and Educational Psychology*, 1(1), 673-683. Available from: https://www.redalyc.org/articulo.oa?id=349852058057

Chazin, K. T., Barton, E. E., Ledford, J. R., & Pokorski, E. A. (2018). Implementation and intervention practices to facilitate communication skills for a child with complex communication needs. *Journal of Early Intervention*, *40*(2), 138-157. https://doi.org/10.1177/1053815118771397

Chazin, K. T., Ledford, J. R., & Pak, N. S. (2021). A systematic review of augmented input interventions and exploratory analysis of moderators. *American Journal of Speech-Language Pathology*, 30(3), 1210-1223. https://doi.org/10.1044/2020_AJSLP-20-00102

Chua, E. C. K., & Gorgon, E. J. R. (2019). Augmentative and alternative communication in the Philippines: A survey of speech-language pathologist competence, training, and practice. *Augmentative and Alternative Communication*, *35*(2), 156-166. https://doi.org/10.1080/07434618.2019.1576223

Conlon, C., & Zupan, B. (2024). The knowledge, confidence and attitudes of Australian speech-language pathologists in augmentative and alternative communication for children and young people. *Journal of Clinical Practice in Speech-Language Pathology*, *26*(1), 3-19. https://doi.org/10.1080/22000259.2024.2316925

Crowe, B., Machalicek, W., Wei, Q., Drew, C., & Ganz, J. (2022). Augmentative and alternative communication for children with intellectual and developmental disability: A mega-review of the literature. *Journal of Developmental and Physical Disabilities*, 1-42. https://doi.org/10.1007/s10882-021-09790-0

Di Mascio, T., Tarantino, L., Cirelli, L., Peretti, S., & Mazza, M. (2019). Designing a personalizable ASD-oriented AAC tool: an action research experience. In *Methodologies and Intelligent Systems for Technology Enhanced Learning, 8th*

UNIVERSIDAD DE MÁLAGA

International Conference 8 (pp. 200-209). Springer International Publishing. https://doi.org/10.1007/978-3-319-98872-6_24

Dietz, A., Quach, W., Lund, S. K., & MCKeLvey, M. (2012). AAC assessment and clinical-decision making: The impact of experience. *Augmentative and Alternative Communication*, *28*(3), 148-159. https://doi.org/10.3109/07434618.2012.704521

Drager, K. D., Postal, V. J., Carrolus, L., Castellano, M., Gagliano, C., & Glynn, J. (2006). The effect of aided language modeling on symbol comprehension and production in 2 preschoolers with autism. *American Journal of Speech-Language Pathology*. https://doi.org/10.1044/1058-0360(2006/012)

Esposito, M., Sloan, J., Tancredi, A., Gerardi, G., Postiglione, P., Fotia, F., Napoli, E., Mazzone, L., Valeri, G., & Vicari, S. (2017). Using tablet applications for children with autism to increase their cognitive and social skills. *Journal of Special Education Technology*, 32(4), 199-209. https://doi.org/10.1177/0162643417719751

Flippin, M., Reszka, S., & Watson, L. R. (2010). Effectiveness of the Picture Exchange Communication System (PECS) on communication and speech for children with autism spectrum disorders: A meta-analysis. *American Journal of Speech-Language Pathology*, 19(2), 178-195. https://doi.org/10.1044/1058-0360(2010/09-0022)

Frost, L. A., & Bondy, A. S. (1985). PECS training manual. Newark: Pyramid Educational Consultants.

García, F. C., Gabriela, H., & Flores, H. G. H. (2009). La comunicación alternativa en nuestros días: un acercamiento a los medios de la alternancia y la participación. *Razón y Palabra*, 70. Available from: https://dialnet.unirioja.es/servlet/articulo?codigo=3104452

Gavilán, M. S. C. (2022). Uso de las TIC en el proceso de enseñanza-aprendizaje en estudiantes del primer y segundo ciclo de la educación escolar básica. *Ciencia*

UNIVERSIDAD DE MÁLAGA

Latina Revista Científica Multidisciplinar, *6*(6), 8354-8371. https://doi.org/10.37811/cl_rcm.v6i6.4002

Ghanouni, P., Jarus, T., Zwicker, J. G., & Lucyshyn, J. (2020). The use of technologies among individuals with autism spectrum disorders: Barriers and challenges. *Journal of Special Education Technology*, 35(4), 286-294. https://doi.org/10.1177/0162643419888765

Goldbart, J., Chadwick, D., & Buell, S. (2014). Speech and language therapists' approaches to communication intervention with children and adults with profound and multiple learning disability. *International Journal of Language & Communication Disorders*, *49*(6), 687-701. https://doi.org/10.1111/1460-6984.12098

Gómez-Taibo, M. L., & García-Eligio de la Puente, M. T. (2016). Una revisión sobre la aplicación de estrategias para aumentar el input de la comunicación aumentativa y alternativa asistida en personas con trastornos del desarrollo. *Revista de Logopedia, Foniatría y Audiología*, 36(1), 23-35. https://dialnet.unirioja.es/servlet/articulo?codigo=5517651

Gómez-Taibo, M. L., & García-Eligio de la Puente, M. T. (2018). La intervención de la comunicación aumentativa y alternativa en el traumatismo craneoencefálico. *Revista de Investigación en Logopedia*, *8*(1), 43-62. http://dx.doi.org/10.5209/RLOG.59529

González, A. L. (2018). Intervenciones focalizadas basadas en la evidencia dirigidas al alumnado con trastorno del espectro autista. *Siglo Cero*, 49(2), 73-87. http://dx.doi.org/10.14201/scero20184927387

Goossens, C., & Crain, S. (1986). *Establishing multiple communication displays. Augmentative communication: An introduction*, 337-344.

Hall, A. R. (2014). *Semantically-based therapeutic approach through aided language stimulation in a child with autism spectrum disorder* (Doctoral dissertation). Duquesne University, Pittsburgh, PA.

UNIVERSIDAD DE MÁLAGA

https://www.proquest.com/openview/6a97b3df621998998ffd417fa37d643c/1?pq-origsite=gscholar&cbl=18750

Hanley, E., Lehane, E., Martin, A. M., & Dalton, C. (2024). Factors influencing communication partners of persons with severe/profound intellectual disability use of augmentative and alternative communication: An integrative review. *Disability and Rehabilitation: Assistive Technology*, *19*(7), 2454-2470. https://doi.org/10.1080/17483107.2024.2313079

Hanley, E., Martin, A. M., Dalton, C., & Lehane, E. (2023). Communication partners experiences of communicating with adults with severe/profound intellectual disability through augmentative and alternative communication: A mixed methods systematic review. *Journal of Intellectual Disabilities*, *27*(4), 1107-1134. https://doi.org/10.1177/17446295221115914

Jagaroo, V., & Wilkinson, K. (2008). Further considerations of visual cognitive neuroscience in aided AAC: The potential role of motion perception systems in maximizing design display. *Augmentative and Alternative Communication*, *24*(1), 29-42. https://doi.org/10.1080/07434610701390673

Jonsson, A., Kristoffersson, L., Ferm, U., & Thunberg, G. (2011). The ComAlong communication boards: parents' use and experiences of aided language stimulation. *Augmentative and Alternative Communication*, 27(2), 103-116. https://doi.org/10.3109/07434618.2011.580780

Laher, Z., & Dada, S. (2023). The effect of aided language stimulation on the acquisition of receptive vocabulary in children with complex communication needs and severe intellectual disability: a comparison of two dosages. *Augmentative and Alternative Communication*, 1-14. https://doi.org/10.1080/07434618.2022.2155566

Landa R. J. (2018). Efficacy of early interventions for infants and young children with, and at risk for, autism spectrum disorders. *International Review of Psychiatry*, 30(1), 25–39. https://doi.org/10.1080/09540261.2018.1432574

UNIVERSIDAD DE MÁLAGA

Lang, R., Hancock, T. B., & Singh, N. N. (Eds.). (2016). Early intervention for young children with autism spectrum disorder. *Springer*.

Liang, J., & Wilkinson, K. (2018). Gaze toward naturalistic social scenes by individuals with intellectual and developmental disabilities: Implications for augmentative and alternative communication designs. *Journal of Speech, Language, and Hearing Research*, *61*(5), 1157-1170. https://doi.org/10.1044/2018_JSLHR-L-17-0331

Light, J. C., Drager, K. D., & Nemser, J. G. (2004). Enhancing the appeal of AAC technologies for young children: Lessons from the toy manufacturers. *Augmentative and Alternative Communication*, 20, 3, 137-149. https://doi.org/10.1080/07434610410001699735

Light, J., Wilkinson, K. M., Thiessen, A., Beukelman, D. R., & Fager, S. K. (2019). Designing effective AAC displays for individuals with developmental or acquired disabilities: State of the science and future research directions. *Augmentative and Alternative Communication*, *35*(1), 42-55. https://doi.org/10.1080/07434618.2018.1558283

Logan, K., Iacono, T. & Trembath, D. (2017). A systematic review of research into aided AAC to increase social-communication functions in children with autism spectrum disorder. *Augmentative and Alternative Communication*, 33(1), 51-64. https://doi.org/10.1080/07434618.2016.1267795

Lund, S. K., & Light, J. (2007). Long-term outcomes for individuals who use augmentative and alternative communication: Part III–contributing factors. *Augmentative and Alternative Communication*, *23*(4), 323-335. https://doi.org/10.1080/02656730701189123

Lund, S. K., Quach, W., Weissling, K., McKelvey, M., & Dietz, A. (2017). Assessment with children who need augmentative and alternative communication (AAC): Clinical decisions of AAC specialists. *Language, Speech, and Hearing Services in Schools*, *48*(1), 56-68. https://doi.org/10.1044/2016_LSHSS-15-0086

UNIVERSIDAD DE MÁLAGA

Martínez Abella, A. (2023). *Las Tecnologías de la Información y la Comunicación (TIC) como herramienta para la intervención del alumnado con Trastorno del Espectro Autista (TEA)*. Repositorio Institucional de la Universidad de Oviedo.

Muttiah, N., Drager, K. D., Beale, B., Bongo, H., & Riley, L. (2022). The effects of an intervention using low-tech visual scene displays and aided modeling with young children with complex communication needs. *Topics in Early Childhood Special Education*, 42(1), 91-104. https://doi.org/10.1177/0271121419844825

O'Neill, T., Light, J., & Pope, L. (2018). Effects of Interventions That Include Aided Augmentative and Alternative Communication Input on the Communication of Individuals with Complex Communication Needs: A Meta-Analysis. *Journal of Speech, Language, and Hearing Research: JSLHR*, 61(7), 1743–1765. https://doi.org/10.1044/2018_JSLHR-L-17-0132

Pereira, E. T., Montenegro, A., Rosal, A., & Walter, C. (2020). Augmentative and Alternative Communication on Autism Spectrum Disorder: Impacts on Communication. *CoDAS*, 32(6). https://doi.org/10.1590/2317-1782/20202019167

Puig-Pallarols, M. C., & Basil Almirall, C. (2013). Comunicación aumentativa y alternativa para personas con afasia. *Revista de Logopedia, Foniatría y Audiología*, 33(3), 126-135. https://doi.org/10.1016/j.rlfa.2012.10.004

Rombouts, E., Maes, B., & Zink, I. (2017). The behavioural process underlying augmentative and alternative communication usage in direct support staff. *Journal of Intellectual & Developmental Disability*, *42*(2), 101-113. https://doi.org/10.3109/13668250.2016.1219023

Santos, P. D. A., Bordini, D., Scattolin, M., Asevedo, G. R. D. C., Caetano, S. C., Paula, C. S., ... & Tamanaha, A. C. (2021). The Impact of the Implementation of the Picture Exchange Communication System–PECS on Understanding Instructions in Children with Autism Spectrum Disorders. *CoDAS*, 33. https://doi.org/10.1590/2317-1782/20202020041

UNIVERSIDAD DE MÁLAGA

Scarcella, I., Marino, F., Failla, C., Doria, G., Chilà, P., Minutoli, R., ... & Pioggia, G. (2023). Information and communication technologies-based interventions for children with autism spectrum conditions: a systematic review of randomized control trials from a positive technology perspective. Frontiers in Psychiatry, 14, 1212522.

Schlosser, R., & Sigafoos, J. (2002). Selecting graphic symbols for an initial request lexicon: Integrative review. *Augmentative and Alternative Communication*, 18(2), 102-123. https://doi.org/10.1080/07434610212331281201

Semino, S., Zanobini, M., & Usai, M. C. (2021). Visual memory profile in children with high functioning autism. *Applied Neuropsychology: Child*, *10*(1), 26-36. https://doi.org/10.1080/21622965.2019.1594231

Sennott, S. C., Light, J. C., & McNaughton, D. (2016). AAC modeling intervention research review. *Research and Practice for Persons with Severe Disabilities*, 41(2), 101-115. https://doi.org/10.1177/1540796916638822

Sevcik, R. A., Barton-Hulsey, A., & Romski, M. (2008). Early intervention, AAC, and transition to school for young children with significant spoken communication disorders and their families. *Seminars in Speech and Language*, 29(2), 92–100. https://doi.org/10.1055/s-2008-1079123

Suárez Gómez, L. A. (2013). Diseño de un plan de intervención en comunicación aumentativa y alternativa como medio para mejorar la interacción comunicativa en un estudiante con síndrome de Down (Tesis de posgrado). *Universidad Pedagógica Nacional, Bogotá DC, Colombia*.

Thiessen, A., Brown, J., Beukelman, D., & Hux, K. (2017). The effect of human engagement depicted in contextual photographs on the visual attention patterns of adults with traumatic brain injury. *Journal of Communication Disorders*, *69*, 58-71. https://doi.org/10.1016/j.jcomdis.2017.07.001

UNIVERSIDAD DE MÁLAGA

Thistle, J. J., & Wilkinson, K. M. (2012). What are the attention demands of aided AAC?. *Perspectives on Augmentative and Alternative Communication*, *21*(1), 17-22. https://doi.org/10.1044/aac21.1.17

Thistle, J. J., & Wilkinson, K. M. (2013). Working memory demands of aided augmentative and alternative communication for individuals with developmental disabilities. *Augmentative and Alternative Communication*, *29*(3), 235-245. https://doi.org/10.3109/07434618.2013.815800

Valencia, K., Rusu, C., Quiñones, D., & Jamet, E. (2019). The impact of technology on people with autism spectrum disorder: a systematic literature review. *Sensors*, 19(20), 4485. https://doi.org/10.3390/s19204485

Viera, A., & Reali, F. (2020). Comunicación aumentativa y alternativa y construcción narrativa en niños con parálisis cerebral. *Polyphonía: Revista de Educación Inclusiva*, *4*(1).

Wandin, H., Tegler, H., Svedberg, L., & Johnels, L. (2023). A Scoping Review of Aided AAC Modeling for Individuals With Developmental Disabilities and Emergent Communication. *Current Developmental Disorders Reports*, *10*(2), 123-131. https://doi.org/10.1007/s40474-023-00275-7

Wilkinson, K. M., & Light, J. (2014). Preliminary study of gaze toward humans in photographs by individuals with autism, Down syndrome, or other intellectual disabilities: Implications for design of visual scene displays. *Augmentative and Alternative Communication*, *30*(2), 130-146. https://doi.org/10.3109/07434618.2014.904434

Wormnæs, S., & Abdel Malek, Y. (2004). Egyptian speech therapists want more knowledge about augmentative and alternative communication. *Augmentative and Alternative Communication*, *20*(1), 30-41. https://doi.org/10.1080/07434610310001629571

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4

Effects of aided augmented input in autism spectrum disorder: A scoping review

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4.1 Introduction

The need to improve the quality of life for people with complex communication needs has led to the use of augmentative and alternative communication (AAC) with or without assistance in numerous interventions (Cerpa Reyes et al., 2023). In this context, recent research has highlighted the effectiveness of AAC interventions for autism spectrum disorder (ASD) who have these needs, especially children, showing an increase in communicative opportunities (Landa, 2018; Lorah et al., 2024; Pereira et al., 2020; Therrien et al., 2016).

Due to its characteristics, aided augmented input emerges as an approach that can be beneficial for users with ASD who have complex communication needs (Biggs et al., 2018; Drager, 2009). However, previous reviews of this strategy are limited, outdated, or have focused on other intervention methodologies related to language modeling implementation (Chazin et al., 2021; Sennott et al., 2016; Wandin et al., 2023). For example, training with large amounts of linguistic input can help individuals learn grammatical and semantic patterns and rules, thus producing coherent and relevant texts or speeches (Gibson et al., 2021; Jensen de López et al., 2022; Shi et al., 2021). This differs from aided augmented input, where additional support is provided to promote receptive and expressive communicative skills during natural interactions. This approach combines the interlocutor's spoken language (oral input) with corresponding pictograms (visual input), aiming to facilitate a communicative response from the user (Goossens & Crain, 1986).

Consequently, the purpose of this scoping review was to deepen knowledge about aided augmented input interventions and their effects on participants with ASD, by systematizing the available information. This chapter aims not only to

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consolidate understanding in this area of study in a simplified manner but also to facilitate the design of future interventions, which have served as the foundation for the theoretical and practical development of this doctoral thesis.

4.2 Method

A scoping review was conducted with the aim of identifying and analyzing studies that examine the use of strategies based on aided augmented input, as well as the effectiveness of different types of AAC supports in users with ASD. Additionally, the factors influencing their implementation and the outcomes achieved were evaluated. For this purpose, the guidelines outlined in the PRISMA framework for scoping reviews (PRISMA-ScR) (Tricco et al., 2018) were followed, adapting them to the objectives of the current research.

4.2.1 Inclusion and exclusion criteria

The studies included in the review had to meet the following criteria: a) original experimental studies with specified outcomes; b) intervention methodology based on aided augmented input; c) participants aged 3 or older, diagnosed with ASD, and in school age or adolescence; d) published in English, due to the widespread use of this language in the global scientific community, its predominant indexing in databases and journals, and its relevance in scientific communication; and e) studies published between 2010 and 2024, inclusive. The latter criterion was chosen due to paradigm shifts and technological developments, particularly in AAC resources and supports, where advancements tend to occur in short periods, as reflected in the last decade (Durán Cuartero, 2021).

Additionally, the exclusion criteria were: a) studies that used methodologies not aligned with the characteristics of aided augmented input; b) other systematic reviews, such as works not published in scientific journals, intervention protocols,

press releases, conference presentations, abstracts, and letters to the editor; c) studies that included only participants with conditions other than ASD; and d) works that did not describe the effects, outcomes, or conclusions of the intervention.

4.2.2 Screening of articles

The literature search was conducted using the Web of Science, Scopus, Semantic Scholar, PubMed, and PsycInfo databases. The final search for this study was performed on April 26, 2024. The main terms of interest for this review were: "autism spectrum disorder", "ASD", "augmentative and alternative communication", "AAC", "aided augmented input", "aided language stimulation", "aided language modeling", "aided AAC input", "communication", and "language".

The combination of terms that yielded the best results, using Boolean terms "AND" and "OR" as needed was as follows: *("aided augmented input" OR "aided language stimulation" OR "aided language modeling" OR "aided AAC input") AND ("communication") AND ("language") AND ("augmentative and alternative communication") AND ("autism spectrum disorder" OR "ASD").*

1141 papers were identified, which were reduced to 1019 after removing duplicates. Upon reviewing titles and abstracts based on the established eligibility criteria, 965 papers were excluded. Then, 54 papers were analyzed in detail, of which 37 did not meet specific criteria and were excluded.

A total of 17 papers were finally included in the scoping review, as they met all criteria (Figure 10).

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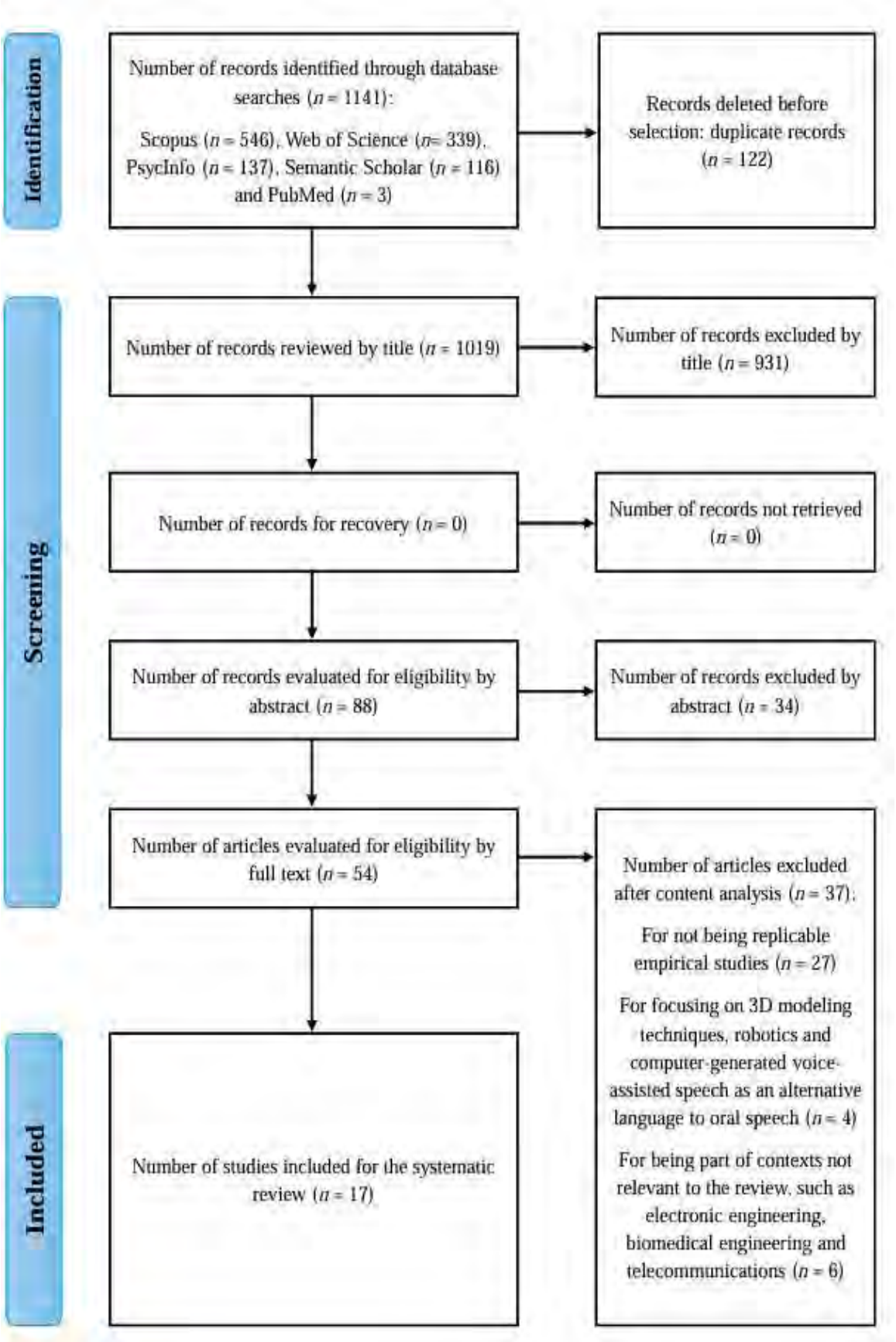


Figure 10: PRISMA Flow chart describing the bibliography selection process

4.2.3 Interrater reliability

Following the methodology outlined in the scoping review by Wandin et al. (2023), the interrater reliability was assessed using the Percentage Agreement index, expressed in Equation 4.1.

$$\textbf{Percentage Agreement} = \frac{\textbf{Number of Agreements}}{\textbf{Total Number of Decisions}} \times \mathbf{100} \qquad (4.1)$$

Interrater reliability between the primary author and the supervisor for the title and abstract screening was 96.3%. During the full-text review, the two evaluators each assessed 50% of the remaining 54 full texts (27 texts each). The initial inter-observer agreement for the full-text screening was 85% (83% and 87%) before consensus discussions. All discrepancies were resolved through discussion, ensuring unanimous agreement on the final selection.

4.3 Results

This research study analyzed a sample of 17 academic papers published between 2010 and 2024, from four different countries. These countries were: the United States (70.59 %), Canada (5.88 %), the United Kingdom (5.88 %) and South Africa (17.65 %).

Specifically, the United States was represented by the papers published by Allen et al. (2021); Brady et al. (2015); Dorney and Erickson (2019); Finke et al. (2017); Harjusola-Webb and Robbins (2012); Kasari et al. (2014); Lorah et al. (2015); McFadden et al. (2014); Muttiah et al. (2022); Park et al. (2023); Remner et al. (2016); and Schlosser et al. (2013). Canadian literature consisted of the work published by Trottier et al. (2011). The United Kingdom was represented

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by Emerson and Dearden (2013); and South Africa contributed the papers by Hassim (2019); Laher and Dada (2023); and Ngwira (2019).

The extracted characteristics from the studies included information about the authors, year of publication, study design, sample size, characteristics of the experimental group, intervention tools, and follow-up (Table A.1 from Appendix A). Among all the studies analyzed, the total number of participants meeting the inclusion criteria proposed by the authors was n=184, from whom n=134 (72.83 %) were male participants and n=33 (17.93 %) female participants. There were only two studies that did not specify the gender of participants in the analyzed sample (Allen et al., 2021; Remner et al., 2016). However, none of the studies divided the groups by gender for analysis. Instead, analyses were conducted either globally or individually.

All participants had an ASD diagnosis and did not present any visual or hearing challenges. Most studies (76.47%) established the ASD diagnosis based on previous reports by developmental pediatricians, neurologists, or clinicians, independently from the researchers. There were three studies (17.65%), namely Finke et al. (2017); Harjusola-Webb and Robbins (2012) and Brady et al. (2015), that confirmed the ASD diagnosis using the Diagnostic and Statistical Manual of Mental Disorders–Fourth Edition, DSM-IV (APA, 1994). One study (5.88%), conducted by Kasari et al. (2014), validated the diagnosis using the Autism Diagnostic Observation Schedule–Second Edition (ADOS-2) (Lord et al., 1999).

Although being conducted in a school setting was not an inclusion criterion, the majority of the studies were conducted in educational environments. Specifically, ten studies were conducted in school settings, including preschools and classrooms (Dorney & Erickson, 2019; Finke et al., 2017; Harjusola-Webb & Robbins, 2012; Laher & Dada, 2023; Lorah et al., 2015; McFadden, Kamps &

Heitzman-Powell, 2014; Trottier et al., 2011). Four studies were conducted in clinical or structured settings, including university research laboratories or controlled clinical environments (Brady et al., 2015; Hassim, 2019; Ngwira, 2019; Remner et al., 2016). Three studies were carried out in naturalistic settings such as the participants' homes or family-inclusive group settings (Allen et al., 2021; Muttiah et al., 2022; Park et al., 2023). Additionally, Emerson and Dearden (2013) implemented their intervention in an individualized educational setting tailored to the participant's needs, while Schlosser et al. (2013) conducted their study in a controlled experimental laboratory environment.

These findings are consistent with the trend observed in previous research, where school and clinical settings are commonly chosen for interventions targeting communication, social and behavioral skills in children with ASD (Du et al., 2024; Sutton et al., 2019). This distribution highlights the importance of selecting contexts that provide consistent routines and opportunities for social interaction, essential for generalizing learned skills.

In the majority of the studies, the interventions were implemented by a variety of professionals, reflecting a multidisciplinary approach to aided augmented input strategies:

- Teachers/Educators participated in 29% of the studies (Dorney & Erickson, 2019; Harjusola-Webb & Robbins, 2012; Laher & Dada, 2023; McFadden et al., 2014; Trottier et al., 2011), primarily in school settings, where they were trained to use aided augmented input strategies.
- Speech therapists were involved in 29% of the studies (Allen et al., 2021; Brady et al., 2015; Finke et al., 2017; Kasari et al., 2014; Remner

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et al., 2016), focusing on AAC interventions and providing visual models with speech-generating devices.

- Researchers/Specialists in AAC conducted 24% of the studies (Schlosser et al., 2013; Hassim, 2019; Ngwira, 2019; Muttiah et al., 2022), designing and supervising interventions in clinical and experimental settings.
- Parents were involved in 6% of the studies (Park et al., 2023), supporting generalization of social skills in family-inclusive group settings.
- Other educational professionals, including paraprofessionals and teaching assistants, supported the implementation of AAC strategies in 12% of the studies (Dorney & Erickson, 2019; Laher & Dada, 2023).

The implementation of aided augmented input varied in flexibility across the studies. In school-based interventions, teachers and educational staff tailored the use of AAC resources to fit classroom routines, with some adapting the materials to the specific needs of their students (Dorney & Erickson, 2019; Laher & Dada, 2023). In clinical and experimental settings, the interventions were more structured, maintaining consistency to evaluate the effectiveness of different doses and modalities of aided input (Hassim, 2019; Ngwira, 2019; Remner et al., 2016). This flexibility reflects the adaptability of aided augmented input across different settings and populations with ASD, emphasizing the importance of context-specific adjustments. These findings also highlight the significance of prior training, particularly when interventions are implemented by professionals who are naturally part of the educational or clinical environments.

Interventions and results were described in detail in terms of frequency, duration, and a summary of the results is shown (Table A.2 from Appendix A).

The interventions conducted in these studies meet the criteria proposed by Goossens and Crain (1986). Most studies used autism behavior checklists (Schlosser et al., 2013; Remner et al., 2016; Finke et al., 2017; Brady et al., 2015; McFadden et al., 2014; Kasari et al., 2014; Trottier et al., 2011; Lorah et al., 2015), which are based on observable behaviors recorded by the authors during assessment moments in the study.

Checklists allow for participant profiling and tracking their progress in communication, social, or behavioral areas. In addition, the standardized Childhood Autism Rating Scale (CARS) (Schopler et al., 2010) and the Peabody Picture Vocabulary Test Fourth Edition (PPVT-4) (Dunn & Dunn, 2007) were used in three studies (Allen et al., 2021; Hassim, 2019; Ngwira, 2029) for primary measures. Harjusola-Webb and Robbins (2012) and Brady et al. (2015) used the Vineland II Adaptive Behavior Scales (Sparrow et al., 2005). An observational survey test was used by Laher and Dada (2023) to measure participant progress. Additionally, Muttiah et al. (2022) assessed participants' communication skills using the Communication Matrix (Rowland, 2013). In this study, teachers, paraprofessionals, or caregivers provided information about the children and also completed the M-CDI (Fenson et al., 2007) to evaluate expressive vocabulary. Park et al. (2023) included Program for the Education and Enrichment of Relational Skills (PEERS) and ADOS-2 among their assessment tools.

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4.3.1 Implications for receptive and expressive communicative skills

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Schlosser et al. (2013) laid the foundation for the most replicated conditions. They provided a pivotal study on aided augmented input by comparing three instructional modalities: oral input alone, oral input paired with static scene cues (images), and oral input paired with dynamic scene cues (videos). Their research focused on children with ASD or pervasive developmental disorders-not otherwise

specified (PDD-NOS) to evaluate their ability to follow directives involving prepositional phrases such as "Put the boy under the lamp". The results demonstrated that static and dynamic scene cues significantly outperformed spoken input alone, with accuracy rates of 83% and 81%, respectively, compared to 19% for spoken input.

Dynamic scene cues displayed the complete motion of placing an object in its final spatial position relative to another, while static scene cues captured only the final position. Both modalities enhanced comprehension by providing additional visual context, allowing children to better interpret the relationships described in the directives. Interestingly, there was no statistically significant difference between the static and dynamic scene cues, suggesting that the choice of modality can be flexible depending on instructional preferences and resources available.

The study highlighted the limitations of spoken input alone for children with ASD, who often struggle with auditory processing and transient cues. By integrating visual modalities, educators and clinicians can provide more permanent and accessible instructional supports. The findings advocate for the inclusion of static or dynamic visual supports in both educational and therapeutic contexts to enhance directive-following and spatial understanding.

Remner et al. (2016) replicated and expanded upon the foundational work of Schlosser et al. (2013) by exploring the effects of static and dynamic scene cues combined with oral directives on comprehension in children with moderate to severe ASD. This study focused on improving understanding of prepositional phrases such as "put the block on the box" or "put the block behind the box" using aided augmented input strategies. The study utilized ten participants aged 9–20 years, all diagnosed with ASD and exhibiting profound deficits in receptive vocabulary skills, as measured by the Receptive One-Word Picture Vocabulary

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Test (ROWPVT-4). The intervention involved three conditions: a) verbal input alone (e.g., “Put the block on the box”); b) verbal input paired with static scene cues, which depicted the correct spatial relationships as a photograph; and c) verbal input paired with dynamic scene cues, which presented the spatial relationships as a video sequence.

Stimuli included a wooden block and two boxes, and directives targeted seven prepositions (e.g., “in”, “on”, “under”, “between”). Visual cues were displayed on an iPad™, chosen for its capacity to maintain participants' motivation and attention. Participants were tested in randomized sequences during two separate sessions to ensure response stability. The study revealed significant improvements in directive comprehension when visual cues were included. Interestingly, while both static and dynamic cues were effective, no statistically significant difference was observed between the two visual modalities. However, some participants demonstrated a clear preference for dynamic cues, suggesting individual variability in modality effectiveness.

The findings highlight the critical role of visual supports in enhancing language comprehension for people with ASD, particularly for abstract concepts like prepositions. The study emphasizes that mere repetition of verbal instructions does not yield the same benefits as aided augmented input strategies, underscoring the importance of integrating multimodal supports into therapeutic and educational settings.

Hassim (2019) and Ngwira (2019) explored the effects of varying doses of aided augmented input. Both studies highlight the importance of visual supports in complementing oral directives for children with ASD, especially in tasks requiring comprehension of abstract concepts. They emphasize the need to

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consider individual variability in response to input dosage, suggesting that single-input approaches may be insufficient.

Hassim (2019) investigated the effects of varied dosages of aided augmented input on following directives containing prepositions in children with ASD. This study used a within-subject crossover design to expose participants, aged 5 to 11 years, to two conditions of aided input dosage: 20% and 60%. Participants completed pre-tests assessing their noun and preposition knowledge and matching skills to ensure they met the inclusion criteria.

The intervention employed Go Talk Now ® software, presenting Picture Communication Symbols (PCS) alongside spoken directives. For example, participants were instructed to "Put the spoon under the bowl", with PCS symbols displayed in varying frequencies depending on the dosage condition. Results indicated that a higher dosage of aided input (60%) yielded greater accuracy in directive comprehension for the majority of participants, with some exceptions. Nine participants showed better performance at the higher dosage, while four performed better at the lower dosage, highlighting the need for individualized approaches. Additionally, five participants responded equally across conditions, and three did not respond at all. These results underline the potential benefits of tailored input dosages in enhancing receptive language skills.

Ngwira (2019) conducted a similar study focusing on the use of aided augmented input to improve directive comprehension in children with ASD. This research employed real-color photographs instead of PCS symbols, integrated into a naturalistic play-based intervention. The study emphasized varying the frequency of visual and verbal cues. The findings mirrored Hassim's results, confirming that a higher dosage of visual input generally led to improved accuracy

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in following directives, particularly for spatial relationships involving prepositions such as “on”, “under”, and “beside”.

Allen et al. (2021) investigated the effects of different types of visual and oral cue combinations on directive-following accuracy in ASD children, aged 4 to 10 years, with moderate-to-severe communication challenges. The study employed three instructional modalities: a) spoken input alone (SPO), participants were given verbal directives without accompanying visual aids; b) dynamic scene cues combined with spoken input (SC), with short video clips demonstrated the spatial relationships depicted in the directives (e.g., placing a figurine “behind” an object); and c) element cues paired with spoken input (EC), with static sequences of graphic symbols representing nouns, prepositions, and objects were presented. This research focused on how integrating various visual supports with oral input could enhance the comprehension of spatial prepositions in directive-following tasks.

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Participants were pre-screened for basic match-to-sample (MTS) skills and receptive vocabulary. The intervention was conducted in their homes in a controlled setting to minimize distractions. Visual and oral cues were presented using an iPad™. The study revealed significant differences in directive-following accuracy across conditions. The SC condition resulted in the highest accuracy and was significantly more effective than both SPO and EC conditions. Interestingly, the study found a positive correlation between participants' pre-existing spoken noun knowledge and their performance in the SC condition. This suggests that dynamic scene cues may activate and leverage semantic networks associated with known vocabulary.

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This study supports the efficacy of dynamic scene cues as a tool for enhancing directive comprehension in children with ASD. Unlike static element cues, which

require participants to interpret syntactic relationships, dynamic scene cues explicitly depict these relationships, making them more accessible for people with limited receptive language skills.

Laher and Dada (2023) conducted a study investigating the impact of an intervention based on aided augmented input on receptive vocabulary acquisition in children with complex communication needs and severe intellectual disabilities, including those with ASD. The intervention utilized communication boards measuring 50 x 70 cm, each displaying 10 x 10 cm-colored pictographic symbols created with Boardmaker Plus ® v6.1.6 software. During tailored activities, the researcher guided participants by pointing to these symbols while articulating the corresponding words, thereby providing augmented input to facilitate language learning. The intervention compared two dosages of aided augmented input: 40% and 70%. Receptive vocabulary acquisition was assessed to determine the effectiveness of each dosage level.

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The results indicated that all participants demonstrated receptive vocabulary acquisition when aided augmented input was provided at a 70% dosage. In contrast, only two participants showed vocabulary gains at the 40% dosage level. These findings suggest that a higher dosage of augmented input may be more effective in facilitating receptive vocabulary acquisition for children with complex communication needs and severe intellectual disabilities, including those with ASD. Additionally, the acquired vocabulary was maintained following a six-day withdrawal period, indicating the intervention's potential for promoting lasting language gains.

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This study underscores the importance of dosage in the application of aided augmented input interventions, as noted previously by Hassim (2019) and Ngwira (2019). Laher and Dada (2023) demonstrated that utilizing communication

boards with pictographic symbols, combined with a higher dosage of aided augmented input, effectively improves receptive vocabulary in children with severe intellectual disabilities and complex communication needs, including those with ASD.

Finke et al. (2017) demonstrated the effectiveness of aided augmented input in combination with a least-to-most prompting (LTM) procedure to enhance multi-symbol message production in children with ASD who relied on AAC. The intervention focused on integrating aided augmented input during interactive book-reading activities to support language and communication development. The study involved six children aged 8 to 12 years who used AAC devices. During the intervention, the Proloquo2Go ® software was used to present multi-symbol messages alongside spoken language, aligning with the principles of the strategy intervention. The LTM procedure added a structured hierarchy of prompts—starting with minimal assistance and progressing to more explicit guidance—to encourage children to construct messages with two or more symbols. The intervention emphasized modeling, where the facilitator combined verbal input with the visual display of symbols to reinforce language learning.

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The results indicated a consistent increase in the production of multi-symbol messages across all participants following the introduction of aided augmented input and LTM strategies. This approach also fostered greater attention and engagement during book-reading sessions. The study highlights the potential of the strategy to support multi-symbol communication and its role in promoting meaningful language interactions for children with ASD who use AAC.

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Similarly, Harjusola-Webb and Robbins (2012) explored the impact of aided augmented input in naturalistic interventions implemented by teachers to enhance communication in preschoolers with ASD. Teachers received training on

implementing aided augmented input strategies such as combining spoken language with gestures, pointing to visual supports (e.g., pictograms), and modeling communication during child-led activities. The intervention was tailored to the children's individual interests, with teachers using aided augmented input to respond to and expand on the children's communicative attempts.

The study found that aided augmented input strategies increased opportunities for communication and resulted in a significant improvement in expressive communication among the children. Teachers' consistent use of these techniques, such as pointing to symbols while speaking, created a supportive linguistic environment that allowed children to connect visual and verbal inputs. This approach facilitated natural communication exchanges without disrupting the flow of classroom routines, demonstrating the feasibility and effectiveness of aided augmented input in educational settings.

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Emerson and Dearden (2013) conducted a case study focusing on a 10-year-old nonverbal boy with ASD to assess the impact of using "full" language within the framework of the "least dangerous assumption". This educational philosophy posits that, in the absence of conclusive data, educators should make assumptions that, if incorrect, will have the least harmful effect on the student. In this context, it involves presuming competence and providing rich language input, even when a child's receptive language abilities are uncertain.

The intervention employed aided augmented input strategies to enhance comprehension, literacy, and motivation. Engaging resources such as matching images with words, spelling exercises, and sentence formation tasks were utilized. The researchers (speech therapists) provided "full" language input by using complete sentences and a rich vocabulary, rather than simplifying language or relying solely on minimal speech approaches.

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The study revealed that the child demonstrated improved comprehension and vocabulary acquisition following the intervention. These findings suggest that providing rich language input, even to nonverbal children with ASD, can facilitate language development and literacy skills. The results challenge the assumption that children with limited expressive abilities cannot benefit from complex language exposure. This case study underscores the importance of adopting the "least dangerous assumption" by presuming competence and providing enriched language input to children with ASD, regardless of their expressive language abilities. Educators and practitioners are encouraged to utilize aided augmented input strategies and avoid underestimating the potential of nonverbal children. By offering comprehensive language exposure, there is potential to enhance comprehension, literacy, and overall communication skills in this population.

Similarly, Dorney and Erickson (2019) explored the impact of a classroom-based AAC intervention on preschool students with ASD. The intervention incorporated three evidence-based, transactional approaches: a) attributing communicative meaning to student behaviors; b) providing aided augmented input; and c) focusing on graphic symbols representing core vocabulary. Data collection methods included observation field notes, Individualized Education Programs (IEPs), and direct communication assessments. The researchers aimed to explore interaction patterns between educators and students while analyzing improvements in student communication, as measured by the Communication Matrix.

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The results indicated a transactional relationship between educators' and students' communication across the classrooms. Specifically, the preschool students learned to use abstract graphic symbols representing core vocabulary to make requests, a development attributed to the educators' focus on this

communicative function. Additionally, several students demonstrated growth in the use of non-symbolic communication for social interaction and information sharing, which was associated with the educators' increased use of aided augmented input.

This study highlights the potential of using graphic symbols to teach requesting and basic vocabulary to children with ASD, thereby fostering functional communication for specific purposes. The findings suggest that educators' intentional focus on aided augmented input and the use of core vocabulary symbols can effectively enhance communication skills in preschool students with ASD.

Brady et al. (2015) conducted a pilot study to evaluate a multimodal intervention aimed at enhancing expressive word learning in school-age children with ASD, aged 6 to 10 years, who have limited expressive vocabularies. The intervention combined speech sound practice with AAC strategies to teach individualized vocabulary words. These words were selected based on each child's existing speech sound repertoire and principles of phonotactic probability.

The intervention utilized Proloquo2Go ® software to provide visual models and interactive routines, accompanied by physical prompts such as pointing and corrective feedback. The results indicated that five children, termed “High Responders”, demonstrated significant gains in spoken-word learning across successive word sets. The remaining five children, labeled “Low Responders”, did not meet the learning criteria. Comparative analyses revealed that High Responders had relatively higher skills in receptive language, imitation, and oral motor abilities prior to the intervention.

This study supports the efficacy of combining oral and visual input through multimodal interventions to promote effective communication in children with

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ASD across diverse contexts. The findings suggest that integrating speech sound practice with AAC resources can enhance the production of spoken words, particularly in children with certain pre-existing skills. However, further research is recommended to explore the factors influencing the varying responsiveness of children with ASD to such resources, using an intervention based on aided augmented input.

Muttiah et al. (2022) investigated the use of low-tech Visual Scene Displays (VSDs) combined with aided augmented input in naturalistic contexts. The intervention focused on three preschool-aged children with ASD at a presymbolic level of communication. The VSDs featured interactive "hotspots" representing people, objects, and events, which were paired with spoken input during interactive play sessions.

The results demonstrated significant increases in the number of communication turns and unique semantic concepts expressed by the participants. For example, one participant increased from 0-7 communication turns at baseline to 20-28 turns during intervention sessions. This study highlighted the effectiveness of combining oral input with visual elements in creating meaningful communicative opportunities, emphasizing the potential of low-tech solutions for populations with complex communication needs. These findings align with previous research (e.g., Schlosser et al., 2013; Hassim, 2019) that supports the use of multimodal strategies to enhance receptive and expressive language skills, while also underscoring the feasibility of applying aided augmented input in naturalistic settings.

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4.3.2 Implications for social and behavioral skills

Park et al. (2023) evaluated the impact of aided augmented input on social skills in children with ASD through structured didactic lessons, role-playing

scenarios, and behavioral learning activities. They conducted a study evaluating the effectiveness of the Program for the Education and Enrichment of Relational Skills (PEERS ®) for Preschoolers, a parent-assisted social skills training program tailored for young children with ASD. The intervention was designed to address the challenges children with ASD face in forming reciprocal friendships by enhancing their social functioning through developmentally appropriate strategies.

The study involved a two-part evaluation of the PEERS ® for Preschoolers program. Modifications to the original PEERS ® curriculum included the incorporation of developmentally appropriate social skills, increased parental involvement, and the integration of behavioral strategies within play-based activities. Parents were actively engaged in the intervention, facilitating the generalization of skills to naturalistic settings.

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The intervention led to significant improvements in several areas: a) social responsiveness: enhanced ability to engage in social interactions; b) social cognition: improved understanding of social cues and contexts; and c) social motivation: increased willingness to participate in social activities. Additionally, there were notable reductions in: a) restricted and repetitive behaviors: decreased engagement in repetitive actions or adherence to rigid routines; and b) problem behaviors: reduction in behaviors that interfere with daily functioning and social interactions.

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Previously, McFadden et al. (2014) highlighted the role of group play as a key strategy for fostering social and communication skills of children with ASD, aged 6 to 8 years. The intervention incorporated several evidence-based social skills-teaching procedures, including direct instruction, priming, prompting, peer mediation, contingent reinforcement, and token economies, directly in the recess

setting to increase appropriate social behaviors. Elements of Peer Networks and Pivotal Response Training were included.

The intervention was implemented during recess, a naturalistic and less structured environment, to promote the generalization of social skills. The program included class-wide social skills lessons, priming, adult prompting and feedback, peer prompting and praise, and a token economy. Peers were trained to model, initiate, prompt, and reinforce social behaviors and interactions with the target children.

The results demonstrated significant increases in social communication between focus children and their peers. Notably, the children with ASD were able to generalize their improved social skills to non-intervention recesses, indicating the effectiveness of the intervention in promoting lasting behavioral changes. The study also observed a reduction in behavioral challenges during recess, suggesting that enhanced social interactions contributed to better overall behavior in less structured settings.

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4.3.3 Aided augmented input combined with SGDs

Several studies incorporated Speech-Generating Devices (SGDs) into aided augmented input interventions. Kasari et al. (2014) conducted a study to evaluate the effectiveness of communication interventions for minimally verbal children with ASD, aged 5 to 8 years. The research focused on the use of SGDs within naturalistic communication settings to enhance spontaneous language use, based on the aided augmented input strategy. Participants were randomized to receive a blended developmental and behavioral intervention, specifically Joint Attention, Symbolic Play, Engagement, and Regulation (JASP+EMT), either with or without the addition of an SGD. In the first stage, all children received two sessions per week for three months. In the second stage, the intervention was

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adapted based on the child's early response, either by increasing the number of sessions or by adding the SGD.

The results indicated that children who received the intervention with the SGD (JASP+EMT+SGD) demonstrated significant improvements in spontaneous communicative utterances, the use of novel words, and the frequency of comments, compared to those who received the intervention without the SGD. The study also found that starting the intervention with the SGD and intensifying it for children who were slow responders led to better post-treatment outcomes.

This study suggests that incorporating SGDs can effectively enhance language development in minimally verbal children with ASD. The use of SGDs, combined with strategies focusing on joint attention and symbolic play, can expand children's expressive capabilities and increase spontaneous communication within relatively short periods. These findings support the integration of aided augmented input in interventions aimed at improving communication skills in this population.

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Trottier et al. (2011) demonstrated that SGD use enhanced social interactions and AAC instruction. Participants with limited verbal abilities initially struggled to produce more than 20 words, but by the end of the intervention, they increased their communicative acts and social skills. Lorah et al. (2015) extended this work by using iPads™ equipped with Proloquo2Go ®. Their intervention, which included verbal prompts and pictograms, improved participants' ability to respond to specific social cues, highlighting the versatility of SGDs in teaching social communication skills.

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Therefore, it is important to comparatively analyze different types of AAC supports within a common intervention strategy, in this case, aided augmented input. This is justified by the variety of AAC resources and supports observed in

the studies analyzed. Future research should aim to evaluate the effectiveness of aided augmented input using and comparing linguistically relevant and diverse AAC resources and tools (Figure 11), adapted for people with ASD and complex communication needs. This thesis will address these comparisons in the studies presented in the following chapters.

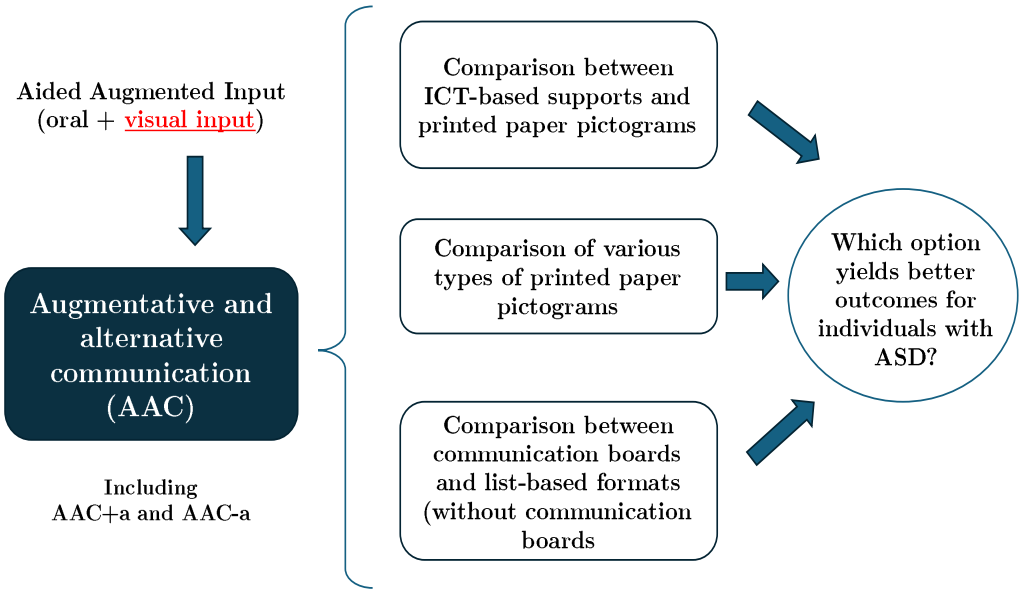


Figure 11: Framework for comparing AAC tools within the aided augmented input strategy

4.4 Discussion

The present scoping review aimed to deepen the existing knowledge on aided augmented input with ASD. Firstly, the findings indicate that such intervention can be effective in children and adolescents diagnosed with ASD who have complex communication needs, that is, difficulties in engaging in functional communicative exchanges through human verbal language in speech, signs, or in the form of writing (Calleja & Rodríguez, 2018; Moorcroft et al., 2018).

Secondly, the analyzed studies show that participants with ASD rely on visual stimuli to better understand the meaning of a word, a sentence, and to even follow

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oral directives (Schlosser et al., 2013; Laher & Dada 2023). Furthermore, individual customization, AAC support, and appropriate reinforcement are key to success (Scarcella et al., 2023). These observations are consistent with previous findings, which concluded that this intervention approach represents a teaching method with great benefits for the user to associate symbolic expressions with oral input, giving them meaning based on the words used by the interlocutor (Drager et al., 2006).

Thirdly, it is worth noticing that interventions have different approaches and AAC supports or resources, ranging from pictograms printed on paper (Schlosser et al., 2013; Remner et al., 2016; Allen et al., 2021; Laher & Dada, 2023; Harjusola-Webb & Robbins, 2012; Emerson & Dearden, 2013; Dorney & Erickson, 2019; Park et al., 2023; McFadden et al., 2014; Muttiah et al., 2022) to ICT software (Brady et al., 2015; Finke et al., 2017; Hassim, 2019; Ngwira, 2019) and SGDs devices (Kasari et al., 2014; Lorah et al., 2015; Trottier et al., 2011). Their common aim is to adapt to participants' individual skills and preferences. Finally, the results of the review emphasize benefits in expressive and receptive communication skills, in the reduction of problematic behaviors, and in social development. In addition, intervention based on aided augmented input can have a positive effect on the production of messages and the acquisition of new vocabulary by users, sometimes achieving the generalization of these advances in the natural contexts in which they operate (Brady et al., 2015).

Despite the findings discussed, the present study has some limitations that should be mentioned. Although the 17 studies analyzed spanned four countries, this may introduce bias and limit the generalizability of the results. For instance, the review did not identify any studies from Spanish-speaking contexts. This could

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indicate a significant scarcity of research in these settings, even though this intervention strategy is gaining increasing international recognition.

The heterogeneity of ASD (Mottron & Bzdok, 2020) and the differences between the contexts of each country make it challenging to draw clear conclusions, despite the positive outcomes observed in the analyzed studies. Moreover, the small sample size in most cases, especially in those cases with a single participant, may also limit the generalization of the results. However, it is also worth noticing that the number of participants is constrained by the variety of diagnoses, age ranges, and levels of impairment, which makes it challenging to find a broad sample that meets the inclusion criteria.

Given the new questions and hypotheses that may arise from this review, the need for further research in the field of people with ASD is emphasized. As highlighted in previous chapters, research on AAC targeting the ASD population plays a crucial role in clinical, educational, and social contexts (Holyfield et al., 2017; Llaneza et al., 2010). Differences in design and functionality can significantly impact the outcomes and performance of users, posing the challenge of identifying the most suitable option for each case (Agius et al., 2024; Lorah et al., 2022).

On the other hand, longitudinal studies tracking participants over time could provide valuable insights into the long-term effectiveness of aided augmented input for people with ASD. All the studies analyzed had durations of days, weeks, or even months, which suggests that time must be considered in order to observe changes in participants' performance. Another important consideration is the integration of emerging technologies into aided augmented input. With ongoing technological advancements, new supports, applications, and resources may affect

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the effectiveness and accessibility of this intervention in ways that differ from more traditional resources, such as printed pictograms.

4.5 Conclusions

It is reasonable to suggest that aided augmented input contributes to improvements in specific skills among children and adolescents with ASD, particularly in communication (both receptive and expressive language), social interactions, and behavior—critical areas for this population (Salvadó et al., 2012) Based on the studies mentioned, several common themes and key areas can be identified that may influence the approach to aided augmented input in children with ASD and complex communication needs. The following key points are highlighted, along with a reflection on the implications for future research:

- Use of visual supports combined with spoken language: Most of the studies analyzed show that the integration of visual cues (static or dynamic) with spoken language significantly improves language comprehension and expression in children with ASD.
- Variety of aided augmented input modalities: It is observed that visual supports have positive effects on the comprehension of children with ASD, although some studies suggest that the choice of AAC modalities may depend on individual preferences or available resources. This finding implies that there is no "one-size-fits-all" approach, and it is essential to personalize interventions based on the characteristics and needs of each child.
- Increased dosage of aided augmented input: Several studies highlight that a higher percentage of the intervention strategy (e.g., more pictograms combined with spoken language) can yield better results in language comprehension and expression. It is reasonable to assume

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that consistent use of aided augmented input, tailored to the intervention, will produce better outcomes.

- Natural and context-based interventions: Many studies emphasize the importance of designing interventions that are natural and tailored to the characteristics of the users. These interventions can be implemented in family, educational, or clinical settings, allowing for more effective improvement of skills.

On the other hand, this review highlights several areas that require further exploration:

- Comparison of different AAC tools: Although several studies demonstrate the effectiveness of different forms of AAC, more extensive comparative studies between the various AAC modalities are needed to determine which offers the best results in terms of learning speed, generalization, and improvement in the targeted skills. This will help identify the most effective methodologies in these cases.
- Impact on social and behavior skills: While some studies evaluate the impact of visual supports on communication and social behavior, it would be valuable to further explore how the intervention strategy can affect social skills and behavior in children with ASD. Improving these aspects can have a profound impact on their emotional development and their ability to form relationships.
- Assessment of intervention adjustment based on comprehension and expression levels: The individualized adjustment of the intervention level according to each child's receptive comprehension and expressive skills remains a key area that requires more exploration. Some children

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may benefit more from a visual approach using technological supports, while others might benefit better from paper-based visual supports.

In conclusion, aided augmented input has the potential to transform how children with ASD interact with their environment, enhancing their skills. However, further research is needed to corroborate these findings, especially in Spanish-speaking contexts. Building on the key points highlighted, this review served as the theoretical foundation for this thesis, whose main studies (Chapters 5, 6, and 7) focused on evaluating the effectiveness of this intervention strategy by comparing different AAC resources and supports to achieve significant improvements in their development.

4.6 References

Agius, M. M., Stansfield, J., & Murray, J. (2024). A comparison of differing organizational formats for teaching requesting skills to children with autism. *Augmentative and Alternative Communication*, 1-12. https://doi.org/10.1080/07434618.2024.2370825

Allen, A. A., Shane, H. C., Schlosser, R. W., & Haynes, C. W. (2021). The effect of cue type on directive-following in children with moderate to severe autism spectrum disorder. *Augmentative and Alternative Communication*, 37(3), 168-179. https://doi.org/10.1080/07434618.2021.1930154

American Psychiatric Association (APA) (1994). *Diagnostic and Statistical Manual of Mental Disorders* (4th Edition). Washington DC, American Psychiatric Association.

Biggs, E. E., Carter, E. W., & Gilson, C. B. (2018). Systematic review of interventions involving aided AAC modeling for children with complex communication needs. *American Journal on Intellectual and Developmental Disabilities*, *123*(5), 443-473. https://doi.org/10.1352/1944-7558-123.5.443

UNIVERSIDAD DE MÁLAGA

Brady, N. C., Storkel, H. L., Bushnell, P., Barker, R. M., Saunders, K., Daniels, D., & Fleming, K. (2015). Investigating a multimodal intervention for children with limited expressive vocabularies associated with autism. *American Journal of Speech-Language Pathology*, 24(3), 438-459. https://doi.org/10.1044/2015_AJSLP-14-0093

Calleja Reina, M & Rodríguez, J. M. (2018). *La comunicación aumentativa y alternativa para hacer frente a las necesidades complejas de comunicación en usuarios de bajo perfil cognitivo*. En Postigo Pinazo, E., Calleja Reina, M., & Gabau Vila, E. (2018). Disability and Communication. Scientific Analysis, Total Communication and ICT Tools and Case Studies (pp. 163-174). McGraw Hill Education.

Cerpa Reyes, C., Jorquera Arellano, L., & Toro Lisboa, J. (2023). Comunicación Aumentativa Alternativa para una Educación Inclusiva: Experiencias y Desafíos. *Revista Latinoamericana de Educación Inclusiva*, 17(1), 95-110. http://dx.doi.org/10.4067/s0718-73782023000100095

Chazin, K. T., Ledford, J. R., & Pak, N. S. (2021). A systematic review of augmented input interventions and exploratory analysis of moderators. *American Journal of Speech-Language Pathology*, 30(3), 1210-1223. https://doi.org/10.1044/2020_AJSLP-20-00102

Dorney, K. E., & Erickson, K. (2019). Transactions Within a Classroom-Based AAC Intervention with Preschool Students with Autism Spectrum Disorders: A Mixed-Methods Investigation. *Exceptionality Education International*, 29(2). https://doi.org/10.5206/eei.v29i2.9401

Drager, K. D. (2009). Aided modeling interventions for children with autism spectrum disorders who require AAC. *Perspectives on Augmentative and Alternative Communication*, 18(4), 114-120. https://doi.org/10.1044/aac18.4.114

Drager, K. D., Postal, V. J., Carrolus, L., Castellano, M., Gagliano, C., & Glynn, J. (2006). The effect of aided language modeling on symbol comprehension and

UNIVERSIDAD DE MÁLAGA

production in 2 preschoolers with autism. *American Journal of Speech-Language Pathology*. https://doi.org/10.1044/1058-0360(2006/012)

Du, G., Guo, Y., & Xu, W. (2024). The effectiveness of applied behavior analysis program training on enhancing autistic children's emotional-social skills. *BMC Psychology*, *12*(1), 568. https://doi.org/10.1186/s40359-024-02045-5

Dunn, L. M., & Dunn, D. M. (2007). *PPVT-4: Peabody picture vocabulary test*. Pearson Assessments.

Durán Cuartero, S. (2021). Technologies for teaching and learning of students with autism spectrum disorder: a systematic review. *Innoeduca. International Journal of Technology and Educational Innovation*, 7(1), 107-121. https://doi.org/10.24310/innoeduca.2021.v7i1.9771

Emerson, A., & Dearden, J. (2013). The effect of using 'full' language when working with a child with autism: Adopting the 'least dangerous assumption'. *Child Language Teaching and Therapy*, 29(2), 233-244. https://doi.org/10.1177/0265659012463370

Fenson, L., Marchman, V. A., Thal, D. J., Dale, P. S., Reznick, J. S., & Bates, E. (2007). *MacArthur-Bates communicative development inventories: User's guide and technical manual* (2nd ed.). Baltimore, MD: Paul H. Brookes.

Finke, E. H., Davis, J. M., Benedict, M., Goga, L., Kelly, J., Palumbo, L., ... & Waters, S. (2017). Effects of a least-to-most prompting procedure on multi-symbol message production in children with autism spectrum disorder who use augmentative and alternative communication. *American Journal of Speech-Language Pathology*, 26(1), 81-98. https://doi.org/10.1044/2016_AJSLP-14-0187

Gibson, J. L., Pritchard, E., & de Lemos, C. (2021). Play-based interventions to support social and communication development in autistic children aged 2–8 years: A scoping review. *Autism & Developmental Language Impairments*, 6. https://doi.org/10.1177/23969415211015840

UNIVERSIDAD DE MÁLAGA

Goossens, C., & Crain, S. (1986). Establishing multiple communication displays. Augmentative communication: An introduction, 337-344.

Harjusola-Webb, S. M., & Robbins, S. H. (2012). The effects of teacher-implemented naturalistic intervention on the communication of preschoolers with autism. *Topics in Early Childhood Special Education*, 32(2), 99-110. https://doi.org/10.1177/0271121410397060

Hassim, R. (2019). *Effects of varied dosage of aided input on following directives that contain prepositions for children with Autism Spectrum Disorder (ASD)* [Doctoral dissertation, University of Pretoria]. DSpace. https://repository.up.ac.za/handle/2263/76855

Holyfield, C., Drager, K. D., Kremkow, J. M., & Light, J. (2017). Systematic review of AAC intervention research for adolescents and adults with autism spectrum disorder. *Augmentative and Alternative Communication*, 33(4), 201-212. https://doi.org/10.1080/07434618.2017.1370495

Jensen de López, K. M., Kraljević, J. K., & Struntze, E. L. B. (2022). Efficacy, model of delivery, intensity and targets of pragmatic interventions for children with developmental language disorder: A systematic review. *International Journal of Language & Communication Disorders*, 57(4), 764-781. https://doi.org/10.1111/1460-6984.12716

Kasari, C., Kaiser, A., Goods, K., Nietfeld, J., Mathy, P., Landa, R., ... & Almirall, D. (2014). Communication interventions for minimally verbal children with autism: A sequential multiple assignment randomized trial. *Journal of the American Academy of Child & Adolescent Psychiatry*, 53(6), 635-646. https://doi.org/10.1016/j.jaac.2014.01.019

Laher, Z., & Dada, S. (2023). The effect of aided language stimulation on the acquisition of receptive vocabulary in children with complex communication needs and severe

UNIVERSIDAD DE MÁLAGA

intellectual disability: a comparison of two dosages. *Augmentative and Alternative Communication*, 1-14. https://doi.org/10.1080/07434618.2022.2155566

Landa R.J. (2018). Efficacy of early interventions for infants and young children with, and at risk for, autism spectrum disorders. *International Review of Psychiatry*, 30(1), 25–39. https://doi.org/10.1080/09540261.2018.1432574

Llaneza, D. C., DeLuke, S. V., Batista, M., Crawley, J. N., Christodulu, K. V., & Frye, C. A. (2010). Communication, interventions, and scientific advances in autism: a commentary. *Physiology & Behavior*, 100(3), 268-276. https://doi.org/10.1016/j.physbeh.2010.01.003

Lorah, E. R., Holyfield, C., Griffen, B., & Caldwell, N. (2024). A systematic review of evidence-based instruction for individuals with autism using mobile augmentative and alternative communication technology. *Review Journal of Autism and Developmental Disorders*, 11(1), 210-224. https://doi.org/10.1007/s40489-022-00334-6

Lorah, E. R., Holyfield, C., Miller, J., Griffen, B., & Lindbloom, C. (2022). A systematic review of research comparing mobile technology speech-generating devices to other AAC modes with individuals with autism spectrum disorder. *Journal of Developmental and Physical Disabilities*, 34(2), 187-210. https://doi.org/10.1007/s10882-021-09803-y

Lorah, E. R., Karnes, A., & Speight, D. R. (2015). The acquisition of intraverbal responding using a speech generating device in school aged children with autism. *Journal of Developmental and Physical Disabilities*, 27, 557-568. https://doi.org/10.1007/s10882-015-9436-2

Lord, C., Rutter, M., DiLavore, P. C., Risi, S., Gotham, K., & Bishop, S. L. (1999). *ADOS. Autism diagnostic observation schedule. Manual*. Los Angeles: WPS.

UNIVERSIDAD DE MÁLAGA

McFadden, B., Kamps, D., & Heitzman-Powell, L. (2014). Social communication effects of peer-mediated recess intervention for children with autism. *Research in Autism Spectrum Disorders*, 8(12), 1699-1712. https://doi.org/10.1016/j.rasd.2014.08.015

Moorcroft, A., Scarinci, N., & Meyer, C. (2018). A systematic review of the barriers and facilitators to the provision and use of low-tech and unaided AAC systems for people with complex communication needs and their families. *Disability and Rehabilitation: Assistive Technology*, 14(7), 710–731. https://doi.org/10.1080/17483107.2018.1499135

Mottron, L., & Bzdok, D. (2020). Autism spectrum heterogeneity: fact or artifact? *Molecular Psychiatry*, 25(12), 3178-3185. https://doi.org/10.1038/s41380-020-0748-y

Muttiah, N., Drager, K. D., Beale, B., Bongo, H., & Riley, L. (2022). The effects of an intervention using low-tech visual scene displays and aided modeling with young children with complex communication needs. *Topics in Early Childhood Special Education*, 42(1), 91-104. https://doi.org/10.1177/0271121419844825

Ngwira, S. P. T. (2019). *The effects of quantity of aided input on the accuracy of instruction following in children with Autism Spectrum Disorder* [Doctoral dissertation, University of Pretoria]. DSpace. https://repository.up.ac.za/handle/2263/76747

Park, M. N., Moulton, E. E., & Laugeson, E. A. (2023). Parent-assisted social skills training for children with autism spectrum disorder: PEERS for preschoolers. *Focus on Autism and Other Developmental Disabilities*, 38(2), 80-89. https://doi.org/10.1177/10883576221110158

Pereira, E. T., Montenegro, A., Rosal, A., & Walter, C. (2020). Augmentative and Alternative Communication on Autism Spectrum Disorder: Impacts on Communication. *CoDAS*, 32(6). https://doi.org/10.1590/2317-1782/20202019167

UNIVERSIDAD DE MÁLAGA

Remner, R., Baker, M., Karter, C., Kearns, K., & Shane, H. (2016). Use of augmented input to improve understanding of spoken directives by children with moderate to severe autism spectrum disorder. *eHEARSAY, Journal of the Ohio Speech Language Hearing Association*, 6(3), 4-10.

Rowland, C. (2013). *Communication Matrix for parents and professionals: Handbook: Online Communication Matrix*. Portland, OR: Oregon Health and Science University. Retrieved from https://www.communicationmatrix.org/Uploads/Pdfs/Handbook.pdf

Salvadó, B., Palau Baduell, M., Clofent Torrentó, M., Montero Camacho, M., & Hernández Latorre, M. A. (2012). Modelos de intervención global en personas con trastorno del espectro autista. *Revista de Neurologia*, 54(1), 63-71. https://doi.org/10.33588/rn.54S01.2011710

Scarcella, I., Marino, F., Failla, C., Doria, G., Chilà, P., Minutoli, R., ... & Pioggia, G. (2023). Information and communication technologies-based interventions for children with autism spectrum conditions: a systematic review of randomized control trials from a positive technology perspective. *Frontiers in Psychiatry*, 14, 1212522. https://doi.org/10.3389/fpsyt.2023.1212522

Schlosser, R. W., Laubscher, E., Sorce, J., Koul, R., Flynn, S., Hotz, L., ... & Shane, H. (2013). Implementing directives that involve prepositions with children with autism: A comparison of spoken cues with two types of augmented input. *Augmentative and Alternative Communication*, 29(2), 132-145. https://doi.org/10.3109/07434618.2013.784928

Schopler, E., Reichler, R. J., & Renner, B. R. (2010). *The childhood autism rating scale (CARS)*. Los Angeles, CA: Western Psychological Services.

Sennott, S. C., Light, J. C., & McNaughton, D. (2016). AAC modeling intervention research review. *Research and Practice for Persons with Severe Disabilities*, 41(2), 101-115. https://doi.org/10.1177/1540796916638822

UNIVERSIDAD DE MÁLAGA

Shi, B., Wu, W., Dai, M., Zeng, J., Luo, J., Cai, L., ... & Jing, J. (2021). Cognitive, language, and behavioral outcomes in children with autism spectrum disorders exposed to early comprehensive treatment models: a meta-analysis and meta-regression. *Frontiers in Psychiatry*, 12, 691148. https://doi.org/10.3389/fpsyt.2021.691148

Sparrow, S.S., Cicchetti, D.V., & Balla, D.A. (2005). *Vineland-II adaptive behavior scales, second edition, survey forms manual*. Bloomington, MN: PsychCorp.

Sutton, B. M., Webster, A. A., & Westerveld, M. F. (2019). A systematic review of school-based interventions targeting social communication behaviors for students with autism. *Autism*, *23*(2), 274-286. https://doi.org/10.1177/1362361317753564

Therrien, M. C., Light, J., & Pope, L. (2016). Systematic review of the effects of interventions to promote peer interactions for children who use aided AAC. *Augmentative and Alternative Communication*, 32(2), 81-93. https://doi.org/10.3109/07434618.2016.1146331

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., ... & Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Annals of Internal Medicine*, *169*(7), 467-473. https://doi.org/10.7326/M18-0850

Trottier, N., Kamp, L., & Mirenda, P. A. T. (2011). Effects of peer-mediated instruction to teach use of speech-generating devices to students with autism in social game routines. *Augmentative and Alternative Communication*, 27(1), 26-39. https://doi.org/10.3109/07434618.2010.546810

Wandin, H., Tegler, H., Svedberg, L., & Johnels, L. (2023). A Scoping Review of Aided AAC Modeling for Individuals With Developmental Disabilities and Emergent Communication. *Current Developmental Disorders Reports*, *10*(2), 123-131. https://doi.org/10.1007/s40474-023-00275-7

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5

Aided augmented input and the EC+ support: Effects of AAC with technological influence

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5.1 Introduction

The development and advancement of information and communication technologies (ICT) have facilitated their integration into educational and therapeutic contexts, both for addressing disabilities and for implementing AAC systems (Durán Cuartero, 2021). ICT encompasses digital tools such as computers, applications, software, and mobile devices, which support the collection, storage, processing, and transmission of information. These tools are recognized for their portability, versatility, and accessibility, promoting their adoption based on user needs (Aspiranti et al., 2020; Quiroga et al., 2019).

Lehman (1998) already demonstrated that children with ASD are often drawn to ICT due to their strong visual processing skills. Moreover, ICT provides a structured, controlled, and organized environment that enhances user interaction, fosters individualized and understandable contingencies, reduces stress, and facilitates anticipation of different stimuli (Charitaki, 2015; Ntalindwa et al., 2019; Voss et al., 2019). Additionally, these technologies create intervention frameworks that compensate for many of the difficulties experienced by people with ASD, as digital devices enhance perception-action opportunities, interaction, comprehension, planning, and problem-solving processes (Gómez & García, 2012; Gutiérrez et al., 2012; Passerino & Santarosa, 2008).

Nowadays, technology is becoming increasingly integrated into daily life, leading to transformations in various human environments. As a result, the implementation of emerging ICT-based supports from a therapeutic perspective is becoming more common, given their significant impact on education, social interaction, and family dynamics. When properly integrated, these technologies can enhance both productivity and the quality of instruction (Quiroga et al., 2019). Due to these advantages, there has been a growing interest in utilizing ICT

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in the teaching and learning processes of students with various disabilities or limitations, including ASD (Guillén et al., 2016). However, this process is not without challenges. As highlighted by Lozano Martínez et al. (2016), for an ICT-based software or support system to be considered suitable for ASD, it must meet several key criteria:

- Adaptability to the individual's abilities, needs, learning pace, processing style, developmental level, and interests.
- A motivating and intuitive interface with a clear layout, prominent visual components, and multimodal information formats such as text, audio, and icons.
- Configurable options to maximize usability, including features such as text-to-speech playback and adjustable difficulty levels.
- A structured content presentation that enables users with ASD to understand task objectives, ensuring a positive learning experience.
- Appropriate and motivating reinforcements for correct and incorrect responses, aligned with the therapeutic goals set by professionals.

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It is important to emphasize that there are no universal programs specifically designed for all people with ASD. Instead, these programs are adapted to specific characteristics that define each person. This means that the fundamental principle behind the use of ICT in this population is to employ tools—whether specifically designed for ASD or not—that target the improvement and development of essential skills that may be impaired or require reinforcement, always from a personalized approach. The communicative purpose of ICT in children with ASD primarily aims to enhance both the quantity and quality of their communicative output, whether verbal or nonverbal. However, as previously stated, its

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application must be adapted to the needs of each individual (da Silva et al., 2011; Lozano Martínez et al., 2016).

For people with Level 3 ASD, these technological resources focus on eliciting reactions or interactions with their environment and those within it, fostering executive function development, or increasing the production of echoic responses in cases where functional language is absent. This is achieved by providing stimuli that represent the target word or phrase to encourage repetition. In other cases, the goal is to develop intraverbal communication—where the expected response differs from the stimulus—by using ICT tools that display or vocalize words through images, pictograms, or written text. This approach helps expand vocabulary and enables individuals to respond spontaneously to simple questions and requests. When people with ASD successfully expand their communicative repertoire, ICT also facilitates the development of more complex grammatical structures, the ability to answer "yes-no" and open-ended questions, the understanding of abstract concepts such as spatial awareness and time management, and the improvement of receptive language skills (Guzmán et al., 2017).

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Over the past years, numerous applications have been developed for mobile phones (both Android and iOS), computers, and other devices to enhance the quality of life of people with various conditions, disorders, or disabilities. In the case of ASD, several widely used therapeutic applications have been designed to support communication and learning. For example, *JABTalk* ® facilitates voice-based communication, while *Palabras Especiales* ® helps users recognize words by matching images with corresponding sounds. *Sígueme* ® focuses on improving visual attention in children with ASD, whereas *AbaPlanet* ® is designed to stimulate learning through perceptual-visual and cognitive-visual activities.

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Additionally, *Proloquo4Text* ® serves as a tool for users with language impairments, enabling them to write, engage, and communicate in social interactions. Meanwhile, *Proloquo2Go* ® supports literacy and verbal development. Other examples focused on intervention in communication and language development include *PictoTEA* ®, *José Aprende* ®, *Jocomunico* ®, and *DictaPicto* ® (Montes Pérez & Morales Díaz, 2017; Moya Giménez, 2021; Pahisa-Solé, 2020; Quezada et al., 2023). ARASAAC also offers a range of online resources that integrate ICT tools, including the "*Aula de TIC",* which allows users to edit and share pictograms and other materials through an online platform. Furthermore, educational video games based on these stimuli have been developed to provide interactive and engaging learning experiences (Luque & Morillas, 2018).

Given the data presented so far, the question arises as to whether it is worthwhile to implement ICT resources capable of complementing the aided augmented input strategy as innovative elements in the intervention of Level 3 ASD cases. In this study, we opted to use EC+ (Table 7) as an ICT resource that functions as an aided AAC (AAC+a) support tool. The multimodal EC+ application (Luque et al., 2018) was developed at the University of Málaga and meets the criteria for being considered an innovative tool compatible with the proposed intervention strategy. EC+ was created within the framework of the European Erasmus+ Project and was officially published on June 16, 2018.

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Table 7

Main characteristics of EC+

Feature	Description
Logotype	
Vocabulary stored	A linguistic corpus of around 450 terms, modeled on the expressive repertoire of a typical 3-year-old.
Organization	Vocabulary presented in a linear list format. Displayed up to 20 items in a scrollable list.
Pages and navigation	Navigation through vertical or horizontal scrolling without predefined pages.
Customization	Allowed limited customization of vocabulary content.
Color coding of cells	No color coding implemented.
Graphic symbols	Used custom symbols from the application's pre-designed library.
Output	Use the multimodal option to view a real image, the sign language symbol, a video of the action, and the written word.
Sentence bar	No sentence bar available.
Feedback	Provided auditory feedback (text-to-speech) but no visual or tactile feedback.
Interface visual example	

Note. The images included in this table were retrieved from the EC+ app and were directly obtained by the author of this thesis.

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The tool includes a free mobile app for installation on smartphones or tablets (iOS and Android operating systems) and an online academic portal accessible through any web browser. Its name, "*Enhancing Communication Plus*", reflects its primary objective: to improve communication and interaction for people with complex communication needs. EC+ is currently available in Spanish, Catalan, English, German and Dutch.

Based on the expressive communication repertoire typically associated with a three-year-old child, EC+ was optimized for users with communication difficulties or minimal linguistic abilities, resulting in a custom-designed linguistic corpus of approximately 400 terms. The most notable feature of this tool is its multimodal communication approach (Figure 12), where information is presented primarily through visual, auditory, and gestural means. To achieve this, EC+ integrates spoken words, written words, pictograms, real images, and sign language interpreter videos for each of the concepts included in the corpus. The verbs also include a video demonstrating the action being performed.

To date, no studies have been found that combine in-person aided augmented input activities with EC+. Additionally, there is limited research comparing this type of support with unaided AAC (AAC-a) resources during interventions in these contexts (Marble-Flint et al., 2019). This may be attributed to the continuous evolution of the field and the underutilization of these resources, partly due to a lack of understanding of their purposes (Marzal et al., 2023). The aim of this study is to determine whether the combination of aided augmented input with an AAC+ support like EC+ improves the most affected areas in children with Level 3 ASD: communication, social skills, and behavior (Velarde-Incháustegui et al., 2021). The hypothesis is that EC+, due to its features as a technology-based AAC tool, will lead to more favorable outcomes.

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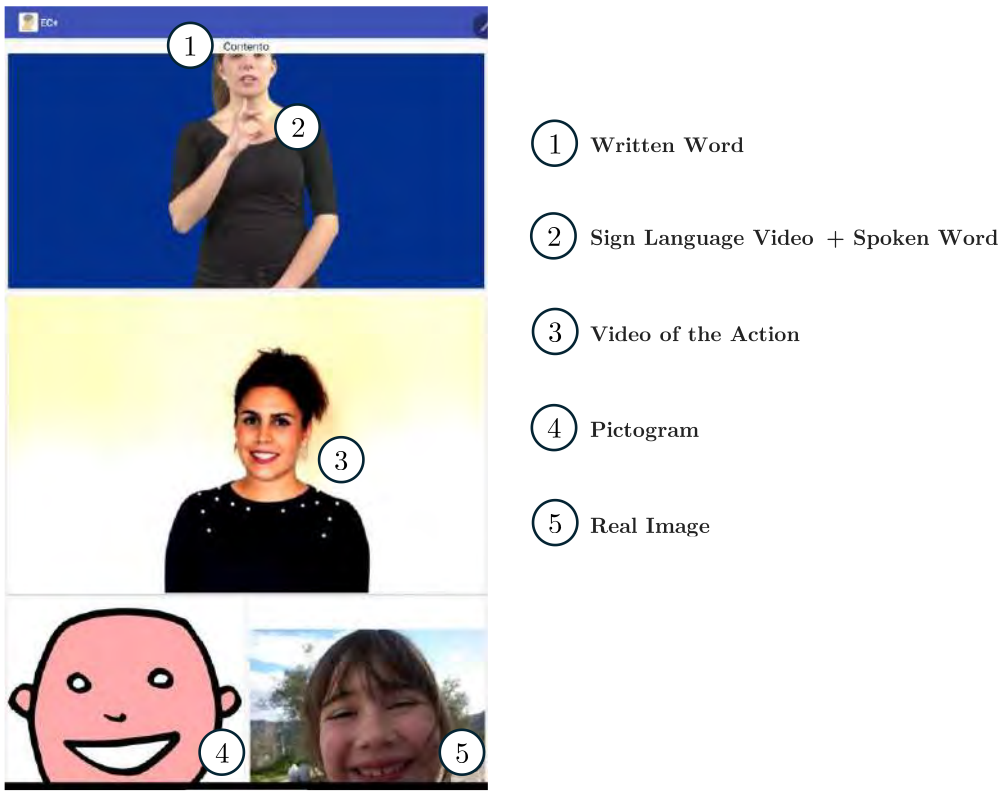


Figure 12: EC+ multimodal function example

5.2 Method

5.2.1 Participants

The sample selection was intentional, focusing on participants with specific characteristics relevant to the study's objectives in the province of Málaga, Spain. Initially, 45 potential participants were identified and underwent a rigorous selection process to ensure sample homogeneity and study reliability. Ultimately, 30 participants met the following inclusion criteria: (a) school-aged children between 6 and 12 years old, as this age range represents a critical developmental period for acquiring essential social, communicative, and academic skills (Lima & Laplane, 2016). This stage also demonstrates diagnostic stability (Fombonne et al., 2021; De Pimentel, 2024) and research indicates that prevalence is significantly higher among children aged 6 to 12 compared to those under 5 and over 13 (Talantseva et al., 2023); (b) Spanish had to be their native language and

instructional language from birth, since the study was conducted in a Spanish-speaking context; (c) diagnosed with Level 3 ASD, evaluated by professionals with clinical experience based on the DSM-5 (APA, 2013); (d) with complex communication needs, meaning they encounter challenges in engaging in functional communicative exchanges through human verbal language (speech, sign language, or writing), according to the Adaptive Behavior Composite (ABC), shown through a percentile rank of 1 or below, using the Vineland Adaptive Behavior Scales-3 (Vineland-3) (Sparrow et al., 2016); (e) with an affected level of comprehension and expression, based on the Protocol for the Assessment of the Linguistic Communicative Profile of Individuals with Intellectual Disabilities and Complex Communication Needs (PCL-DIS-NCC) (Calleja Reina et al., 2021); (f) who are able to concentrate for at least 10 minutes on an activity, as reported by the teacher and family members; (g) who have not been diagnosed with a visual and hearing impairment; (h) they were not fully familiar with the AAC resources used in the study, as verified through reports from the relevant speech therapists; and (i) whose participation is authorized by informed consent signed by their parents or legal guardians.

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The sample size was determined based on the availability of participants who met the established inclusion criteria, while also taking into account the practical constraints of the study. The equivalence between groups was ensured through the random assignment of participants, following CONSORT guidelines. This method guarantees a balanced distribution of baseline characteristics and minimizes bias when comparing the effects between groups. To ensure data privacy and anonymity in accordance with international ethical standards, each of the 30 participants was assigned a number based on the order of consultation. They were then randomly allocated into two groups of 15 using the Random.org software. Group A received an intervention based on aided augmented input using

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the EC+ app, while Group B received the same intervention strategy using paper-based pictograms, without exposure to any AAC+a or assistive technology during the study.

For the initial participant evaluation (Table 8), the following tools were utilized: (a) the Vineland-3, which assesses adaptive behavior from birth through adulthood; (b) the Test of Nonverbal Intelligence (TONI-4) (Brown et al., 2019; Fopiano, 2021), a nonverbal assessment designed to evaluate Intelligence Quotient (IQ) in people with language, hearing, or motor difficulties, used to establish participants' average IQ; and (c) the PCL-DIS-NCC, which measures comprehension, communication partners, communicative functions, communication modes, and conversational topics across five subscales, with a maximum score of 48 (Calleja Reina et al., 2021).

Table 8

Participant descriptions in the EC+ vs. paper-based pictograms study

	Group A	Group B
Participants	*n*=15	*n*=15
Gender	13 male 2 female	12 male 3 female
Age (mean and standard deviation)	8.33 (2.09)	7.47 (1.59)
TONI-4 (mean IQ and standard deviation)	59.07 (11.62)	50.33 (5.70)
Vineland-3 (ABC)	Percentage = <1	Percentage = <1
PCL-DIS-NCC (mean and standard deviation)	• PCL-EC: 21.87 (3.79) • PCL-EE-VI: 18.67 (1.17) • PCL-EE-FC: 21.53 (2.10) • PCL-EE-MC: 20.47 (4.51) • PCL-EE-T: 17.47 (1.99)	• PCL-EC: 21.33 (.90) • PCL-EE-VI: 18.53 (1.45) • PCL-EE-FC: 22.53 (1.35) • PCL-EE-MC: 19.47 (4.15) • PCL-EE-T: 19.67 (1.63)

Note. IQ: Intelligence Quotient; ABC: Adaptative Behavior Composite; PCL-EC: Comprehension Scale; PCL-EE-VI: Variety of Interlocutors; PCL-EE-FC: Communication Functions; PCL-EE-MC: Communication Modes; PCL-EE-T: Topics and Preferences. Compiled by the author.

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5.2.2 Setting and materials

The study was carried out in centers specialized in ASD and other neurodevelopmental disorders. A total of 45 therapy sessions were conducted, the majority of them were led by the principal author of the thesis. Due to the number of participants, the study did not begin on the same day for everyone. To address this, each participant's schedule was calculated based on their initial assessment, ensuring that all received the same number of intervention days and evaluation moments. The author was accompanied by a secondary communication partner (the independent observer, a speech therapist) who occasionally provided support to facilitate the children's participation. The independent observer was familiar to the participant; however, since not all participants attended the same place, the observer varied depending on the center.

Each therapy session ranged from 15 to 30 minutes and was scheduled 2 to 3 times per week, based on the availability of the participants and the center's timetable. To avoid fatigue or frustration among the children, 5-minute breaks were integrated into the sessions, which did not count toward the overall intervention time. These breaks were strategically placed after various activities to keep the children's interest alive and ensure they remained focused and engaged.

The therapy sessions were conducted individually in a speech therapy office designed to minimize visual and auditory distractions. Communication contexts for both groups included play with toys and objects, social interaction with the therapist, and the monitoring of problematic behaviors during the session. A consistent set of motivators (toys, music, food, and resources) was used throughout the intervention, identified through each participant's preference assessment and family interviews conducted before the study. These motivators,

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along with the AAC supports, were strategically placed on the table at an optimal distance to help manage participants' impulses and enhance the intervention strategy (Holland et al., 2020; Martin & Wilkins, 2022). However, not all items and pictograms were introduced at the same time. Each week a new stimulus from the original set that had not yet been used was added to the intervention. This approach is supported by recent research suggesting that the acquisition of new skills can be enhanced by gradually introducing new stimuli while explicitly associating them with already well-known ones (Muttiah et al., 2022; Semino et al., 2021).

A list of pictograms was developed and organized into two main categories: (1) those forming the original core vocabulary set and (2) those to be progressively introduced on a weekly basis. The selection of these items was grounded in previous research focused on early communication development in children with ASD and complex communication needs. The list was specifically developed based on the foundational work of Beukelman and Mirenda (2013) and Wilkinson and Hennig (2007), who emphasize the importance of including high-frequency, functional, and socially relevant vocabulary in AAC systems for children with limited expressive language. This list will be used consistently across all studies that comprise this dissertation (see Appendix B).

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The speech therapist positioned themselves either next to or across from the participant to maintain an effective control of the environment and encourage interaction (Holland et al., 2020). The therapist's role included pointing to pictographic symbols while delivering aided augmented input, which helped the child grasp the meaning of words, situations, images and their connections to real objects This approach provided suitable linguistic input, encouraged extended

responses, and celebrated the children's successes (Gunning et al., 2019; León Cruz, 2020; Logan et al., 2017).

Designated AAC resources based on pictograms were used for each group, selected for the study due to their distinctive characteristics, which justified the comparison between them (Figure 13). Each resource includes its own set of pictograms, meeting key criteria to be considered representative and useful for user with ASD (Hervás et al., 2020).

EC+



ARASAAC

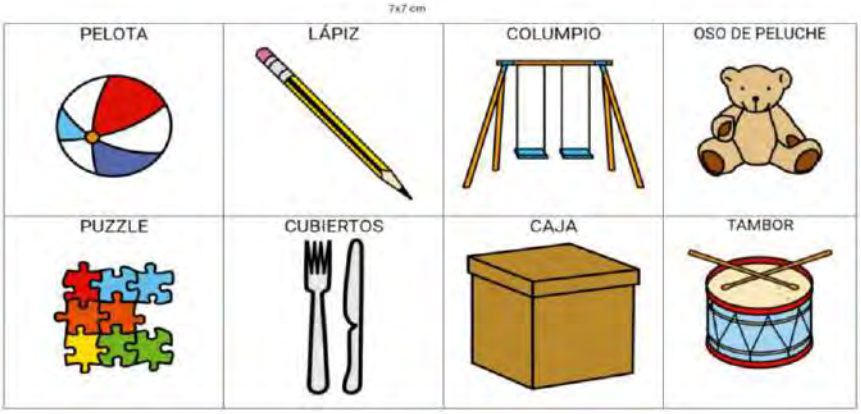


Figure 13: Example of EC+ and ARASAAC pictograms

For Group A, the EC+ app was used. This application offers more than 400 specially designed pictograms featuring clear, colorful drawings on white backgrounds to enhance iconicity and minimize distractions (Dowse, 2021). The methodology follows a Total Communication approach, which incorporates multiple modes of communication to support people with diverse linguistic needs. This approach combines verbal speech, sign language, gestures, facial expressions, written language and AAC systems, allowing individuals to use the most effective

methods for both expression and comprehension (Batool et al., 2021; Keskinen et al., 2012; Postigo Pinazo et al., 2018). The vocabulary terms are categorized into semantic fields: "Actions", "Food and Drinks", "Animals", "Qualities", "Quantifiers and Articles", "Games, Routines, and Social Formulas", "Toys", "Objects and Places", "Household Objects and Places", "Body Parts", "People", "Prepositions and Locatives", "Clothing", "Time", "Vehicles", and a final category labeled "Uncategorized", which includes sign language expressions.

Users can enlarge pictograms and images with a single click and customize them to fit their communicative and cognitive needs. EC+ also offers evidence-based informational documents covering concepts related to 15 conditions, including severe autism, cerebral palsy, Angelman syndrome, childhood epileptic encephalopathies, and Rett syndrome, among others (Luque et al., 2018). This information can be found in the "*SÍNDROMES*" section of the app, next to the "*COMUNICACIÓN*" section, which includes reliable information on Total Communication, general considerations, language acquisition, and other aspects. The entire text is presented in one of the selected languages offered by the app.

Multimedia resources can be adjusted in three different resolutions to improve compatibility and reduce storage usage. Words are organized into basic and advanced lists, which include prepositions and determiners. EC+ also provides an academic portal, allowing users to log in and edit elements of the app through the web service, in order to retrieve information and plan activities within the school environment. Upon launching the app, it connects to the service to update and download resources in the selected language. The academic portal ensures these updates are available in EC+ and allows other users to refresh their lists with new elements (Chicano & Luque, 2017). The app was installed on a Huawei ® MediaPad M5 Pro tablet with a 1920 x 1200 resolution and a 10.8-inch

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screen. This setup was specifically chosen to enhance item visualization and facilitate effective user interaction (Alzrayer et al., 2019; Lozano Martínez et al., 2016).

For Group B, pictograms were obtained from the Aragonese Portal of Augmentative and Alternative Communication (ARASAAC) (Gobierno de Aragón, 2007). This resource provides a wide range of AAC materials covering various semantic areas and is available in multiple languages and formats. ARASAAC pictograms are known for their high degree of iconicity and customization, making them particularly effective for communication and comprehension in people with ASD. Additionally, they offer advanced editing options to adapt to the unique needs of each user (Luque & Morillas, 2018).

In this study, laminated 7 x 7 cm pictograms were used, printed in color on a white background to enhance iconicity (Dowse, 2021; Hervás et al., 2020). The pictograms included vocabulary related to objects, food, clothing, people, verbs, and other relevant concepts for the child. Each pictogram featured the corresponding written word in uppercase black letters at the top, helping to associate the graphic representation with the written term.

The characteristics of ARASAAC and the resources it offers will be explained in detail in Chapter 6, given their significance in the study presented there.

5.2.3 Design and procedure

A quasi-experimental study (Harris et al., 2006) was conducted with two independent groups over a 16-week intervention period. The study aimed to compare both AAC resources and determine whether EC+ yielded better results by evaluating participants' progress. The independent variable was the aided augmented input strategy using either EC+ app pictograms (AAC+a) or

ARASAAC printed pictograms (AAC-a). The dependent variables were the Vineland-3 Scale scores in communication, social skills, and disruptive behavior. These scores were assessed on a scale ranging from 0% (no correct independent responses) to 100% (five or more correct independent responses), with a 20-percentage-point increase per correct response.

The study started on different days for participants, so individualized schedules were created based on their initial assessments to ensure equal intervention days and evaluation moments. The design and the three key evaluation moments were structured as follows: at Moment 1 baseline measures of Communication, Social and Behavioral Range (pre-intervention assessment) were established. From week 2 through week 13, Group A received aided augmented input with EC+, while Group B used ARASAAC pictograms (intervention period). At Moment 2, participants' progress was assessed at week 7 (intermediate assessment). Finally, at Moment 3, the final measurement (post-intervention assessment) was performed at week 16 after a 15-day break without training, to measure skill retention and evaluate changes in the different areas of the participants.

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During the intervention sessions, participants sat in a chair in front of a table equipped with either a tablet or printed pictograms, along with relevant materials and motivators. The speech therapist remained nearby to guide and facilitate interaction, pointing to pictographic symbols to support comprehension and association with real-world objects or situations. The goal of this approach was to provide effective aided augmented input, reinforcing responses and promoting successful interactions (Holland et al., 2020). The strategy intervention involved integrating natural social and communicative routines, such as playing with toys, engaging in activities, and interacting with a communication partner. Each child

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was given at least twenty opportunities to communicate during each activity, following the approach described by Muttiah et al. (2022).

In EC+, the communication partner had to click on the desired pictogram to activate the app's multimodal functions. A second click was required to highlight and enlarge the selected pictogram, making it stand out from the other options. For verbs, after displaying the corresponding pictogram, an additional click on the video was performed when necessary to reinforce the concept of the action. In some cases, clicking on the real-life image was also used to ensure a deeper understanding of more complex concepts or when a concrete reference was not readily available. In all instances, the pictogram was always clicked first, with the written word displayed at the top of the picture. For this study, the sign language feature was not used, as it could have been too complex for the participants. Additionally, ARASAAC pictograms were presented and organized individually, following the aided augmented input strategy as described in the next chapter.

The selected activities were compatible with both types of AAC+a and AAC-a resources and were structured as joint action games and exercises (Hassan et al., 2021). These activities targeted various skills, including environmental awareness, emotion recognition, category sorting, object discrimination, two-element associations, request formulation, literacy concepts, and sentence construction using a noun and an adjective. Additionally, emotional and behavioral concepts were introduced to prevent disruptive behaviors such as self-injury, damage to the environment, or destruction of materials (Martínez-González & Gil, 2019).

All therapy sessions were meticulously documented using a combination of written notes, skills checklists, and video recordings to ensure a comprehensive and detailed account of the procedures. Written notes captured real-time

observations and immediate reactions during the sessions, providing context and qualitative data. The skills checklists were used to systematically record the participants' progress and performance across various tasks and activities documenting whether the participant achieved the objective independently, unsuccessfully, or with assistance from the interlocutor. Video recordings served as an invaluable tool for subsequent analysis, allowing the author to review and verify the accuracy of the recorded data and assess the interventions in a detailed manner when necessary.

5.2.4 Measures

This study evaluated core aspects of communication (receptive and expressive), social skills, and behavior. To assess these areas, the Spanish version of the Vineland-3 scale was used, allowing for measurements at the three designated evaluation moments (Pepperdine & McCrimmon, 2018; Roselló et al., 2018). This standardized test measures the areas of communication, daily skills, socialization, motor skills, and maladaptive behavior. Vineland-3 measures these components based on a Raw Score quantified by the performance of age-appropriate behaviors for each user, with three possible response options: 2 = Generally or frequently; 1 = Sometimes; 0 = Never (Sparrow et al., 2016). Then, the total Raw Score is transformed into the v-Scale Score based on the scale's standardized norms, classified by age groups. None of the participants obtained the highest score in the evaluated areas.

The main measure considered for this study was the Communicative Range, derived from the combined v-Scale Scores of the Receptive, Expressive, and Writing subtests. The Receptive language domain included 39 questions examining skills such as responding to questions, understanding words, and following instructions. The Expressive language domain involved 49 questions

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assessing abilities such as producing sounds, expressing emotions, using vocabulary, and communicating non-verbally. The Writing domain comprised 38 questions evaluating skills like letter recognition, reading and understanding symbols, among other actions related to the receptive component of literacy.

Secondary measures comprised the Social Range, which assessed the total v-Scale Score through evaluations of Interpersonal Relationships, Play and Leisure, and Coping Skills. Interpersonal Relationships encompassed 43 questions examining the user's ability to recognize family members or others, engage in interactions, make eye contact, and exhibit spontaneous responses like smiling. Play and Leisure involved 36 questions evaluating interest in surroundings, interactions with toys, and sharing behaviors. Coping Skills included 33 questions analyzing adaptive skills such as seeking comfort, asking for help, using polite expressions, managing emotions, and adjusting behavior (Sparrow et al., 2016). The Behavioral Range was also considered, comprising Section A (13 questions), Section B (11 questions), and Section C (20 questions) of the Vineland-3, focusing on quantifying disruptive behaviors like self-injury, damage to property, and hindrances to learning (Martínez-González & Gil, 2019).

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In line with the methodology employed by Venter et al. (1992), Brady et al. (2015), and Harjusola-Webb and Robbins (2012), this study opted to evaluate adaptive behavior rather than nonverbal cognitive development. The decision was based on the absence of a standardized tool that adequately addressed the age range and behavioral characteristics of our participants. The Vineland-3 assessment was selected because it met the required criteria to assess the intended outcomes.

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While the Vineland-3 is traditionally administered through a structured interview with parents or teachers, for this study, the Comprehensive

Parent/Caregiver Form was completed by the independent observer. This decision was based on several methodological considerations, which are consistently applied in the subsequent studies presented in this thesis. First, having a trained professional complete the form helped reduce potential social desirability bias, which could have been present if the form were filled out by parents, who may have unintentionally exaggerated their child's skills (Roselló et al., 2018). The speech therapist, having been present throughout all therapy sessions, could rely on direct behavioral observations rather than retrospective accounts, ensuring a more objective assessment. This approach aligns with the Vineland-3's requirement for responses to reflect behaviors observed over time (Sparrow et al., 2016). Additionally, involving an independent speech therapist ensured consistency and objectivity in data collection, especially since the author attended the vast majority of the sessions. This separation of roles was critical to avoid introducing bias into the evaluation process. By utilizing a speech therapist who had extensive interaction with the participants, we ensured that the responses were grounded in systematic and contextually relevant observations, particularly valuable for assessing children with complex communication needs.

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Following the procedures described by Pepperdine and McCrimmon (2018), the reliability of the measurements was confirmed using Cronbach's alpha coefficient, with results indicating a satisfactory level of internal consistency and test-retest reliability for the evaluated skills. The internal consistency coefficients for the adaptive domains in the Comprehensive Form and ABC ranged from 0.76 to 0.89, while in the Domain-Level Form and ABC, values ranged from 0.79 to 0.88.

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Test-retest reliability was assessed using corrected correlations, with two administrations conducted by the same examiner and respondent, independent of

the evaluation moments. The interval between observations ranged from 10 days (Observation 1) to 30 days (Observation 2). The corrected r values for the adaptive domains and ABC in the Comprehensive Form ranged from 0.74 to 0.91, indicating a satisfactory level of reliability for assessing the target skills in the 30 participants of the study.

5.2.5 Data analysis

The independent variable was the aided augmented input strategy using EC+ (AAC+a) compared to the strategy using ARASAAC pictograms (AAC-a). The dependent variables were the scores obtained on the Vineland-3 scale in the areas of communication, social skills, and disruptive behaviors. Scores ranged from 0% (no correct independent responses) to 100% (5 or more correct independent responses), with a 20% increase in correct responses.

Data analysis was conducted using SPSS® Statistics version 27.0. Mean scores between the two groups were compared using Student's t-test and repeated-measures ANOVA, considering the between-subjects factor. A significance level of $p<.001$ was set to determine differences between the evaluation moments.

The independent observers, all of whom were speech therapists and varied by center, recorded concordance data in 71% of baseline sessions and 80% of training and maintenance sessions. Concordance was established when the observers and the author identified independent or prompted responses, while disagreement occurred when one observer classified a response as independent and the other did not. Interobserver Agreement (IA) was calculated and is expressed in Equation 5.1.

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$$IA = \left(\frac{Number\ of\ Agreements}{Number\ of\ Agreements + Disagreements}\right) \times 100 \qquad (5.1)$$

An average agreement of 88% was observed during baseline, increasing to 92% during training and maintenance. After each session, the speech therapist completed a checklist, later compared with the evaluation instruments. Analysis revealed that procedures were consistently followed with a 90% reliability in all baseline, training, and maintenance assessments. The author's continuous presence throughout all testing stages ensured reliability.

5.3 Results

The present study identified differences in the analyzed components between participants who received the strategy intervention with EC+ (Group A) and those who did with ARASAAC pictograms (Group B). For a more detailed overview of the scores obtained in the evaluated areas, see Appendix C of the thesis.

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5.3.1 Communicative Range evaluation

First, performance in the Communicative Range was evaluated by comparing the scores obtained based on the type of resource used. Statistically significant differences were found in the adaptive behavior scale measures across all three evaluation moments.

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At Moment 1, the mean difference was 10.70 ($t=26.45$, $p<.001$); at Moment 2, the difference was 17.00 ($t=38.91$, $p<.001$); and at Moment 3, the mean difference reached 24.40 points ($t=38.40$, $p<.001$). Additionally, the mean differences between Groups A and B were analyzed (Figure 14).

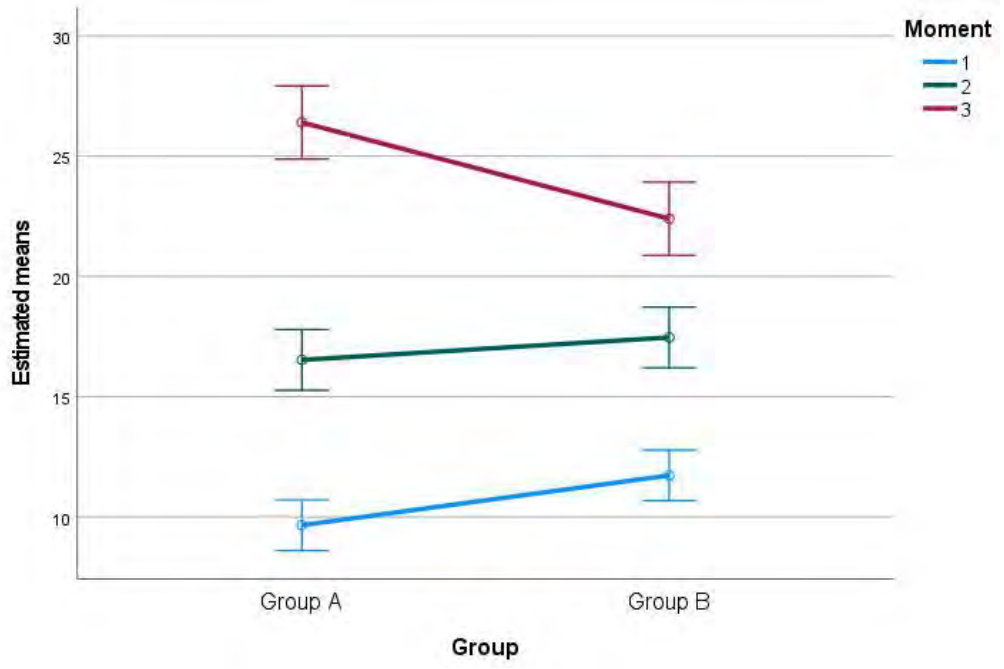


Figure 14: Comparison of Communicative Range in the EC+ vs. paper-pictograms study

The results showed an improvement in the Communicative Range for Group A of 16.73 points (SD=3.15), compared to 10.67 points (SD=2.55) for the Group B. Table 9 shows the differences between the first and last assessments in participants. A repeated measures ANOVA revealed that the EC+ combined intervention achieved a statistically significant score, outperforming the paper-based pictogram intervention, which did not include AAC+a support ($F_{(1.28)}$=382.50, p<.001, η^2=.932, β-1=1).

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Table 9

Communicative Range in the EC+ vs. paper-pictograms study

		Group A			Group B		
		Moment 1	Moment 2	Moment 3	Moment 1	Moment 2	Moment 3
Mean		9.67	16.53	26.40	11.73	17.47	22.40
Standard deviation		2.12	2.32	3.15	1.83	2.44	2.55
Standard error mean		.54	.60	.81	.47	.63	.66
95% Confidence Interval	Lower Limit	8.61	15.27	24.88	10.68	16.20	20.88
	Upper Limit	10.71	17.79	27.92	12.78	18.72	23.92
RS rec (mean and standard deviation)		47.93 (8.31)	55.60 (8.87)	67.67 (5.13)	47.07 (6.44)	53.60 (7.79)	60.40 (5.90)
RS exp (mean and standard deviation)		67.53 (12.80)	72.40 (11.67)	83.73 (8.09)	66.07 (10.21)	70.67 (9.17)	78.47 (6.81)
RS wrn (mean and standard deviation)		10.07 (8.33)	11.40 (7.88)	15.53 (8.77)	7.93 (5.95)	9.73 (7.30)	11.13 (7.27)

Note. RS rec: Raw Score Receptive; RS exp: Raw Score Expressive; RS wrn: Raw Score Written.

5.3.2 Social Range evaluation

An initial analysis was conducted to assess the Social Range among participants. Statistically significant differences were found in the developmental test measures across different evaluation time points. At Moment 1, a mean difference of 13.86 was observed ($t=24.37$, $p<.001$); at Moment 2, the difference increased to 20.53 ($t=25.83$, $p<.001$); and by Moment 3, it reached 28.66 ($t=51.97$, $p<.001$). Subsequently, mean differences between Groups A and B were analyzed (Figure 15).

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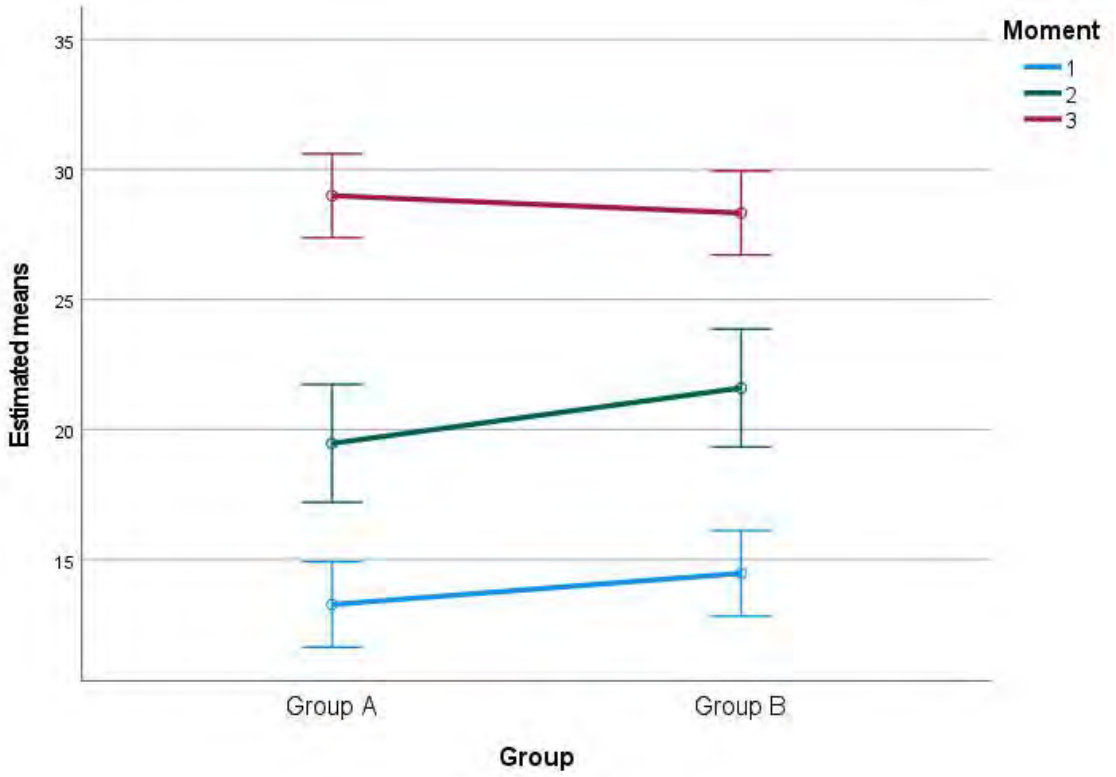


Figure 15: Comparison of Social Range in the EC+ vs. paper-pictograms study

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The results indicated an improvement in the Social Range mean score of 15.73 points (SD=2.56) for Group A, compared to 13.86 points (SD=3.47) for Group B. Table 10 shows the differences between the first and last assessments in participants. Finally, a repeated-measures ANOVA was conducted, revealing differences in the Social Range when comparing the two groups after 16 weeks. However, the difference was not substantial, as the EC+ intervention showed only slightly better results ($F_{(2.00)}$=150.52, p<.001, η^2=.843, β-1=1).

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Table 10

Social Range in the EC+ vs. paper-pictograms study

		Group A			Group B		
		Moment 1	Moment 2	Moment 3	Moment 1	Moment 2	Moment 3
Mean		13.27	19.47	29.00	14.47	21.60	28.33
Standard deviation		3.63	5.37	2.56	2.47	2.82	3.47
Standard error mean		.93	1.38	.66	.63	.72	.89
95% Confidence Interval	Lower Limit	11.62	17.19	27.38	12.82	19.33	26.71
	Upper Limit	14.91	21.73	30.61	16.11	23.86	29.94
RS ipr (mean and standard deviation)		35.47 (9.15)	40.13 (10.54)	56.33 (9.64)	37.07 (9.13)	42.07 (8.54)	54.80 (9.76)
RS pla (mean and standard deviation)		25.27 (8.24)	34.53 (11.76)	45.00 (9.73)	22.07 (6.82)	32.67 (7.97)	42.60 (7.95)
RS cop (mean and standard deviation)		1.93 (1.38)	7.80 (5.85)	22.80 (9.31)	1.80 (1.01)	9.27 (5.12)	17.20 (10.16)

Note. RS ipr: Raw Score Interpersonal Relationships; RS pla: Raw Score Play and Leisure; RS cop: Raw Score Coping Skills.

5.3.3 Behavioral Range evaluation

The same procedure as in previous analyses was followed. An initial analysis was conducted to evaluate the progression of the Behavioral Range among participants. Significant differences were found in the developmental test measures across all three evaluation moments in both groups. In Moment 1, a mean difference of 28.16 was observed ($t=36.78$, $p<.001$); in Moment 2, the difference was 21.26 ($t=20.57$, $p<.001$); and in Moment 3, the mean difference was 11.66 ($t=14.66$, $p<.001$). Next, mean differences between Groups A and B were analyzed (Figure 16).

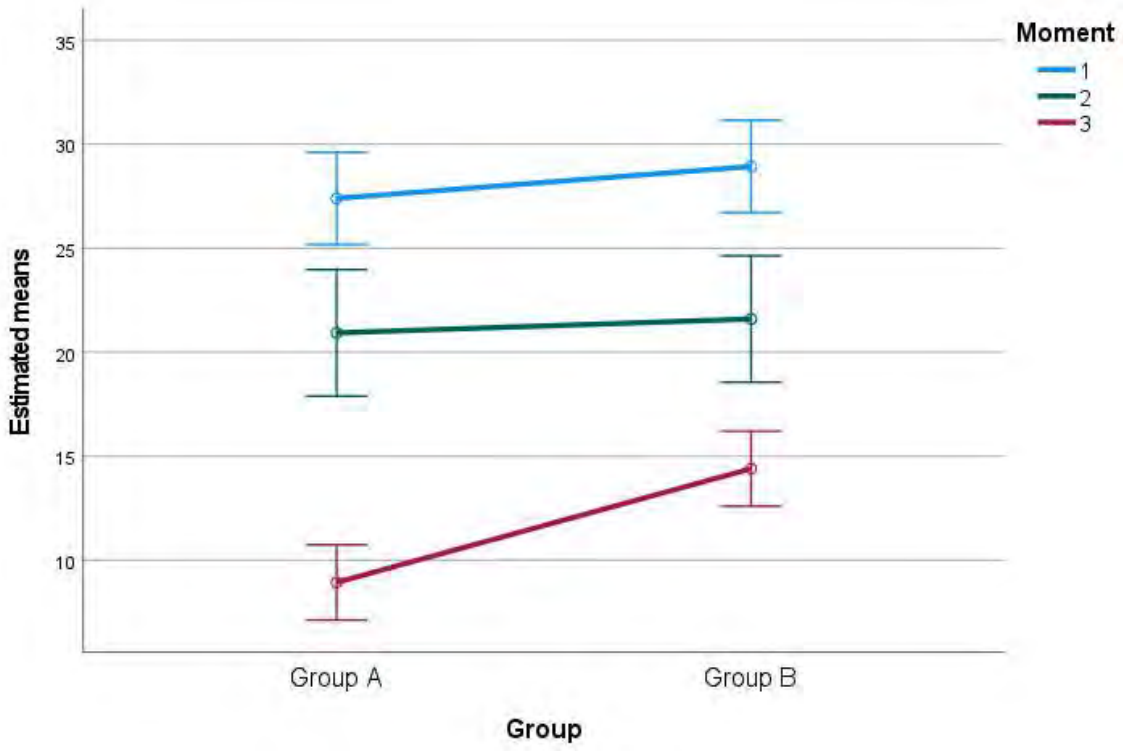


Figure 16: Comparison of Behavioral Range in the EC+ vs. paper-pictograms study

Group A showed an average improvement of 18.47 points (SD=2.91) in the Behavioral Range, compared to an improvement of 14.53 points (SD=3.85) in Group B. Table 11 illustrates the differences between the first and final participant evaluations. A repeated-measures ANOVA was conducted. The results indicated that the intervention combined with the EC+ app led to a significant reduction in disruptive behaviors compared to the intervention using paper-based pictograms, following a 16-week intervention period ($F_{(2.00)}$=186.78, $p<.001$, $\eta^2=.870$, β-1=1).

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Table 11

Behavioral Range in the EC+ vs. paper-pictograms study

		Group A			Group B		
		Moment 1	Moment 2	Moment 3	Moment 1	Moment 2	Moment 3
Mean		27.40	20.93	8.93	28.93	21.60	14.40
Standard deviation		5.39	6.64	2.91	2.46	4.68	3.85
Standard error mean		1.39	1.71	.75	.63	1.21	.99
95% Confidence Interval	Lower Limit	25.18	17.89	7.12	26.71	18.55	12.59
	Upper Limit	29.61	23.97	10.73	31.15	24.64	16.20
Section A (mean and standard deviation)		7.73 (2.57)	6.67 (2.79)	2.73 (1.33)	8.87 (1.99)	7.07 (1.87)	4.93 (2.12)
Section B (mean and standard deviation)		7.33 (2.19)	6.20 (2.51)	3.20 (1.85)	7.20 (1.61)	5.87 (1.99)	4.07 (1.83)
Section C (mean and standard deviation)		12.33 (2.32)	8.07 (2.31)	3.07 (1.94)	12.87 (1.59)	8.67 (2.66)	5.40 (2.84)

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5.4 Discussion

In the present study, the use of EC+ stands out as an AAC+a support with multimodal features, setting it apart from previous research in the field of ASD intervention. Multimodality, which integrates visual, auditory, and tactile stimuli, provides a comprehensive approach that enhances aided augmented input. This type of intervention has not yet been sufficiently explored in the literature, particularly in this population, making it a valuable complement to existing studies that have primarily focused on more unidimensional methods, such as the use of paper-based pictograms or specialized software without incorporating

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multiple sensory modalities (Durán Cuartero, 2021; Keskinen et al., 2012; Therrien et al., 2016).

While these interventions have proven effective, they are often limited to a single communication channel, which may restrict their impact on improving communication, social, and behavioral skills. In contrast, using a tool like EC+ in combination with aided augmented input enables a rich and individualized learning experience that caters to each user's specific needs. It also leverages the natural affinity that children with ASD have for digital resources, a factor reflected in the study's results.

Both the paper-based pictogram intervention (Group B) and the combined intervention with the app (Group A) demonstrated improvements in the assessed areas. However, Group A showed a considerable increase in Communicative Range compared to Group B, indicating greater interaction with their environment, people, and surrounding elements. The use of a tablet may be particularly appealing to children, capturing their attention more effectively than traditional paper-based methods (Marble-Flint et al., 2019). The interactive and engaging nature of the app enhances the learning experience, increasing the likelihood of sustained attention, higher engagement during activities, and greater participant motivation (Aspiranti et al., 2020; Marzal et al., 2023).

Regarding the Behavioral Range, a significant difference in favor of the technology-based support was also observed. Group A showed a greater reduction in disruptive behaviors compared to Group B, suggesting that the EC+-assisted strategy had a stronger impact on behavior management than the use of paper-based pictograms alone. Tablets can offer substantial behavioral benefits (Esposito et al., 2017). The structured and predictable nature of tablet-based activities, particularly with EC+, can provide a sense of security and routine for

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children with ASD, helping them maintain focus and reducing frustration that often leads to disruptive behaviors (Charitaki, 2015; Odom et al., 2015).

The minimal difference in Social Range between the study groups can be attributed to the effectiveness of both resources in promoting social interaction, although Group A achieved slightly higher scores. Both formats provide structured visual supports that help children with ASD understand and engage in social interactions. The systematic use of visual cues, routines, and interactive activities in both groups supports the development of social skills such as eye contact, turn-taking, and initiation of communication (Alzrayer et al., 2019; Rojas, 2024). The individualized approach, combined with the aided augmented input strategy, may explain the similar social skill outcomes observed in both groups (Hassan et al., 2021).

Lastly, it is worth noting that a key advantage of using a tablet for EC+ is that all elements are displayed in an organized and compact manner on a single screen. This layout makes it easier, faster, and more intuitive to select the appropriate item while following the aided augmented input strategy. The interface allows for seamless navigation by simply tapping and scrolling up or down, as it is presented in a list format.

In contrast, paper-based pictograms require meticulous organization and ensuring that all necessary symbols are available during the activity. This demands extensive preparation both before and during intervention sessions (Reichle et al., 2019). Such a setup can slow down interactions with communication partners, making exchanges more time-consuming and complex due to the need to search through multiple options. Technology AAC supports, like those implemented in EC+, have been shown to enhance accessibility and

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reduce cognitive load, allowing for more efficient and engaging communication experiences (Currie, 2018; Holyfield & Lorah, 2023).

Some limitations of the study include the relatively small sample size. As noted in previous studies (Esposito et al., 2017; Marble-Flint et al., 2019), this may limit the generalizability of the findings, particularly given the high heterogeneity of the ASD population. The broad spectrum of communicative, cognitive, functional, and sensory profiles within ASD (Mottron & Bzdok, 2020) is reflected in this study's results, where significant differences between Groups A and B were observed from the initial assessment. To mitigate this issue, efforts were made to ensure that participants in both groups were as homogeneous as possible based on inclusion criteria. Another limitation is that the use of both the tablet and paper-based pictograms within the speech therapy setting may create less natural interaction scenarios. Since these tools are introduced in a structured environment rather than in spontaneous daily communication, there is a risk that language stimulation may feel artificial or constrained. To mitigate this, it is essential to carefully design and structure the intervention to ensure that aided augmented input flows as naturally as possible, promoting meaningful and functional communication that can be transferred to real-life situations.

Conducting this initial study led to the development of several future research directions. As observed, both EC+ and ARASAAC printed pictograms proved to be effective resources for the type of intervention and the characteristics of the participants, despite their differences. This highlighted the importance of using these two resources as a foundation for further research, each with a distinct perspective: comparing ARASAAC pictograms with other AAC-a resources, as well as evaluating EC+ against a different AAC+a support. These aspects will be explored in Chapters 6 and 7, respectively. The studies included in this thesis

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followed the key procedures outlined here, ensuring a cohesive approach aimed at determining which AAC support or material is most effective for children with level 3 ASD and complex communication needs.

5.5 Conclusions

This study provides evidence supporting the effectiveness of combining technology-based supports like the EC+ app with aided augmented input strategies. Promising results were obtained in Spanish-speaking children with Level 3 ASD who have complex communication needs, as well as in social and behavioral domains, reinforcing the advantages of this technological resource. In conclusion, the findings highlight the value of integrating such supports, offering a multimodal, interactive and effective approach to fostering the overall development of children with ASD. This integration can serve as a valuable complement to paper-based resources and AAC-a supports while acknowledging their continued relevance in this field.

The research fulfills specific objective 5, as presented in Section 1.2 of Chapter 1 of the thesis.

UNIVERSIDAD DE MÁLAGA

5.6 References

Alzrayer, N.M., Banda, D.R., & Koul, R.K. (2019). The effects of systematic instruction in teaching multistep social-communication skills to children with autism spectrum disorder using an iPad. *Developmental Neurorehabilitation*, 22(6), 415-429. https://doi.org/10.1080/17518423.2019.1604578

American Psychiatric Association (APA) (2013). Diagnostic and statistical manual of mental disorders (5th ed.). *Washington, DC: American Psychiatric Publishing.* https://doi.org/10.1176/appi.books.9780890425596

UNIVERSIDAD DE MÁLAGA

Aspiranti, K. B., Larwin, K. H., & Schade, B. P. (2020). iPads/tablets and students with autism: A meta-analysis of academic effects. *Assistive Technology, 32*(1), 23–30. https://doi.org/10.1080/10400435.2018.1463575

Batool, S., Tahir, T., Gul, R., & Ishfaq, U. (2021). Attribution styles of deaf children: Application of Weiner theory. *Webology*, 18(3), 610-625.

Beukelman, D. R., & Mirenda, P. (2013). *Augmentative and Alternative Communication: Supporting Children and Adults with Complex Communication Needs* (4th ed.). Paul H. Brookes Publishing.

Brady, N. C., Storkel, H. L., Bushnell, P., Barker, R. M., Saunders, K., Daniels, D., & Fleming, K. (2015). Investigating a multimodal intervention for children with limited expressive vocabularies associated with autism. *American Journal of Speech-Language Pathology*, 24(3), 438-459. https://doi.org/10.1044/2015_AJSLP-14-0093

Brown, L., Sherbenou, R. J. & Johnsen, S. K. (2019). Test of Nonverbal Intelligence (TONI-4). *Encyclopedia of Autism Spectrum Disorders, 2021.* https://doi.org/10.1007/978-3-319-91280-6

Calleja Reina, M., Luque, M.L., & Rodríguez Santos, J.M. (2021). Protocolo de Valoración del Perfil Comunicativo Lingüístico de personas con necesidades complejas de comunicación y discapacidad intelectual (PCL-DIS-NCC). En M. Calleja Reina (Ed.), *Necesidades complejas de comunicación y enfermedades minoritarias* (pp. 30-35). McGraw Hill Education.

Charitaki, G. (2015). The effect of ICT on emotional education and development of young children with Autism Spectrum Disorder. *Procedia Computer Science*, 65, 285-293. https://doi.org/10.1016/j.procs.2015.09.081

Chicano, F., & Luque, G. (2017). A mobile application and academic portal to support professionals working with people having severe intellectual or developmental

UNIVERSIDAD DE MÁLAGA

disabilities. *Procedia-Social and Behavioral Sciences*, 237, 568-575. https://doi.org/10.1016/j.sbspro.2017.02.108

Currie, E. (2018). Critical Review: In children with Autism Spectrum Disorder, do high-tech devices surpass low-tech devices when evaluating increased communication skills?.

da Silva, M. L., Simões, C., Gonçalves, D., Guerreiro, T., Silva, H., & Botelho, F. (2011). TROCAS: communication skills development in children with autism spectrum disorders via ICT. In *Human-Computer Interaction–INTERACT 2011: 13th IFIP TC 13 International Conference, Lisbon, Portugal, September 5-9, 2011, Proceedings, Part IV 13* (pp. 644-647). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-23768-3_103

De Pimentel, G. U. A. (2024). Autism Spectrum Disorder (ASD): A major problem to address. *Horizonte Médico (Lima)*, 24(1), e2631–e2631. https://doi.org/10.24265/horizmed.2024.v24n1.00

Dowse, R. (2021). Designing and reporting pictogram research: Problems, pitfalls and lessons learnt. *Research in Social and Administrative Pharmacy*, 17(6), 1208-1215. https://doi.org/10.1016/j.sapharm.2020.08.013

Durán Cuartero, S. (2021). Technologies for teaching and learning of students with autism spectrum disorder: a systematic review. *Innoeduca. International Journal of Technology and Educational Innovation*, 7(1), 107-121. https://doi.org/10.24310/innoeduca.2021.v7i1.9771

Esposito, M., Sloan, J., Tancredi, A., Gerardi, G., Postiglione, P., Fotia, F., Napoli, E., Mazzone, L., Valeri, G., & Vicari, S. (2017). Using tablet applications for children with autism to increase their cognitive and social skills. *Journal of Special Education Technology*, 32(4), 199-209. https://doi.org/10.1177/0162643417719751

UNIVERSIDAD DE MÁLAGA

Fombonne, E., MacFarlane, H., & Salem, A. C. (2021). Epidemiological surveys of ASD: advances and remaining challenges. *Journal of Autism and Developmental Disorders*, 51, 4271-4290. https://doi.org/10.1007/s10803-021-05005-9

Fopiano, J. (2021). Test of Nonverbal Intelligence (TONI-4). In: *Volkmar, F.R. (eds) Encyclopedia of Autism Spectrum Disorders*. Springer, Cham. https://doi.org/10.1007/978-3-319-91280-6_1784

Gobierno de Aragón (2007). *Portal Aragonés de la Comunicación Aumentativa y Alternativa, ARASAAC*. Author of pictograms: Sergio Palao. Retrieved from: ARASAAC (http://www.arasaac.org). Licenced by: CC (BY-NC-SA).

Gómez, J. L. C., & García, V. A. (2012). Tecnologías de la información y la comunicación: aplicaciones en el ámbito de los trastornos del espectro del autismo. *Siglo Cero: Revista Española Sobre Discapacidad Intelectual*, 43(242), 6-25.

Guillén, S. G., Rojas, D. G., & Fernández, S. J. (2016). Uso de las TIC en el Trastorno de Espectro Autista: aplicaciones. *Edmetic*, 5(2), 134-157. https://doi.org/10.21071/edmetic.v5i2.5780

Gunning, C., Breathnach, Ó., Holloway, J., McTiernan, A., & Malone, B. (2019). A systematic review of peer-mediated interventions for preschool children with autism spectrum disorder in inclusive settings. *Review Journal of Autism and Developmental Disorders*, *6*, 40-62. https://doi.org/10.1007/s40489-018-0153-5

Gutiérrez, G. H., Casas, X., Sevilla, J., Escribano, L. R., Carpio, C. P., Plaza, J., ... & Le Groux, S. (2012). Pictogram Room: Aplicación de tecnologías de interacción natural para el desarrollo del niño con autismo. A*nuario de Psicología Clínica y de la Salud*, (8), 41-46.

Guzmán, G., Putrino, N., Martínez, F., & Quiroz, N. (2017). Nuevas tecnologías: Puentes de comunicación en el trastorno del espectro autista (TEA). *Terapia Psicológica*, 35(3), 247-258. https://doi.org/10.4067/s0718-48082017000300247

UNIVERSIDAD DE MÁLAGA

Harjusola-Webb, S. M., & Robbins, S. H. (2012). The effects of teacher-implemented naturalistic intervention on the communication of preschoolers with autism. *Topics in Early Childhood Special Education*, 32(2), 99-110. https://doi.org/10.1177/0271121410397060

Harris, A. D., McGregor, J. C., Perencevich, E. N., Furuno, J. P., Zhu, J., Peterson, D. E., & Finkelstein, J. (2006). The use and interpretation of quasi-experimental studies in medical informatics. *Journal of the American Medical Informatics Association*, 13(1), 16-23. https://doi.org/10.1197/jamia.M1749

Hassan, A., Pinkwart, N., & Shafi, M. (2021). Serious games to improve social and emotional intelligence in children with autism. *Entertainment Computing*, 38, 100417. https://doi.org/10.1016/j.entcom.2021.100417

Hervás, R., Bautista, S., Méndez, G., Galván, P., & Gervás, P. (2020). Predictive composition of pictogram messages for users with autism. *Journal of Ambient Intelligence and Humanized Computing*, 11, 5649–5664. https://doi.org/10.1007/s12652-020-01925-z

Holland, C. M., Blanche, E. I., & Thompson, B. L. (2020). Quantifying therapists' activities during sensory integration treatment for young children with autism. *Physical & Occupational Therapy in Pediatrics*, 41(3), 284–299. https://doi.org/10.1080/01942638.2020.1847235

Holyfield, C., & Lorah, E. (2023). Effects of high-tech versus low-tech AAC on indices of happiness for school-aged children with multiple disabilities. *Journal of Developmental and Physical Disabilities*, *35*(2), 209-225. https://doi.org/10.1007/s10882-022-09858-5

Keskinen, T., Heimonen, T., Turunen, M., Rajaniemi, J. P., & Kauppinen, S. (2012). SymbolChat: A flexible picture-based communication platform for users with intellectual disabilities. *Interacting with Computers*, 24(5), 374-386. https://doi.org/10.1016/j.intcom.2012.06.003

UNIVERSIDAD DE MÁLAGA

Lehman, J. (1998). A featured based comparison of software preferences in typically-developing children versus children with autism spectrum disorders. *CMU School of Computer Science*.

León Cruz, I. (2020). Modification of mental rigidity and associated disruptive behaviours in a child diagnosed with autism spectrum disorder (ASD*). Know and Share Psychology*, 1(3). http://dx.doi.org/10.25115/kasp.v1i3.3689

Lima, S. M., & Laplane, A. L. F. D. (2016). Escolarização de alunos com autismo. *Revista Brasileira de Educação Especial*, 22, 269–284. https://doi.org/10.1590/S1413-65382216000200009

Logan, K., Iacono, T. & Trembath, D. (2017). A Systematic Review of Research into Aided AAC to Increase Social-Communication Functions in Children with Autism Spectrum Disorder. *Augmentative and Alternative Communication*, 33(1), 51-64. https://doi.org/10.1080/07434618.2016.1267795

Lozano Martínez, J., Ballesta Pagán, F.J., Alcaraz García, S., & Cerezo Máiquez, M.C. (2016). Information and communication technologies (ICT) in the teaching and learning process of students with autism spectrum disorder (ASD). *Revista Fuentes*, 14, 193–208.

Luque P. G., Postigo Pinazo, E., Calleja Reina, M., & Chicano, F. (2018). *EC+* (1.0) [App]. Google Play. https://bit.ly/3ravvgV

Luque, F. C. & Morillas, C. M. (2018). Iconicidad y facilidad de aprendizaje de los símbolos pictográficos ARASAAC. *Revista de Logopedia, Foniatría y Audiología*, 38(3), 95-104. https://doi.org/10.1016/j.rlfa.2018.04.002

Marble-Flint, K. J., Strattman, K. H., & Schommer-Aikins, M. A. (2019). Comparing iPad® and paper assessments for children with ASD: An initial study. *Communication Disorders Quarterly*, 40(3), 152-155. https://doi.org/10.1177/1525740118780750

UNIVERSIDAD DE MÁLAGA

Martin, R., & Wilkins, J. (2022). Creating visually appropriate classroom environments for students with autism spectrum disorder. *Intervention in School and Clinic*, 57(3), 176–181. https://doi.org/10.1177/10534512211014882

Martínez-González, A., & Gil, J. (2019). Análisis mediante bio-feedback, adaptación escolar y intervención neuroeducativa de un caso de autismo grave. *Revista Iberoamericana de Diagnóstico y Evaluación Psicológica*, 53(4), 185–195. https://doi.org/10.21865/ridep53.4.14

Marzal, A., Rico, G.M., García, R.J.G., & Pérez, M.C. (2023). Las TIC y la competencia sociocomunicativa del alumnado con TEA: una revisión sistemática. *Edmetic*, 12(1), 1-21. https://doi.org/10.21071/edmetic.v12i1.14578

Montes Pérez, A., & Morales Díaz, M. (2017). Estudio comparativo de las diferentes aplicaciones para autismo y Asperger: Propuesta educativa a través de una APP. *Prácticas Innovadoras Inclusivas: Retos y Oportunidades*.

Mottron, L., & Bzdok, D. (2020). Autism spectrum heterogeneity: fact or artifact?. *Molecular Psychiatry*, 25(12), 3178-3185. https://doi.org/10.1038/s41380-020-0748-y

Moya Giménez, L. (2021). DiverTEA. *App para aprender jugando [Trabajo Fin de Grado, Universidad de Alicante]*. Repositorio RUA. https://bit.ly/46x9uK6

Muttiah, N., Drager, K. D., Beale, B., Bongo, H., & Riley, L. (2022). The effects of an intervention using low-tech visual scene displays and aided modeling with young children with complex communication needs. *Topics in Early Childhood Special Education*, 42(1), 91-104. https://doi.org/10.1177/0271121419844825

Ntalindwa, T., Soron, T. R., Nduwingoma, M., Karangwa, E., & White, R. (2019). The use of information communication technologies among children with autism spectrum disorders: Descriptive qualitative study. *JMIR Pediatrics and Parenting*, 2(2). https://doi.org/10.2196/12176

UNIVERSIDAD DE MÁLAGA

Odom, S. L., Thompson, J. L., Hedges, S., Boyd, B. A., Dykstra, J. R., Duda, M. A., ... & Bord, A. (2015). Technology-aided interventions and instruction for adolescents with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 45, 3805-3819. https://doi.org/10.1007/s10803-014-2320-6

Pahisa-Solé, J. (2020). *Jocomunico: un sistema de comunicació que transforma els pictogrames a llenguatge natural*. UAB divulga. https://bit.ly/3LQU35S

Passerino, L. M., & Santarosa, L. M. C. (2008). Autism and digital learning environments: Processes of interaction and mediation. *Computers & Education*, 51(1), 385-402. https://doi.org/10.1016/j.compedu.2007.05.015

Pepperdine, C. R., & McCrimmon, A. W. (2018). Test review: Vineland Adaptive Behavior Scales, (Vineland-3) by Sparrow, SS, Cicchetti, DV, & Saulnier, CA. *Canadian Journal of School Psychology*. https://doi.org/10.1177/0829573517733845

Postigo Pinazo, E., Calleja Reina, M., & Gabau Vila, E. (2018). *Disability and communication. Scientific analysis, total communication and ICT tools and case studies*. McGraw Hill Education.

Quezada, Á., Rodríguez, A., Jimenez, S., & Zúñiga, H. G. A. (2023). Desarrollo de software que apoya la mejora de las habilidades motoras en niños con Autismo. *Estudios e Innovaciones Educativas Empleando la Tecnología*, 171. https://doi.org/10.61728/AE24050081

Quiroga, L. P., Jaramillo, S., & Vanegas, O. L. (2019). Ventajas y desventajas de las TIC en la educación "Desde la primera infancia hasta la educación superior". *Revista Educación y Pensamiento*, 26(26), 77-85

Reichle, J., Simacek, J., & Parker-McGowan, Q. E. (2019). Considerations in implementing aided low-tech AAC systems for individuals with autism spectrum disorder and complex communication needs.

UNIVERSIDAD DE MÁLAGA

Rojas, V. R. M. (2024). Videomodelado y Autonomía de Personas Autistas. Revisión de Elementos para un Programa de Intervención Educativa. *Educación*, 30(1), e3190-e3190. https://doi.org/10.33539/educacion.2024.v30n1.3190

Roselló, B., Berenguer, C. & Baixauli, I. (2018). El funcionamiento adaptativo de niños con trastorno del espectro autista: impacto de los síntomas y de los problemas comportamentales y emocionales. *International Journal of Developmental and Educational Psychology*, 3(1), 247-257. https://doi.org/10.17060/ijodaep.2018.n1.v3.1268

Semino, S., Zanobini, M., & Usai, M. C. (2021). Visual memory profile in children with high functioning autism. *Applied Neuropsychology: Child*, *10*(1), 26-36. https://doi.org/10.1080/21622965.2019.1594231

Sparrow, S.S., Cicchetti, D.V. & Saulnier, C.A. (2016). *Vineland Adaptive Behavior Scales, Third Edition (Vineland-3).* San Antonio, TX: Pearson. https://doi.org/10.1177/0829573517733845

Talantseva, O. I., Romanova, R. S., Shurdova, E. M., Dolgorukova, T. A., Sologub, P. S., Titova, O. S., ... & Grigorenko, E. L. (2023). The global prevalence of autism spectrum disorder: A three-level meta-analysis. *Frontiers in Psychiatry*, 14, 1071181. https://doi.org/10.3389/fpsyt.2023.1071181

Therrien, M. C., Light, J., & Pope, L. (2016). Systematic review of the effects of interventions to promote peer interactions for children who use aided AAC. *Augmentative and Alternative Communication*, 32(2), 81–93. https://doi.org/10.3109/07434618.2016.1146331

Velarde-Incháustegui, M., Ignacio-Espíritu, M. E., & Cárdenas-Soza, A. (2021). Diagnóstico de Trastorno del Espectro Autista- TEA, adaptándonos a la nueva realidad, Telesalud. *Revista de Neuro-Psiquiatría*, 84(3), 175–182. https://doi.org/10.20453/rnp.v84i3.4034

UNIVERSIDAD DE MÁLAGA

Venter, A., Lord, C., & Schopler, E. (1992). A follow-up study of high-functioning autistic children. *Journal of Child Psychology and Psychiatry*, *33*(3), 489-597. https://doi.org/10.1111/j.1469-7610.1992.tb00887.x

Voss, C., Schwartz, J., Daniels, J., Kline, A., Haber, N., Washington, P., ... & Wall, D. P. (2019). Effect of wearable digital intervention for improving socialization in children with autism spectrum disorder: a randomized clinical trial. *JAMA Pediatrics*, 173(5), 446-454. https://doi.org/10.1001/jamapediatrics.2019.0285

Wilkinson, K. M., & Hennig, S. (2007). The state of research and practice in augmentative and alternative communication for children with developmental/intellectual disabilities. *Mental Retardation and Developmental Disabilities Research Reviews*, *13*(1), 58-69. https://doi.org/10.1002/mrdd.20133

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6

Comparison of ARASAAC and commercially available pictograms using the aided augmented input strategy

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6.1 Introduction

The alterations of expressive or receptive communication in ASD have led to design strategies and resources adapted to the characteristics of this population, as is the case with the use of AAC, whose visuospatial characteristics generate an increase in the acquisition of new communicative skills, including phonological awareness, increased vocabulary and social skills (Langarika-Rocafort et al., 2021). AAC combines both technological and traditional supports such as pictograms, software, intervention strategies and modeling (Biggs et al., 2018).

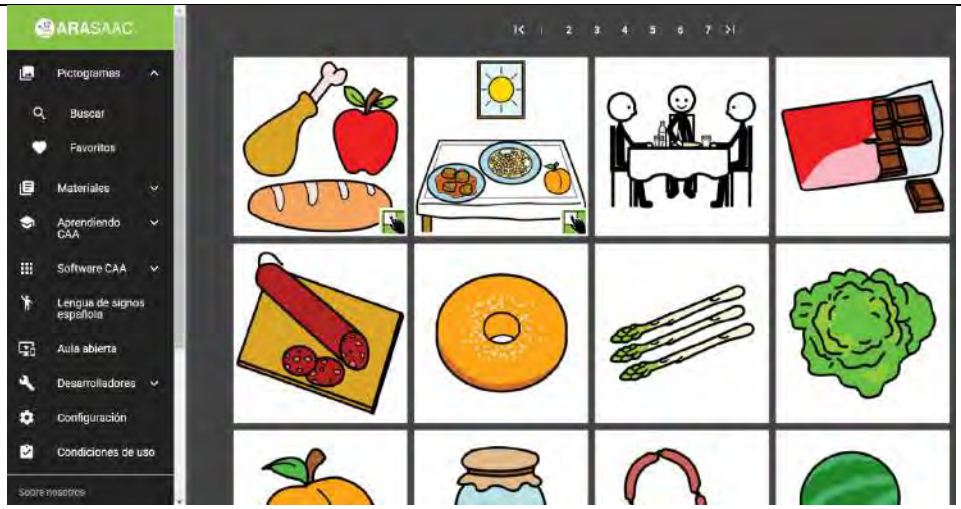
In this context, there are various systems and applications, each with its own set of pictograms and features. One such system is ARASAAC (Gobierno de Aragón, 2007), developed as a comprehensive, free online resource by the Department of Education, Culture, and Sports of the regional government of Aragón, Spain. It offers a wide range of pictographic symbols and adapted materials, under a Creative Commons license (BY-NC-SA), to support people with communication difficulties and help them express their needs, wishes and thoughts in an effective way (Table 12).

ARASAAC has an accessible and thoughtful design to facilitate its use by both professionals and family members. It is available in different languages, such as Spanish, English, Portuguese, French, German and Italian, among others, which makes it available worldwide (Paolieri & Marful, 2018).

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Table 12

Main characteristics of ARASAAC

Feature	Description
Logotype	ARASAAC
Target audience	Primarily designed for people with communication difficulties, including those with ASD, cognitive impairments, and language disorders.
Access and usability	Fully accessible online with an intuitive design, ensuring usability by both professionals and family members.
Customization for users	Customizable to meet individual needs, including options for modifying symbols, backgrounds, and text to suit various communication profiles.
Advanced options	Includes high-resolution icons, zoom features, and the ability to move icons to ensure that symbols can be adapted for specific contexts.
Educational integration	Frequently integrated into educational settings, providing resources for teachers and educators to enhance learning for students with communication challenges.
Collaborative features	The platform supports user-generated content, where users and professionals can share adaptations, fostering community engagement.
Interface visual example	

Note. The images included in this table were retrieved from the official ARASAAC website (https://www.arasaac.org) and were directly obtained by the author of this thesis.

ARASAAC has an extensive collection of more than 30.000 pictograms and AAC resources with different graphic representations. These include symbols of food, leisure, places, objects, actions, emotions, education and concepts among other semantic areas, presented in five different options: color pictograms, black and white pictograms, photographs, sign language videos and descriptions with photographs containing how to sign a specific word (Rodrigo & Corral, 2013). ARASAAC pictograms have a high degree of iconicity (Cabello & Bertola, 2015), which facilitates communication and understanding for people with ASD and other special needs (Luque & Morillas, 2018). Furthermore, they can all be changed in different ways in order to adapt to individual needs or carry out interventions, including the edition of icon characteristics, background color and frame color, verb tense, physical features of the person represented, word class identifier, adding plural or strikethrough. As for the text options, the written word can be placed at the top or bottom of the pictogram to customize the letter font, size and color. It is also possible to add new words or switch between upper- and lower-case letters. And last, advanced options allow zooming the icon, moving it or making it high-resolution (Méndez et al., 2018).

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One of the most noteworthy features of ARASAAC is that it has an inclusive approach, providing tools that encourage the active participation of people with communication difficulties in their social and educational environment. This platform also promotes collaboration and resource sharing, allowing users to share their own creations and adaptations, which further enriches the diversity and usefulness of the collection of pictograms and materials available. All pictograms can be downloaded and printed, allowing you to create everything from communication boards to custom dice, board games, storybooks, personalized calendars, and much more. (Bertola, 2017). In recent years, the pictograms and

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resources from the ARASAAC platform have become some of the most widely used in Spain (Hervás et al., 2020).

Previous studies, such as those seen in Chapter 4, have used aided augmented input strategy with children diagnosed with ASD, showing an increase in symbol production and improved word comprehension when paired with symbols. However, there is still insufficient evidence to conclusively establish the effectiveness of this strategy in children with Level 3 ASD in a Spanish-speaking context, particularly regarding their most affected skills: communication (receptive and expressive skills), social interaction, and behavior (Sauer et al., 2021). Additionally, the vast array of pictograms compatible with this strategy can present challenges during intervention, highlighting the need for studies that compare different types of pictograms. It is essential to compare diferent types of pictograms with others, as this can uncover the distinct advantages or limitations of each approach, helping professionals make well-informed decisions about the most effective resources for each child, based on their specific needs and circumstances.

This study aims to compare the effectiveness of different AAC-a resources by analyzing their impact on participants when presented in printed format and when combined with aided augmented input. The hypothesis is that pictograms with more iconic design features will lead to better symbol comprehension and production. For this reason, the study evaluated the effectiveness of ARASAAC pictograms, given their unique characteristics and potential, in comparison to a commercially available pictogram system. To date, no research has examined the combined effects of this intervention strategy with the selected pictograms.

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6.2 Method

6.2.1 Participants

The study sample consisted of participants with ASD from Málaga, Spain, selected through purposive sampling. The sample initially included 40 potential participants, with 25 meeting the following inclusion criteria: (a) school-aged children (6–12 years old) selected for their diagnostic stability (Fombonne et al., 2021; De Pimentel, 2024), prevalence (Talantseva et al., 2023) and because this developmental stage is critical for acquiring fundamental social, communicative, and academic skills (Lima & Laplane, 2016); (b) Spanish as their primary language of instruction; (c) diagnosed with Level 3 ASD, as assessed by clinicians using DSM-5 criteria (APA, 2013); (d) complex communication needs, evidenced by limited functional communicative exchanges through verbal language (speech, signs, or writing); (e) the ability to focus on an activity for at least 10 minutes, according to teacher and caregiver reports; (f) unfamiliarity with the AAC-a resources used in the study, as verified through reports from the relevant speech therapists; (g) no visual or hearing impairments; and (h) signed informed consent from parents or the primary caregiver.

The equivalence between groups was ensured through the random assignment of participants, following CONSORT guidelines. This method guarantees a balanced distribution of baseline characteristics and minimizes bias when comparing the effects between groups. The final sample of 25 participants was assigned identification numbers and randomly divided into Group A and Group B using the Random.org software. Group A received the aided augmented input strategy utilizing ARASAAC pictograms from the initial evaluation through to the end of the study. In contrast, Group B underwent the same aided augmented

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input strategy but with commercially available teaching pictograms, under identical conditions and timeframes.

The sample size was selected according to the number of participants who satisfied the inclusion criteria, while also considering the study's practical limitations. However, for the research in this thesis, an additional 15 participants were added to Group A. These participants were part of one of the research groups (Group B) from the study described in Chapter 5, and their identical characteristics and intervention process justified their inclusion. This integration ensured consistency in participant profiles, allowing for a more robust comparison while maintaining the methodological rigor of the study. As a result, the total sample increased to 40 participants, enhancing the statistical power and generalizability of the findings. Before the intervention began, participants were assessed to document their baseline characteristics (Table 13).

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Table 13

Participant descriptions in the ARASAAC vs. commercial pictograms study

	Group A	Group B
Participants	*n*=21	*n*=19
Gender	18 male 3 female	15 male 4 female
Age (mean and standard deviation)	7.29 (1.45)	7.21 (1.13)
TONI-4 (mean IQ and standard deviation)	50.29 (5.44)	50.16 (5.38)
Vineland-3 (ABC)	Percentage = <1	Percentage = <1
PCL-DIS-NCC (mean and standard deviation)	• PCL-EC: 21.33 (1.01) • PCL-EE-VI: 18.52 (1.32) • PCL-EE-FC: 22.52 (1.43) • PCL-EE-MC: 20.43 (4.20) • PCL-EE-T: 19.81 (1.47)	• PCL-EC: 22.16 (.95) • PCL-EE-VI: 19.00 (1.05) • PCL-EE-FC: 20.26 (1.59) • PCL-EE-MC: 21.26 (4.71) • PCL-EE-T: 17.32 (1.56)

Note. IQ: Intelligence Quotient; ABC: Adaptative Behavior Composite; PCL-EC: Comprehension Scale; PCL-EE-VI: Variety of Interlocutors; PCL-EE-FC: Communication Functions; PCL-EE-MC: Communication Modes; PCL-EE-T: Topics and Preferences. Compiled by the author.

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To measure complex communication needs, the ABC from the Vineland-3 Adaptive Behavior Scale was used, providing a comprehensive understanding of functional abilities in children with ASD (Sparrow et al., 2016). The ABC score aggregates the domains of Communication, Daily Living Skills, and Socialization, with a percentile score below 1% indicating severely limited performance. IQ was measured using TONI-4, suitable for people with verbal, auditory, or motor difficulties (Brown et al., 2019; Fopiano, 2021). To assess language comprehension and expression, the PCL-DIS-NCC protocol was used, evaluating comprehension, range of communication partners, communicative functions, modes of communication, and conversational topics (Calleja Reina et al., 2021).

6.2.2 Setting and materials

All sessions were conducted in multidisciplinary centers, specifically in speech therapy offices. The communication contexts included playing with toys and other objects, social interaction with the communication partner, and quantifying problematic behaviors during the session. A consistent set of motivators (toys, music and resources) was identified through preference assessments and family interviews before the study. These motivators, along with the AAC resources, were strategically placed on the table to help regulate participants' impulses and enhance the intervention strategy (Holland et al., 2020).

Each week, a new item from the original set—previously unused—was introduced during the intervention periods. Sessions were conducted individually, lasting 15 to 30 minutes, and took place 2 to 3 times per week, depending on participant availability and center scheduling. To prevent fatigue and frustration, strategic 5-minute breaks were incorporated after several activities. These breaks were not counted toward the total intervention time, ensuring that children

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remained focused and engaged throughout the sessions. The intervention followed a user-centered approach.

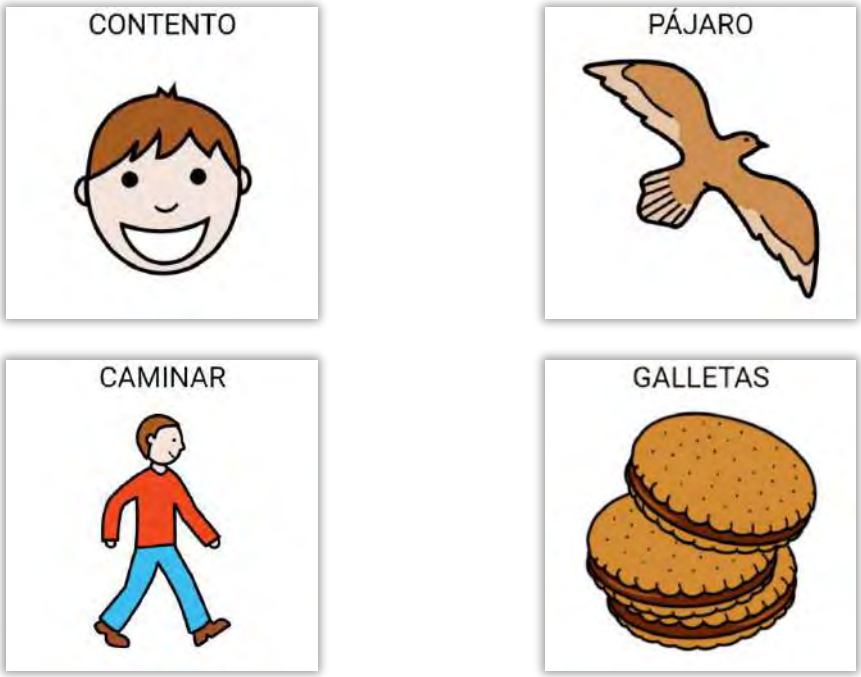
For Group A, ARASAAC pictograms were used to target specific skills during intervention sessions. These pictograms included visual aids for semantic fields (such as clothing, colors, food, vehicles, emotions, places, etc.), general vocabulary, and elements for creating social stories (Paolieri & Marful, 2018). All ARASAAC pictograms were well-defined, color images with a white background to ensure a high level of iconicity. The word was displayed in black uppercase letters at the top to complement the visual representation (Cabello & Bertola, 2015; Laher & Dada, 2023; Rayner, 1998)

For Group B, commercially available educational pictograms from *Mi Estuche de Pictos* ® were used. This practical tool, marketed by Editorial GEU, is designed to support and enhance alternative communication. It includes a collection of 535 pictograms in laminated card format, each measuring 7 × 7 cm. These cards are easy to handle and suitable for both individual and group use. They are recommended for children with ASD, communication difficulties, learning challenges, or those beginning literacy. This resource is currently available in Spanish, Catalan, and Italian for a standard price of €29.95 on the official Editorial GEU website. Additionally, a bilingual version is available, featuring educational pictograms with words in both Spanish and English.

The pictograms feature pre-designed illustrations that do not follow the same principles of iconicity and lack the structured design of ARASAAC pictograms (see an example in Figure 17).

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ARASAAC



Mi Estuche de Pictos ®

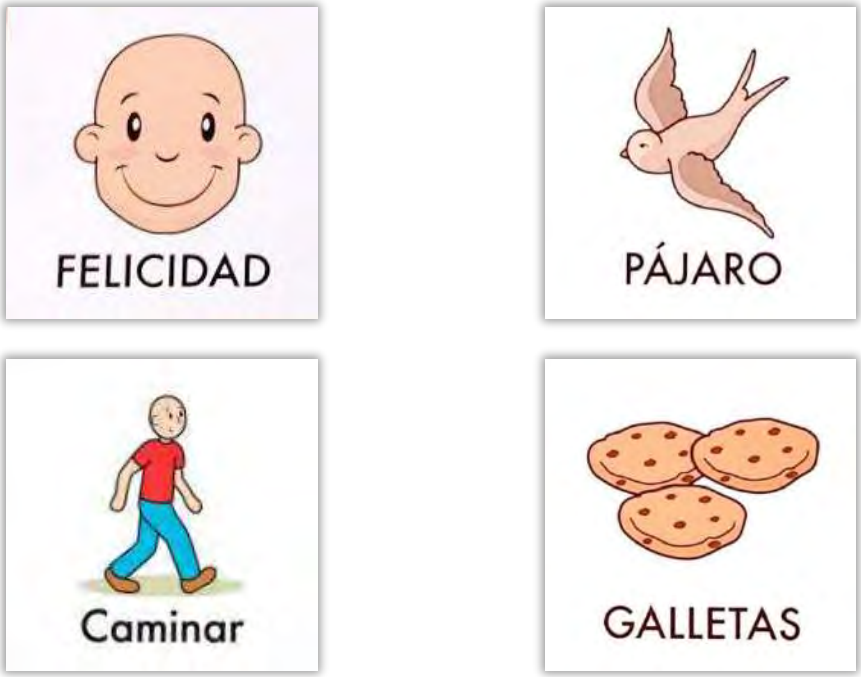


Figure 17: Pictograms examples used in the study

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Mi Estuche de Pictos ® pictograms also have a white background, color images, and written words in black uppercase letters at the bottom. In this case, the pictograms are divided into 17 different categories: "Actions", "Activities/Therapy", "Food", "Animals", "Personal Hygiene", "Colors", "Basic Concepts", "Emotions", "Places", "Transportation", "Numbers", "Professions", "Body Parts", "Time", "Family", "Clothing & Accessories", and "Others" (e.g., "goodbye", "please"). The "Clothing & Accessories" category is only included in the Spanish version, which was used for this study.

This resource was selected for the study due to its recommendation for supporting communication in children with ASD, communication difficulties, learning challenges, or those beginning to develop literacy skills. Additionally, it has received over 1180 highly positive reviews, the majority of which come from professionals whose experiences have served as precedents in the use and recommendation of these pictograms.

All materials are presented on paper, without any technological influence, utilizing AAC-a. In this case, the ARASAAC pictograms were printed on paper and laminated for enhanced durability, matching the size of those used in Group B (7 × 7 cm) to ensure consistency. The pictograms in both groups were adapted to meet the individual needs and preferences of each child, excluding items that were overly complex or inappropriate for their vocabulary or age.

6.2.3 Design and procedure

The study employed a quasi-experimental design (Harris et al., 2006) with two independent groups over 16 weeks to track participant progress. Moment 1 began with a pre-intervention assessment as baseline 1. Group A and Group B received the intervention with the respective AAC resources from week 2 to week 13. An intermediate assessment was conducted at Moment 2 (week 7), followed

by a 15-day break. Moment 3 involved a final measurement at week 16, serving as baseline 2 or post-intervention assessment, assessing receptive and expressive communication skills, social aspects, and general behavior to evaluate skill retention.

The intervention strategies employing aided augmented input were adapted from the research of Muttiah et al. (2022). These strategies involved natural social and communicative routines, such as toy play, engagement in various activities, and interaction with additional speech therapy tools and conversation partners. In each session, children were provided with at least twenty communication opportunities per activity. The speech therapist pointed to the pictographic symbols while implementing the aided augmented input strategy to help the children understand the images and their relation to real-world objects, thereby providing input, creating associations, and reinforcing correct responses (Logan et al., 2017).

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The activities in both groups included environmental awareness, emotional recognition and imitation, exercises for semantic categories, object discrimination, association games, direct requests using pictograms ("I", "want..." with space to add the pictogram and the corresponding item), position games, exercises for classifying good and bad behavior, and basic literacy activities to differentiate sounds, letters, or words and associate written names with categories (Pereira et al., 2020). Sensory integration approaches were also incorporated, along with structured teaching using visual schedules, graphic organizers and simple visual aids, aiming to establish and reinforce connections while addressing potentially negative behaviors through shaping (López, 2015; Noda et al., 2022).

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Since communication boards were not used in this study, the pictograms were shown to participants one at a time, allowing them to associate each with the

corresponding word or concept. The use of individual pictograms aimed to promote focused attention on a single symbol at a time, giving the participant sufficient time to process the meaning of each one before moving on to the next or adding others. The pictograms were selected based on the planned activities.

For storage, ARASAAC pictograms were kept in folders or boxes organized by semantic categories, allowing for quick and efficient access during the sessions. The pictograms from *Mi Estuche de Pictos* ® were stored in their own box with built-in dividers that separate the pictograms into 17 corresponding semantic fields, making them easier to locate. The box measures 9 x 8 x 9 cm. Additionally, for both groups, some pictograms were stored in envelopes or pockets, keeping them easily accessible as needed. This flexible yet structured organization helped maintain a smooth flow during the sessions, stimulating both oral and visual input without any disruptions.

All sessions were documented through written notes, skill checklists, and video recordings to ensure a thorough record and detailed analysis of the procedures. Written notes captured real-time qualitative observations, while skill checklists systematically tracked participants' progress across different tasks. Video recordings were used for in-depth analysis and accuracy verification when necessary.

6.2.4 Measures

The data collection instrument used in this study was the Spanish version of the Vineland-3 Scale, a standardized tool for assessing social and communicative maturity in minimally verbal people with ASD (Pepperdine & McCrimmon, 2018). This scale evaluates communication, daily living skills, socialization, motor skills, and behavior (Comprehensive Form). Scores are based on a Raw Score, which quantifies age-appropriate behaviors using three response options:

2 = Usually or Frequently, 1 = Sometimes, and 0 = Never (Sparrow et al., 2016). The Raw Score is then converted into a Scale-v Score using age-based normative tables (Domain-Level Form). None of the participants achieved the highest possible score in any of the evaluated areas.

To meet the study's objectives, total Scale-v Scores were analyzed in the following domains:

- Communicative Range: Assessed receptive and expressive language through the subtests "Receptive" (39 questions on comprehension and following instructions), "Expressive" (49 questions on speech, emotions, vocabulary, and non-verbal communication), and "Writing" (38 questions on letter recognition, symbol understanding, and literacy-related skills).
- Social Range: Measured social abilities based on the total scores from the subtests "Interpersonal Relationships" (43 questions on recognizing people, engaging in interactions, making eye contact, and spontaneous responses), "Play and Leisure" (36 questions on interest in surroundings, toy interactions, and sharing behaviors) and "Coping Skills" (33 questions on adaptive behaviors like seeking comfort, asking for help, using polite expressions, managing emotions, and adjusting behavior).
- Behavioral Range: Data were obtained from the "Problem Behaviors" subtest, which includes Section A (13 items), Section B (11 items), and Section C (20 items). These sections evaluate disruptive behaviors such as self-injury, environmental and material damage, and learning interference (Martínez-González & Gil, 2019). Higher scores in this domain indicate a greater presence of disruptive behaviors.

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To evaluate the reliability of the measurements, we used the internal consistency of the Vineland-3 Scale, with Cronbach's alpha serving as the primary reliability indicator. Reliability coefficients for all age groups were satisfactory, with adaptive domains in the Comprehensive Form and ABC ranging from 0.74 to 0.87, and the adaptive domains in the Domain-Level Form and ABC ranging from 0.80 to 0.87.

Test-retest reliability was assessed using corrected correlations, following the methods described by Pepperdine and McCrimmon (2018). Two administrations were conducted with the same respondent and examiner, independent of the evaluation moments, with an interval of 12 (Observation 1) to 35 days (Observation 2). Corrected r values for all adaptive domains and the ABC in the Comprehensive Form ranged from 0.72 to 0.90 across all ages, indicating a satisfactory level of reliability for assessing the target skills.

6.2.5 Data analysis

The independent variable was the aided augmented input strategy using ARASAAC pictograms, compared to the strategy using commercially available educational pictograms. The dependent variables in this study were the scores obtained on the Vineland-3 scale, specifically in the domains of communication, social skills, and disruptive behaviors. These scores ranged from 0% (no independent correct responses) to 100% (five or more independent correct responses), with increments of 20% marking improvements in performance.

SPSS® Statistics version 27.0 was used to analyze data. To evaluate potential improvements in participants' performance, the means of both groups were calculated using Student's t-test and repeated ANOVA analyses with the intersubject factor, in order to compare Group A and Group B results. The required significance level was $p<.001$.

The independent observers recorded concordance data in 65% of the baseline sessions and 75% of training and maintenance sessions. Concordance was determined when both observers recognized independent or induced answers. Disagreement occurred when one observer identified an answer as independent, and the other did not. IA was calculated. An average agreement of 90% was observed during baseline, increasing to 94% during training and maintenance. Following each session, the speech therapist completed a checklist which would later be contrasted with the evaluation instruments. Analysis revealed that procedures were consistently followed with a 90% reliability in all baseline, training, and maintenance assessments. The constant presence of the author during the evaluation moments ensured reliability throughout all stages of testing.

6.3 Results

To assess the impact of the intervention strategy on communication, social, and behavioral areas, Vineland-3 scores were analyzed to determine how they varied based on the type of pictograms used. The scores of Group A and Group B were compared across the three evaluation moments. For a more detailed overview of the scores obtained in the evaluated areas, see Appendix D of the thesis.

6.3.1 Communicative Range evaluation

First, performance on the Communicative Range was assessed, which encompasses various facets of communicative-linguistic development, including both expressive and receptive components. Statistically significant differences were found between the measures: Moment 1 showed a mean difference of 12.07 ($t=48.48$, $p<.001$), Moment 2 of 16.20 ($t=46.12$, $p<.001$) and Moment 3 of 19.90 ($t=34.81$, $p<.001$). Next, the mean differences between Group A and B were analyzed (Figure 18).

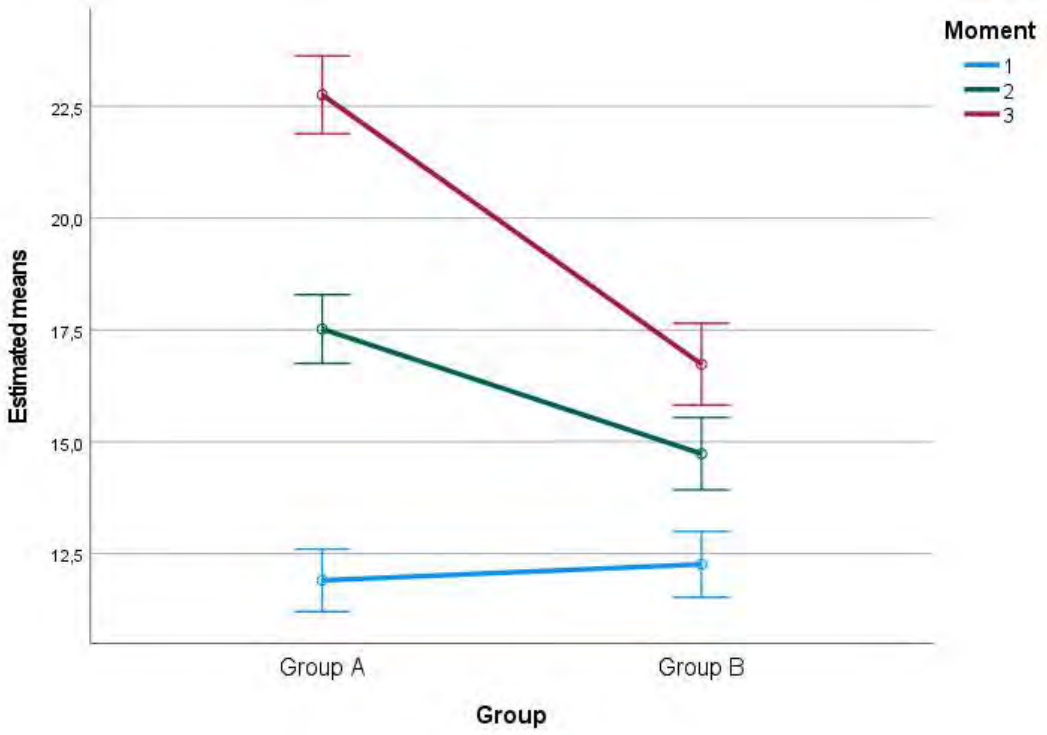


Figure 18: Comparison of Communicative Range in the ARASAAC vs. commercial pictograms study

The results showed an improvement in the Communicative Range of Group A of 10.86 points (SD=2.46) versus 4.48 points (SD=1.19) in Group B. Table 14 shows the differences between the first and last assessments in participants. Additionally, a repeated ANOVA analysis was performed. The results highlight that the combined intervention of ARASAAC and aided augmented input achieves a statistically significant score compared to the intervention with other teaching pictograms ($F_{(1.79)}$=270.35, p<.001, η^2=.877, β-1=1).

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Table 14

Communicative Range in the ARASAAC vs. commercial pictograms study

		Group A			Group B		
		Moment 1	Moment 2	Moment 3	Moment 1	Moment 2	Moment 3
Mean		11.90	17.52	22.76	12.26	14.74	16.74
Standard deviation		1.75	2.20	2.46	1.36	.99	1.19
Standard error mean		.38	.48	.53	.31	.22	.27
95% Confidence Interval	Lower Limit	11.20	16.75	21.89	11.52	13.92	15.82
	Upper Limit	12.60	18.29	23.63	12.99	15.54	17.65
RS rec (mean and standard deviation)		46.62 (5.78)	54.10 (6.83)	62.24 (6.22)	49.05 (5.71)	52.47 (4.11)	56.00 (4.41)
RS exp (mean and standard deviation)		65.19 (9.40)	70.14 (8.42)	76.90 (7.04)	65.53 (7.21)	69.26 (6.10)	71.47 (6.05)
RS wrn (mean and standard deviation)		7.24 (5.29)	8.81 (6.49)	10.62 (6.68)	4.79 (4.49)	7.32 (4.37)	8.26 (4.33)

Note. RS rec: Raw Score Receptive; RS exp: Raw Score Expressive; RS wrn: Raw Score Written.

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6.3.2 Social Range evaluation

An additional analysis was conducted to assess the Social Range based on the type of pictograms used. Social Range scores reflected participants' social skills across various domains, including interactions with conversation partners, the ability to establish emotional connections, and behavior in social contexts. Statistically significant differences were found between the measures of the developmental test. Moment 1 showed a mean difference of 14.72 (t=43.35, p<.001), Moment 2 of 20.05 (t=40.73, p<.001) and Moment 3 of 24.15 (t=31.88,

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p<.001). In a second stage, the mean differences of Group A and B were analyzed (Figure 19).

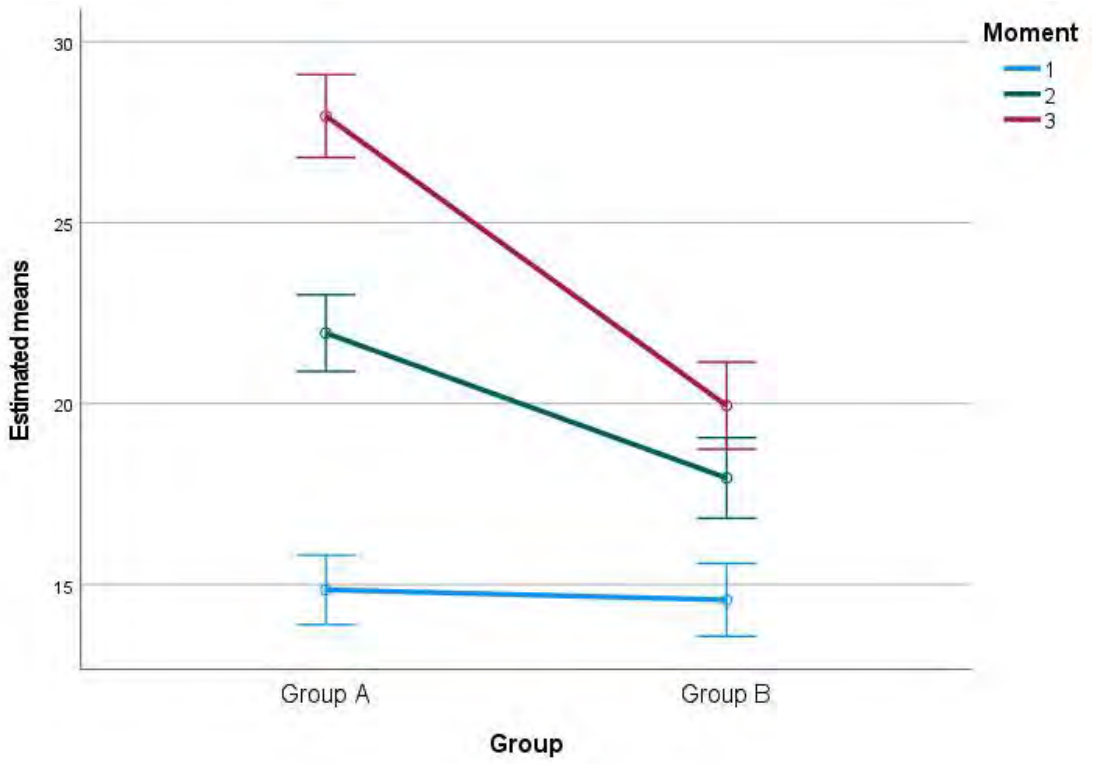


Figure 19: Comparison of Social Range in the ARASAAC vs. commercial pictograms study

The results showed an improvement in the mean Social Range of Group A of 13.09 points (SD=3.26) versus 5.37 points (SD=1.54) in Group B. Table 15 shows the differences between the first and last assessments in participants. A repeated ANOVA analysis was performed. The results show that there are significant differences in the Social Range when comparing the results of the combined intervention of ARASAAC and aided augmented input with the intervention with other pictograms after 16 weeks of training ($F_{(1.82)}$=194.50, p<.001, η^2=.837, β-1=1).

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Table 15

Social Range in the ARASAAC vs. commercial pictograms study

		Group A			Group B		
		Moment 1	Moment 2	Moment 3	Moment 1	Moment 2	Moment 3
Mean		14.86	21.95	27.95	14.58	17.95	19.95
Standard deviation		2.33	2.78	3.26	1.98	1.87	1.54
Standard error mean		.50	.60	.71	.45	.42	.35
95% Confidence Interval	Lower Limit	13.89	20.89	26.80	13.57	16.83	18.74
	Upper Limit	15.81	23.01	29.09	15.58	19.05	21.15
RS ipr (mean and standard deviation)		36.81 (8.01)	42.95 (8.36)	54.38 (8.95)	35.42 (7.71)	43.42 (7.94)	49.21 (7.59)
RS pla (mean and standard deviation)		21.57 (6.85)	32.29 (7.66)	41.57 (7.69)	20.47 (7.11)	26.37 (8.51)	29.42 (6.89)
RS cop (mean and standard deviation)		1.71 (.90)	9.38 (5.13)	16.52 (9.29)	1.74 (1.04)	3.26 (3.01)	4.53 (2.89)

Note. RS ipr: Raw Score Interpersonal Relationships; RS pla: Raw Score Play and Leisure; RS cop: Raw Score Coping Skills.

6.3.3 Behavioral Range evaluation

Finally, the same procedure was followed to determine the evolution of the Behavioral Range in participants, focusing on identifying and quantifying problematic behaviors that may hinder the development of other skills. Significant differences were found between the developmental test measures at the three measurement moments. Moment 1 showed a mean difference of 29.47 (t=76.10, p<.001), Moment 2 of 23.37 (t=36.51, p<.001) and Moment 3 of 16.85 (t=24.81,

p<.001). Next, the mean differences between Group A and B were analyzed (Figure 20).

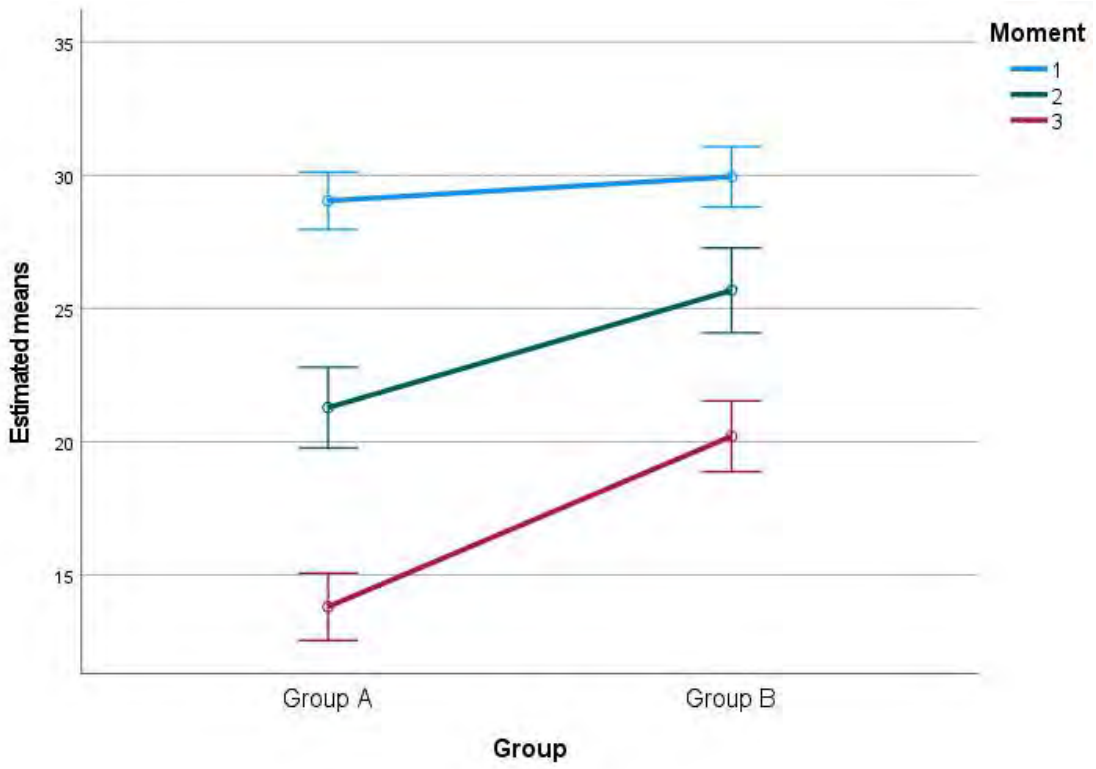


Figure 20: Comparison of Behavioral Range in the ARASAAC vs. commercial pictograms study

The results showed an improvement in the mean Behavioral Range of Group A of 15.24 points (SD=3.45) compared to the improvement of 9.74 points (SD=1.98) in Group B. Table 16 shows the differences between the first and last assessment in participants. A repeated ANOVA analysis was performed. The results showed that the combined intervention of ARASAAC and aided augmented input significantly decreased disruptive behaviors compared to the intervention with other types of pictograms after a 16-week training ($F_{(2.00)}$=270.23, p<.001, η^2=.877, β-1=1).

Table 16

Behavioral Range in the ARASAAC vs. commercial pictograms study

		Group A			Group B		
		Moment 1	Moment 2	Moment 3	Moment 1	Moment 2	Moment 3
Mean		29.05	21.29	13.81	29.95	25.68	20.21
Standard deviation		2.24	4.00	3.45	2.63	2.64	1.98
Standard error mean		.49	.87	.75	.60	.60	.45
95% Confidence Interval	Lower Limit	27.97	19.77	12.54	28.81	24.09	18.88
	Upper Limit	30.12	22.80	15.07	31.08	27.27	21.53
Section A (mean and standard deviation)		8.57 (1.85)	6.81 (1.80)	4.57 (1.93)	9.05 (1.26)	7.74 (1.32)	6.05 (1.64)
Section B (mean and standard deviation)		7.43 (1.50)	5.95 (1.83)	4.00 (1.64)	8.05 (.91)	7.37 (1.11)	6.05 (1.43)
Section C (mean and standard deviation)		13.05 (1.46)	8.52 (2.31)	5.24 (2.50)	12.89 (1.76)	10.58 (1.86)	8.26 (1.66)

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6.4 Discussion

This study aimed to explore the effects of aided augmented input using ARASAAC pictograms and determine whether this combination yields better outcomes compared to the same intervention strategy using other printed pictograms for children diagnosed with Level 3 ASD. In both cases, this intervention approach has been shown to reduce deficits in socio-emotional reciprocity while enhancing participants' interests, shared affect, play skills, and responsiveness to simple social interactions. Individually adapted visual stimuli can be engaging, detailed, and accessible, improving focus and minimizing

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distractions (Bellini et al., 2007; Landa, 2018). In aided augmented input, the integration of visual and auditory input during practice provides a richer and more engaging message (González-Mercado et al., 2016), making this strategy a strong complement to the AAC-a resources used.

The population with ASD is highly heterogeneous, resulting in a wide variety of communicative, cognitive, functional, and sensory profiles within the spectrum (Mottron & Bzdok, 2020). This diversity was reflected in the study's results, where significant differences were observed between Groups A and B from the initial measurement. By Moment 3, participants with ASD in Group A showed a substantial increase compared to Group B in both Communicative and Social Range. These gains contribute to enhancing each child's ability to learn and develop new skills (Jacob et al., 2022).

Participants in Group A showed an increase in scores related to communication skills, leading to more frequent use of gestures, pointing to the referenced object, adhering to conversational rules and turns, and sharing attention more often. The association between the real object and its corresponding pictogram was also accurate. Given the scores obtained, this suggests that ARASAAC pictograms, as described in the study, are more suitable for the participants than the commercially available pictograms used for comparison. However, they still exhibit semantic-pragmatic challenges and difficulties in using oral language (Friedman & Sterling, 2019). These challenges decrease as expressive skills improves, with receptive skills showing a more significant progression. Additionally, there was an increase in the ability to develop, maintain, and understand social interactions. Participants were more likely to adjust their behavior, share activities, and show interest in other people and elements of their environment represented by the pictograms.

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On the other hand, the Behavioral Range showed an inverse trend. AAC-a resources enhanced the intervention sessions, making them more rewarding and satisfying for both the user and the speech therapist. They also helped minimize challenging behaviors and negative situations, fostering a more stable and manageable working environment. This result can be attributed to the participants' increased engagement in activities and the iconicity of the materials, which were tailored to their needs. This captured their attention, boosted motivation, and facilitated anticipation through twenty communication opportunities per activity, repeated over the 16-week study. The gradual increase in the number of pictograms ensured that the process remained manageable and not overwhelming or overly challenging (Castillo Roch & Grau Rubio, 2016; Muttiah et al., 2022). Nevertheless, in the third evaluation moment, Group A demonstrated a significant reduction in problematic behaviors observed during the intervention sessions. The combined strategy with ARASAAC pictograms had a stronger impact in this area compared to strategies using other commercial pictograms.

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The aided augmented input strategy proved beneficial with both ARASAAC pictograms and other commercially available ones. This approach allowed for better retention of information when presented both visually and auditorily, benefiting participants with ASD due to their visuospatial strengths (Gillespie-Smith & Fletcher-Watson, 2014; Pereira et al., 2020). The findings suggest that using this combined strategy with ARASAAC in children with Level 3 ASD significantly enhances the evaluated areas within a controlled speech therapy setting. Despite this, *Mi Estuche de Pictos* ® maintains a high level of iconicity, and the number of pictograms it includes is appropriate for the study population and its characteristics. This makes it a valuable AAC resource that could be

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effectively integrated into intervention sessions, primarily serving as a complementary tool alongside other supports.

In summary, the results in the communicative, social, and behavioral areas showed a positive and encouraging trend in both groups. However, Group A benefited more significantly from the ARASAAC pictograms compared to Group B. These pictograms facilitated visual comprehension and vocabulary representation through a structured and visually accessible system, combined with aided augmented input. This strategy allowed participants to access rich, detailed, and organized input, promoting communication and understanding (Biggs et al., 2018; Dada & Alant, 2009). Moreover, the strategy, along with the pictograms, provided a predictive and consistent environment that supported learning and interaction in various situations of interaction with the interlocutor (Remner et al., 2016; Tato, 2021).

The differences observed between both groups could also be attributed to ARASAAC's high level of customization. The pictograms from the other resource are pre-designed, with one of their main advantages being the large number available, which align well with various activities and interactions between the speech therapist and the child. However, ARASAAC offers an even greater selection of pictograms and vocabulary, making it highly unlikely to encounter situations where a needed pictogram is missing. Additionally, ARASAAC's customization features allow for modifications within the pictograms themselves. While most vocabulary items were used in their default settings, pictograms representing people were often adjusted. Specifically, when referring to the user or a familiar person, physical traits such as skin tone, hair color, and gender could be personalized, making the representations more accurate and relatable.

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The placement of written text within pictograms may also have influenced the results. *Mi Estuche de Pictos* ® displays words in a fixed format at the bottom of the pictograms. For example, within the semantic field of emotions, a pictogram depicting a smiling child is labeled as "FELICIDAD" (in English, "HAPPINESS"). While this is a valid term, other words might be more appropriate in natural or therapeutic contexts, such as "CONTENTO" (in English, "HAPPY"). ARASAAC allows speech therapists to customize these labels, selecting the most contextually relevant word for each case. Moreover, ARASAAC places text in uppercase letters at the top of the pictograms, a design choice that may facilitate visual processing. Research suggests that visual perception follows a top-down approach, where individuals first scan the upper part of an image before moving downward. This aligns with eye-tracking and reading behavior studies, which indicate that people tend to focus on the upper regions of visual stimuli first, influencing how information is perceived and processed (Clifton et al., 2016; Hyönä, 2010). By positioning text at the top, ARASAAC may enhance readability and comprehension, particularly for people with language difficulties who benefit from structured visual cues.

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This study offers several practical implications. First, the findings highlight the importance of interventions focused on communicative, social, and behavioral skills in children with Level 3 ASD. The differences between the first and final assessments in Group A suggest a more favorable and lasting progression. Therefore, the intervention using aided augmented input with ARASAAC pictograms proves effective and could be implemented in various contexts. Second, the study outlines a procedure for conducting interventions with severely affected children with ASD, emphasizing the joint presentation of oral and visual input as essential for understanding reality. Children with ASD will benefit from these visual resources (Acuña & Mendoza, 2020; Cáceres Acosta, 2017; Elisea &

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Pérez, 2021; Noda et al., 2022), with ARASAAC standing out as particularly valuable due to its unique customization features.

This research presents some limitations. First, the inclusion criteria, which aimed to maintain some homogeneity in the groups, limited the sample size. However, similar studies have used comparable sample sizes (e.g., Muttiah et al., 2022) and may still meet the assumptions of the statistical tests used. Second, using the speech therapy office as the primary setting and adapting it to the aided augmented input strategy may create complex and somewhat unnatural situations. To prevent this, it's crucial to consider each participant's preferences, vocabulary, and characteristics, which is why the scenarios in this study were highly controlled. Additionally, paper-based materials are more prone to damage or loss, which highlights the importance of laminating them for durability and having backup copies available when needed.

One of the most significant limitations encountered during the intervention was related to the AAC-a materials themselves. For aided augmented input to be implemented effectively—naturally complementing oral input with the corresponding visual representations—each session requires thorough preparation to ensure that all necessary pictograms are available during activities, games, or social and behavioral skill-building situations. This means that the vocabulary and semantic fields to be targeted must be carefully planned in advance, leaving only a small margin for spontaneous interactions. At times, the process may be slower or briefly interrupted when searching for a pictogram and placing it on the table, making the interaction less fluid. In contrast, technological AAC support simplifies this process, as it typically provides an organized and readily accessible set of elements, making selection much faster.

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6.5 Conclusions

The combined approach of aided augmented input with ARASAAC pictograms offers a promising path for improving skills in children with Level 3 ASD and with complex communication needs, providing alternative communication methods and enhancing comprehension and interaction abilities. However, further research is needed to fully understand the long-term effects and potential variations of the aided augmented input strategy, including the use of other types of pictograms. Such research efforts would provide a more nuanced understanding of the intervention's effectiveness, enabling the development of personalized, evidence-based interventions for people with ASD. This would better prepare professionals and families to work on receptive and expressive communication, as well as social and behavioral skills, by selecting appropriate AAC pictograms or resources alongside the proposed intervention strategy.

This study partially fulfills specific objective 6, as presented in Section 1.2 of Chapter 1 of the thesis.

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6.6 References

Acuña, J., & Mendoza, C. I. (2020). Uso de Pictograma en paciente con Trastorno del Espectro Autista (TEA) en odontología. Relato de caso. *Revista Científica Odontológica*, 2(1).

American Psychiatric Association (APA) (2013). Diagnostic and statistical manual of mental disorders (5th ed.). *Washington, DC: American Psychiatric Publishing.* https://doi.org/10.1176/appi.books.9780890425596

Bellini, S., Peters, J. K., Benner, L., & Hopf, A. (2007). A meta-analysis of school-based social skills interventions for children with autism spectrum disorders. *Remedial and Special Education*, *28*(3), 153-162. https://doi.org/10.1177/07419325070280030401

UNIVERSIDAD DE MÁLAGA

Bertola, L. E. (2017). *Análisis empírico de las características formales de los símbolos pictográficos ARASAAC* [Doctoral dissertation, Department of Developmental and Educational Psychology, University of Murcia, Spain].

Biggs, E. E., Carter, E. W. & Gilson, C. B. (2018). Systematic Review of Interventions Involving Aided AAC Modeling for Children with Complex Communication Needs. *American Journal on Intellectual and Developmental Disabilities*, 123(5), 443-473. https://doi.org/10.1352/1944-7558-123.5.443

Brown, L., Sherbenou, R. J. & Johnsen, S. K. (2019). Test of Nonverbal Intelligence (TONI-4). *Encyclopedia of Autism Spectrum Disorders, 2021.* https://doi.org/10.1007/978-3-319-91280-6

Cabello, F. & Bertola, E. (2015). Características formales y transparencia de los símbolos pictográficos de ARASAAC. *Revista de Investigación en Logopedia*, 5(1), 60-70

Cáceres Acosta, O. (2017). *El uso del pictograma en el proceso de enseñanza-aprendizaje del niño con autismo* [Doctoral dissertation]. Universidad de las Palmas de Gran Canaria.

Calleja Reina, M., Luque, M.L., & Rodríguez Santos, J.M. (2021). Protocolo de Valoración del Perfil Comunicativo Lingüístico de personas con necesidades complejas de comunicación y discapacidad intelectual (PCL-DIS-NCC). En M. Calleja Reina (Ed.), *Necesidades complejas de comunicación y enfermedades minoritarias* (pp. 30-35). McGraw Hill Education.

Castillo Roch, A. & Grau Rubio, C. (2016). Conductas disruptivas en el alumnado con TEA: estudio de un caso. *Ensayos: Revista de la Escuela Universitaria de Formación del Profesorado de Albacete.*

Clifton Jr, C., Ferreira, F., Henderson, J. M., Inhoff, A. W., Liversedge, S. P., Reichle, E. D., & Schotter, E. R. (2016). Eye movements in reading and information processing: Keith Rayner's 40 year legacy. *Journal of Memory and Language*, 86, 1-19. https://doi.org/10.1016/j.jml.2015.07.004

UNIVERSIDAD DE MÁLAGA

Dada, S. & Alant, E. (2009). The Effect of Aided Language Stimulation on Vocabulary Acquisition in Children with Little or No Functional Speech. *American Journal of Speech-Language Pathology*, 18(1), 50-64. https://doi.org/10.1044/1058-0360(2008/07-0018)

De Pimentel, G. U. A. (2024). Autism Spectrum Disorder (ASD): A major problem to address. *Horizonte Médico (Lima)*, 24(1), e2631–e2631. https://doi.org/10.24265/horizmed.2024.v24n1.00

Elisea, B. B., & Pérez, M. R. (2021). *Pictogramas: una propuesta para el Desarrollo de Habilidades Sociales en niños de edad escolar con diagnóstico de Trastorno del Espectro Autista* [Doctoral dissertation] Universidad Autónoma de Querétaro.

Fombonne, E., MacFarlane, H., & Salem, A. C. (2021). Epidemiological surveys of ASD: advances and remaining challenges. *Journal of Autism and Developmental Disorders*, 51, 4271-4290. https://doi.org/10.1007/s10803-021-05005-9

Fopiano, J. (2021). Test of Nonverbal Intelligence (TONI-4). En F. R. Volkmar (Ed.), *Encyclopedia of Autism Spectrum Disorders* (pp. 4793-4797). Springer International Publishing. https://doi.org/10.1007/978-3-319-91280-6_1784

Friedman, L. & Sterling, A. (2019). A Review of Language, Executive Function, and Intervention in Autism Spectrum Disorder. In Seminars in Speech and Language. *Thieme Medical Publishers*, 40(4), 291-304. https://doi.org/10.1055/s-0039-1692964

Gillespie-Smith, K., & Fletcher-Watson, S. (2014). Designing AAC systems for children with autism: Evidence from eye tracking research. *Augmentative and Alternative Communication*, 30(2), 160-171. https://doi.org/10.3109/07434618.2014.905635

Gobierno de Aragón (2007). *Portal Aragonés de la Comunicación Aumentativa y Alternativa, ARASAAC*. Author of pictograms: Sergio Palao. Retrieved from: ARASAAC (http://www.arasaac.org). Licenced by: CC (BY-NC-SA).

UNIVERSIDAD DE MÁLAGA

González-Mercado, Y. M., Rivera-Martínez, L. B. & Domínguez-González, M. G. (2016). Autismo y evaluación. *Ra Ximhai*, 12(6), 525-533. https://doi.org/10.35197/rx.12.01.e3.2016.33.yg

Harris, A. D., McGregor, J. C., Perencevich, E. N., Furuno, J. P., Zhu, J., Peterson, D. E., & Finkelstein, J. (2006). The use and interpretation of quasi-experimental studies in medical informatics. *Journal of the American Medical Informatics Association*, 13(1), 16-23. https://doi.org/10.1197/jamia.M1749

Hervás, R., Bautista, S., Méndez, G., Galván, P., & Gervás, P. (2020). Predictive composition of pictogram messages for users with autism. *Journal of Ambient Intelligence and Humanized Computing*, 11, 5649–5664. https://doi.org/10.1007/s12652-020-01925-z

Holland, C. M., Blanche, E. I., & Thompson, B. L. (2020). Quantifying therapists' activities during sensory integration treatment for young children with autism. *Physical & Occupational Therapy in Pediatrics*, 41(3), 284–299. https://doi.org/10.1080/01942638.2020.1847235

Hyönä, J. (2010). The use of eye movements in the study of multimedia learning. *Learning and Instruction*, 20(2), 172-176. https://doi.org/10.1016/j.learninstruc.2009.02.013

Jacob, U. S., Edozie, I. S. & Pillay, J. (2022). Strategies for Enhancing Social Skills of Individuals with Intellectual Disability: A Systematic Review. *Frontiers in Rehabilitation Sciences*, 3. https://doi.org/10.3389/fresc.2022.968314

Laher, Z., & Dada, S. (2023). The effect of aided language stimulation on the acquisition of receptive vocabulary in children with complex communication needs and severe intellectual disability: a comparison of two dosages. *Augmentative and Alternative Communication*, 1-14. https://doi.org/10.1080/07434618.2022.2155566

Landa R.J. (2018). Efficacy of Early Interventions for Infants and Young Children with, and at Risk for, Autism Spectrum Disorders. *International Review of Psychiatry*, 30(1), 25–39. https://doi.org/10.1080/09540261.2018.1432574

UNIVERSIDAD DE MÁLAGA

Langarika-Rocafort, A., Mondragon, N. I. & Etxebarrieta, G. R. (2021). A Systematic Review of Research on Augmentative and Alternative Communication Interventions for Children Aged 6–10 in the Last Decade. *Language, Speech, and Hearing Services in Schools*, 52(3), 899-916. https://doi.org/10.1044/2021_LSHSS-20-00005

León Cruz, I. (2020). Modification of mental rigidity and associated disruptive behaviours in a child diagnosed with autism spectrum disorder (ASD*). Know and Share Psychology*, 1(3). http://dx.doi.org/10.25115/kasp.v1i3.3689

Lima, S. M., & Laplane, A. L. F. D. (2016). Escolarização de alunos com autismo. *Revista Brasileira de Educação Especial*, 22, 269-284. https://doi.org/10.1590/S1413-65382216000200009

Logan, K., Iacono, T. & Trembath, D. (2017). A Systematic Review of Research into Aided AAC to Increase Social-Communication Functions in Children with Autism Spectrum Disorder. *Augmentative and Alternative Communication*, 33(1), 51-64. https://doi.org/10.1080/07434618.2016.1267795

López, M. D. A. T. (2015). El juego pintado de azul: desarrollo de la comunicación social y el lenguaje en niños con Trastorno del Espectro del Autismo (TEA) por medio de la participación guiada en actividades lúdicas. Available from: https://www.studocu.com/bo/document/universidad-autonoma-gabriel-rene-moreno/medicina-interna-i/autismo/45311056

Luque, F. C. & Morillas, C. M. (2018). Iconicidad y facilidad de aprendizaje de los símbolos pictográficos ARASAAC. *Revista de Logopedia, Foniatría y Audiología*, 38(3), 95-104. https://doi.org/10.1016/j.rlfa.2018.04.002

Martínez-González, A., & Gil, J. (2019). Análisis mediante Bio-Feedback, Adaptación Escolar y Intervención Neuroeducativa de un Caso de Autismo Grave. *Revista Iberoamericana de Diagnóstico y Evaluación Psicológica*, 53(4), 185–195. https://doi.org/10.21865/ridep53.4.14

UNIVERSIDAD DE MÁLAGA

Méndez, G., Hervás, R., Bautista, S. & Galván, P. (2018). Pictoeditor: un editor predictivo basado en pictogramas para facilitar la interacción con personas con discapacidad. In *XIX International Conference on Human-Computer Interaction (Interacción 2018)*.

Mottron, L. & Bzdok, D. (2020). Autism Spectrum Heterogeneity: Fact or Artifact?. *Molecular Psychiatry*, 25(12), 3178-3185. https://doi.org/10.1038/s41380-020-0748-y

Muttiah, N., Drager, K. D., Beale, B., Bongo, H., & Riley, L. (2022). The effects of an intervention using low-tech visual scene displays and aided modeling with young children with complex communication needs. *Topics in Early Childhood Special Education*, 42(1), 91-104. https://doi.org/10.1177/0271121419844825

Noda, H., Tokunaga, A., Imamura, A., Tanaka, G. & Iwanaga, R. (2022). Visual Attention Affects Late Somatosensory Processing in Autism Spectrum Disorder. *International Journal of Neuroscience*, 132(9), 874-880. https://doi.org/10.1080/00207454.2020.1849186

Paolieri, D. & Marful, A. (2018). Norms for a Pictographic System: The Aragonese Portal of Augmentative/Alternative Communication (ARASAAC) System. *Frontiers in Psychology*, 9, 2538. https://doi.org/10.3389/fpsyg.2018.02538

Pepperdine, C. R., & McCrimmon, A. W. (2018). Test review: Vineland Adaptive Behavior Scales, (Vineland-3) by Sparrow, SS, Cicchetti, DV, & Saulnier, CA. *Canadian Journal of School Psychology*. https://doi.org/10.1177/0829573517733845

Pereira, E. T., Montenegro, A., Rosal, A. & Walter, C. (2020). Augmentative and Alternative Communication on Autism Spectrum Disorder: Impacts on Communication. *CoDAS*, 32(6). https://doi.org/10.1590/2317-1782/20202019167

Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin*, 124(3), 372. https://doi.org/10.1037/0033-2909.124.3.372

UNIVERSIDAD DE MÁLAGA

Remner, R., Baker, M., Karter, C., Kearns, K. & Shane, H. (2016). Use of Augmented Input to Improve Understanding of Spoken Directives by Children with Moderate to Severe Autism Spectrum Disorder. *eHEARSAY, Journal of the Ohio Speech Language Hearing Association*, 6(3), 4-10.

Rodrigo, J. & Corral, D. (2013). ARASAAC: portal aragonés de la comunicación aumentativa y alternativa. Software, herramientas y materiales para la comunicación e inclusión. *Informática na Educação: Teoria & Prática*, 16(2). https://doi.org/10.22456/1982-1654.43426

Sauer, A. K., Stanton, J. E., Hans, S. & Grabrucker, A. M. (2021). Autism Spectrum Disorders: Etiology and Pathology. *Exon Publications*, 1-15. https://doi.org/10.36255/exonpublications.autismspectrumdisorders.2021.etiology

Sparrow, S. S., Cicchetti, D. V. & Saulnier, C.A. (2016). Vineland Adaptive Behavior Scales, Third Edition (Vineland-3). *San Antonio, TX: Pearson.* https://doi.org/10.1177/0829573517733845

Talantseva, O. I., Romanova, R. S., Shurdova, E. M., Dolgorukova, T. A., Sologub, P. S., Titova, O. S., ... & Grigorenko, E. L. (2023). The global prevalence of autism spectrum disorder: A three-level meta-analysis. *Frontiers in Psychiatry*, 14, 1071181. https://doi.org/10.3389/fpsyt.2023.1071181

Tato, A. M. P. (2021). *Fratrias com perturbação do espectro do autismo: como potencializar a relação* (Master's thesis). Universidade de Coimbra.

Sparrow, S. S., Cicchetti, D. V. & Saulnier, C.A. (2016). Vineland Adaptive Behavior Scales, Third Edition (Vineland-3). *San Antonio, TX: Pearson.* https://doi.org/10.1177/0829573517733845

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7

Analysis of skill development in children with autism spectrum disorder through aided augmented input and a communication board with technology

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7.1 Introduction

Studies such as Agius et al. (2024) and Lorah et al. (2022) emphasize the need for comparative research among various AAC+a supports, as differences in functionality and design can significantly impact user outcomes. For ASD users, these differences are especially relevant in supporting receptive and expressive communication abilities, social and behavioral functioning (Brady et al., 2015; Sauer et al., 2021). The need for a well-founded justification of the comparisons between different AAC supports becomes evident when considering the cognitive processes involved. As Jagaroo and Wilkinson (2008) emphasize, visual cognitive neuroscience, particularly systems related to motion perception and display design, plays a critical role in how users process information within AAC+a and AAC-a systems.

Two commonly used types of AAC supports are those that organize pictograms into communication boards and those that arrange them into semantically ordered lists (Logan et al., 2022), such as the EC+ app. However, further research is needed to determine which AAC system features are most beneficial for children with ASD through comparative analyses (Aspiranti et al., 2020; Donato et al., 2018). Since previous chapters have explored different ways of presenting AAC resources combined with aided augmented input using both paper-based pictograms and the EC+ application, this chapter examines the same approach through the use of an AAC+a support specifically designed for creating communication boards.

A communication board is a visual tool that organizes symbols, words, or pictures to support both expressive and receptive language in people with communication difficulties. These resources allow users to convey messages

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through pictograms arranged on a surface. To enhance comprehension, templates are often used to structure the boards, enabling users to quickly understand the type of message being communicated, thus facilitating interpretation (Fried-Oken et al., 2015; López Gonzalo, 2019). Communication boards can be either static—such as laminated sheets displaying pictograms—or dynamic, as seen in digital versions integrated into tablets and speech-generating devices (Ganz et al., 2014). They play a crucial role in AAC interventions by providing a structured and accessible means for people with ASD to engage in meaningful interactions, selecting symbols that represent their thoughts, needs, and preferences (Cipta et al., 2019; Lesser & Ebert, 2020). The effectiveness of communication boards depends on several factors, including vocabulary selection, symbol organization, and user familiarity with the system. As a result, their design is a key element in intervention planning to maximize their impact on communication development (Calculator & Luchko, 1983; Garcia, de Oliveira & de Matos, 2016; Gómez et al., 2023).

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This chapter explored an AAC+a resource for presenting communication boards. Specifically, the software SymboTalk – AAC Talker ® was used (Table 17). SymboTalk ® is a free, cross-platform tool available for download on PCs, as well as on Android and iOS mobile devices. This resource is among the most widely used and highly rated internationally (Jeong et al., 2021), currently boasting over 100.000 downloads on the Play Store. It allows users to create communication boards containing between 4 and 50 cells. These boards implement pictograms from the ARASAAC (Gobierno de Aragón, 2007) and also allow the incorporation of photos taken directly from the device's camera, as well as images from the computer or device. Additionally, the application is compatible with multiple languages, including Spanish, English, Italian, French, and Hebrew.

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Table 17

Main characteristics of SymboTalk – AAC Talker ®

Feature	Description
Logotype	
Vocabulary stored	An online library with approximately 200 pre-defined terms
Organization	Vocabulary arranged in a communication board with theme-based categorized cells.
Pages and navigation	Navigation between pages achieved via pre-configured jump cells.
Customization	Highly customizable with options to reorganize cells and modify the visual layout
Color coding of cells	Color-coded cells based on semantic categories (e.g., actions, objects, people).
Graphic symbols	Used ARASAAC pictograms.
Output	Used text-to-speech synthesis configured to vocalize each word and complete sentences.
Sentence bar	Included a sentence bar for combining words to create sentences.
Feedback	Provided auditory feedback (text-to-speech) and visual feedback (highlighted active cells).
Interface visual example	

Note. The images included in this table were retrieved from the SymboTalk – AAC Talker ® app and were directly obtained by the author of this thesis.

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The present study aims to evaluate the effectiveness of two AAC+a supports with distinct functionalities when used in conjunction with the aided augmented input strategy: (1) communication board via SymboTalk – AAC Talker ® software, and (2) list-form without communication boards via EC+ multimodal software. The study's objective is to generate evidence on the practical utility of these approaches for children with Level 3 ASD. To do so, the impact of this intervention was evaluated in terms of communication components, social and behavioral abilities, as these skills are commonly altered in this population (Velarde-Incháustegui et al., 2021).

The initial hypothesis is that aided augmented input will yield significant results with AAC+a supports due to technological advancements, which have enhanced the accessibility and prevalence of assistive technologies to better meet users' communication needs (Baxter et al., 2012; King et al., 2020). This is also supported by the results of chapter 5. However, we hypothesize that EC+ will achieve better outcomes compared to SymboTalk ®, primarily due to its multimodal approach, which offers a more comprehensive set of features. EC+ integrates pictograms, real images, videos, and sign language, allowing users to access information through multiple channels simultaneously.

This hypothesis is grounded in the idea that combining various sensory inputs can strengthen the user's understanding and retention of concepts. This is particularly beneficial for people with communication challenges, as integrating various sensory channels not only supports recognition memory but also boosts engagement and motivation during learning activities. This approach facilitates more effective identification of previously encountered verbal or visual stimuli by people with a diagnosis of ASD (Jagaroo & Wilkinson, 2008; Semino et al., 2021), thereby supporting a deeper and more sustained learning experience. In contrast, while SymboTalk ® relies on a structured and spatially consistent communication

board format, which promotes motor learning and visual processing (Hervás et al., 2020), it may lack the depth of multimodal stimulation that EC+ provides. Thus, we anticipate that participants using EC+ will show greater improvements not only in communication skills but also in social and behavioral abilities, as a result of the enhanced learning opportunities provided by its diverse and multimodal design. This multimodal input is anticipated to support a more dynamic and adaptable learning experience (Brady et al., 2015).

7.2 Method

7.2.1 Participants

The study sample comprised participants with ASD recruited through purposive sampling from various specialized centers in ASD and other neurodevelopmental disorders located in Málaga, Spain. A total of 20 participants were chosen following a rigorous selection process to ensure sample consistency and reliable outcomes. The inclusion criteria were as follows: (a) they were between 6 and 12 years old, chosen for their diagnostic stability, high prevalence rates and because this is a crucial period for developing key communicative and academic skills (De Pimentel, 2024; Fombonne et al., 2021; Lima & Laplane, 2016; Talantseva et al., 2023); (b) Spanish was both their native language and the language of instruction from birth, ensuring consistency with the Spanish-speaking context; (c) they had been diagnosed by experienced clinicians with ASD Level 3 according to DSM-5 criteria (APA, 2013); (d) with complex communication needs, meaning they face difficulties in participating in functional communication through spoken language, sign language, or writing. This is indicated by a percentile rank of 1 or lower on the ABC as measured by the Vineland-3 (Sparrow et al., 2016); (e) with reduced receptive and expressive language skills, as assessed by the PCL-DIS-NCC (Calleja Reina et al., 2021); (f) who are able to maintain attention on an activity for at least 10 minutes, as noted

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by teachers and family members; (g) unfamiliarity with the AAC+a resources used in the study, as verified through reports from the relevant speech therapists who have no diagnosed sensory, visual, or auditory impairments; and (h) whose parents or legal guardians provided informed consent for their participation in the study.

The equivalence between the groups was ensured through random assignment of participants, following CONSORT guidelines. This approach ensures a balanced distribution of baseline characteristics and minimizes bias in comparing the effects of SymboTalk ® and EC+. Specifically, the sample of 20 participants was assigned identification numbers in the order of consultation and then randomly divided into Group A and Group B using the Random.org software. Group A received the aided augmented input strategy utilizing EC+ from the initial evaluation through to the end of the study. In contrast, Group B underwent the same aided augmented input strategy but with SymboTalk – AAC Talker ® software, under identical conditions and timeframes. The choice of the AAC+a supports for each group was determined by the initial randomization process, not by participant characteristics, which helped mitigate potential bias in treatment assignment.

The sample size was determined by the availability of participants meeting the inclusion criteria, along with the practical limitations of the study. Nevertheless, for the research in this thesis, a procedure similar to the one described in Chapter 6 was implemented, adding 15 additional participants to Group A. These participants were part of the research Group A in the study outlined in Chapter 5, and their shared characteristics and identical intervention process provided a valid basis for their inclusion. This integration ensured consistency in the participant profiles, allowing for a more robust comparison while maintaining the methodological rigor of the study. As a result, the total

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sample size increased to 35 participants (Table 18), enhancing the statistical power and generalizability of the results.

Table 18

Participant descriptions in the EC+ vs. SymboTalk – AAC Talker ® study

	Group A	Group B
Participants	*n*=18	*n*=17
Gender	14 male 4 female	15 male 2 female
Age (mean and standard deviation)	9.06 (2.53)	8.41 (1.50)
TONI-4 (mean IQ and standard deviation)	54.06 (11.08)	56.88 (10.36)
Vineland-3 (ABC)	Percentage = <1	Percentage = <1
PCL-DIS-NCC (mean and standard deviation)	• PCL-EC: 22.00 (3.53) • PCL-EE-VI: 18.65 (1.18) • PCL-EE-FC: 21.61 (2.27) • PCL-EE-MC: 20.22 (4.60) • PCL-EE-T: 17.56 (2.03)	• PCL-EC: 21.35 (2.57) • PCL-EE-VI: 18.76 (1.52) • PCL-EE-FC: 21.59 (2.50) • PCL-EE-MC: 19.59 (4.01) • PCL-EE-T: 15.41 (3.35)

Note. IQ: Intelligence Quotient; ABC: Adaptative Behavior Composite; PCL-EC: Comprehension Scale; PCL-EE-VI: Variety of Interlocutors; PCL-EE-FC: Communication Functions; PCL-EE-MC: Communication Modes; PCL-EE-T: Topics and Preferences. Compiled by the author.

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7.2.2 Setting and materials

All therapy sessions took place at multidisciplinary centers where the participants received care, specifically in the speech therapy office, free of visual and auditory distractions. The communication activities involved using toys and various items for play, engaging in social interactions with the communication partner, and tracking problematic behaviors observed during the sessions. A consistent set of motivators —such as toys, music, and other resources— was used throughout the intervention. These motivators were identified during a preference assessment for each participant and through interviews with their family members before the study began.

The items, alongside the AAC+a supports, were strategically placed on the table at an optimal distance to help manage participant impulses and support the intervention strategy (Martin & Wilkins, 2022). However, not all visual stimuli were introduced at the same time, but each week a new stimulus from the original set that had not yet been used was added to the intervention. This approach is supported by recent research suggesting that the acquisition of new skills can be enhanced by gradually introducing new stimuli while explicitly associating them with already well-known ones (Muttiah et al., 2022; Semino et al., 2021).

The author attended most of the therapy sessions, accompanied by an independent observer who was a speech therapist to ensure inter-observer reliability. The independent observer was someone the participant recognized; however, since participants were from different locations, the assigned observer varied depending on the center. All therapy sessions were thoroughly documented through written notes, skills checklists, and video recordings. Written notes captured real-time observations, while checklists systematically tracked participants' progress. Video recordings allowed for detailed analysis and verification of the data.

The aided augmented input strategy was implemented using two AAC+a supports that are sufficiently different to warrant a subsequent comparison: SymboTalk – AAC Talker ® and EC+ (Figure 21). These technology tools were selected for the intervention process based on several reasons. Firstly, the resources were compatible with the characteristics and capabilities of the children with ASD Level 3 involved in the study (Lozano Martínez et al., 2016), as well as with the intervention strategy. Both supports share the same purpose: they are specifically designed to create interactive and educational activities, providing an alternative communication method to supplement or replace spoken language.

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EC+	
SymboTalk ®	

Figure 21: Example of EC+ and SymboTalk – AAC Talker ® interfaces

Secondly, no current studies have been found that have compared EC+ and SymboTalk ® from the approach in a Spanish-speaking contexts, which highlights their relevance for research. Both AAC+a supports were installed on a Huawei® MediaPad M5 Pro tablet, featuring a 1920 x 1200 screen resolution and a 10.8-inch screen. This configuration was selected to improve item comprehension and visual association, promoting efficient interaction with the users (Alzrayer et al., 2019). All content presented on the tablet was configured to maintain maximum brightness and prevent the screen from turning off during the intervention strategy. EC+ allows stimuli to be displayed in both landscape and portrait orientations, while SymboTalk ® supports only landscape mode, aligning with the typical layout of a communication board.

One of the main features of SymboTalk ® is its intuitive interface, which allows users and caregivers to configure and adapt the communication boards to individual needs (Gallardo-Montes et al., 2021). The app includes an extensive

library of pictograms organized into several main semantic fields: “toys”, “clothing”, “verbs”, “food”, “feelings”, “places”, “people”, “letters”, “numbers” and “others” (colours, articles, adjectives). This AAC+a supports text-to-speech functionality, enabling selected pictograms to be read aloud, which facilitates clear and understandable communication.

SymboTalk ® offers two modes: User Mode and Edit Mode. Edit Mode is designed for those who create and customize the boards, while User Mode is intended for communication once all necessary boards and symbols are in place (Suha et al., 2022). In Edit Mode, users can perform various actions, such as adding new pictograms from the ARASAAC repository through a direct search that leads to the available options. Additionally, pictograms can be added using the device’s camera or gallery, allowing the inclusion of real images or internet-sourced pictures. Users can also zoom in, crop, or reposition pictograms to place them appropriately within the communication board. Furthermore, they can edit the name, add labels, change the background color, and include the written word.

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For this study, to ensure that all participants used the same support, the default communication board provided by the SymboTalk ® app in User Mode was used. This meant that the pictograms were directly sourced from ARASAAC, with white backgrounds, except for “I”, “want”, “don’t want”, “yes”, and “no”, which had a light blue background. The written words were displayed in black text at the bottom of each pictogram, with the first letter capitalized and the rest in lowercase. Some participants received additional pictograms based on their specific needs and preferences; however, these additions followed the same formatting as the default pictograms.

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The second support used in this study was the EC+, a high-tech multimodal free software designed to cater to users' cognitive functioning and communication

needs (Chicano & Luque, 2017; Luque et al., 2018). This software was created as part of the European Erasmus+ at University of Málaga, Spain. It integrates speech, pictograms, manual signs via video, real images, and written words, providing versatility across Android and iOS platforms and an academic portal accessible online through any web browser.

The features of EC+ were thoroughly described in chapter 5 of the thesis.

7.2.3 Design and procedure

This study employed the same quasi-experimental design as the previous research (Harris et al., 2006). The process was conducted over 16 weeks to observe potential improvements in the participants' communicative and behavioral skills. There were three evaluation moments: Moment 1 (pre-intervention assessment), Moment 2 (intermediate assessment), and Moment 3 (post-intervention assessment). Due to the number of participants, not all of them commenced the pretest phase on the same day. However, the timeline for each participant was calculated from their initial assessment to ensure that everyone, regardless of their start date, received the same number of intervention days and evaluation moments. A total of 45 sessions were conducted per child.

At Moment 1, behaviors were assessed, including expressive and receptive language skills and overall behavior, which were considered the baseline measure. The intervention phase took place between weeks 2 and 13, during which the aided augmented input strategy was implemented, using EC+ for Group A and SymboTalk ® for Group B. The mid-term evaluation (Moment 2) was conducted at week 7 to measure the progress made during the first half of the intervention. After this, a 15-day break from training was taken, followed by a final assessment at week 16 (Moment 3), which served as the posttest measure. This final assessment aimed to evaluate the participants' progress after the full intervention

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period and determine whether the skills they had acquired were maintained. The post-intervention assessment was regarded as the key measurement for evaluating the outcomes of the intervention, while the intermediate assessment served as a checkpoint to assess progress before the second phase of the intervention. This sequence was chosen to ensure continuous assessment of participant development, providing insight into both immediate and long-term effects of the intervention. The 15-day break without intervention was included to observe the potential maintenance of skills during a short period of discontinuation.

All therapy sessions were led by speech therapists (including the author), while the independent observer occasionally assisted the children in engaging with the activities. They lasted between 15 and 30 minutes and took place 2-3 times per week, depending on the participant's availability and the center's schedule. To prevent participants from becoming fatigued or frustrated, 5-minute breaks were incorporated. These did not count towards the intervention time. They were strategically timed following various activities to maintain interest and ensure that the children remained focused and receptive to the intervention (Holland et al., 2020).

Participants were seated at a small table where they interacted with the speech therapist and the communication aids. During therapy sessions with SymboTalk ®, the speech therapist presented a communication board on the tablet, pointing to relevant symbols and words to facilitate understanding and visual association. This method aimed to enhance item comprehension and support communication interaction effectively. In contrast, sessions with EC+ involved the presentation of the pictograms individually. These could be supplemented with a video demonstration for verbs or a real image of the corresponding element, all displayed on the tablet screen without a communication board. Here, the speech therapist assisted the user in selecting

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appropriate symbols, encouraged communication attempts, and facilitated learning within the system. This approach emphasized user autonomy while adapting to their cognitive and communicative needs during therapy sessions (Kidder & McDonnell, 2017; Kumm et al., 2022).

The intervention procedures based on aided augmented input were adapted from the study by Muttiah et al. (2022). Natural social and communicative routines were implemented, such as playing with toys, engaging in activities, and interacting with other speech therapy resources and the interlocutor. Children were given a minimum of twenty communication opportunities per activity during each intervention session. The activities selected for the two groups were of equal difficulty. Given children's tendency to process information visually (Martin & Wilkins, 2022), highly visual activities were designed to align with their abilities and preferences.

EC+ and SymboTalk ® allowed for activity adaptation, promoting environmental awareness and the recognition and imitation of emotions, crucial for socioemotional development (Gallardo-Montes et al., 2022; Hassan et al., 2021). Semantic categorization included categories such as vehicles, food, clothing, animals, home parts, and colors, facilitating a deeper understanding of the world through clear visual representations (Campos et al., 2020). Object discrimination and association activities improved recognition and concept comprehension, while direct request formulas using pictographic resources promoted expressive and receptive communication and autonomy (Montenegro et al., 2023).

Pictographic organizers of both supports were also used to address social and adaptive behaviors, facilitating comprehension and monitoring of activities, promoting predictability and organization of the environment, and preventing disruptive behaviors (Castillo Roch & Grau Rubio, 2016; Jacob et al., 2022).

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7.2.4 Measures

The Vineland-3 Scale (Spanish version) was primarily used at the three evaluation moments to collect quantitative data on receptive and expressive communication, as well as behavior, which were subsequently analyze (Pepperdine & McCrimmon, 2018; Roselló et al., 2018). This standardized test covers communication, daily living skills, socialization, motor skills, and behavior (Comprehensive Form). Scores are based on age-appropriate behaviors, with responses categorized as 2 (Generally/Frequently), 1 (Sometimes), or 0 (Never). The total Raw Score is converted into a v-Scale Score according to standardized norms, classified by age groups (Domain-Level Form). None of the participants achieved the highest scores in the evaluated areas.

As previously conducted in the earlier chapters, this study primarily measured Communicative Range based on v-Scale Scores from the Receptive, Expressive, and Writing subtests. The Receptive domain assessed the understanding of words, instructions, and questions, while the Expressive domain evaluated sound production, vocabulary use, and non-verbal communication. The Writing domain focused on literacy-related receptive skills such as letter recognition and symbol comprehension. Secondary measures included the Social Range, which analyzed interpersonal relationships, play and leisure activities, and coping skills. Additionally, the Behavioral Range was assessed through the Vineland-3, measuring disruptive behaviors such as self-injury, property damage, and learning difficulties (Sparrow et al., 2016).

To evaluate the reliability of the measurements, we used the internal consistency of the Vineland-3 Scale, with Cronbach's alpha serving as the primary reliability indicator. The reliability coefficients for all age groups were generally satisfactory, with the adaptive domains in the Comprehensive Form and ABC

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ranging from 0.73 to 0.86. The Domain-Level Form and ABC demonstrated reliability coefficients between 0.79 and 0.86. Test-retest reliability was measured using corrected correlations, as outlined by Pepperdine and McCrimmon (2018). Two administrations were conducted with the same respondent and examiner, independent of the evaluation moments, with an interval of 12 (Observation 1) to 35 days (Observation 2). The corrected r values for all adaptive domains and the ABC in the Comprehensive Form ranged from 0.70 to 0.88 across different age groups, reflecting a satisfactory level of reliability for evaluating the targeted skills.

7.2.5 Data analysis

To assess reliability of the implementation of procedures, both the independent observers and the author collected live data in every moment of evaluation, and once in the post-intervention phase using a checklist of the procedural steps. An agreement mean of 73% in scores was observed at Moment 1. Agreement was determined when both recognized independent or induced responses. Inter-rater agreement was calculated, obtaining a 89% average during the therapy and maintenance sessions (Moment 2 and Moment 3). The speech therapist filled out a procedure checklist, which showed a 84% reliability across the three evaluation moments, indicating strong agreement.

The data analysis was conducted using the 27.0 version of SPSS® Statistics. Since the requirements of parametric statistics were met, the means obtained with the two groups were compared using the Student's T-Test and the ANOVA repeated measures in relation to the intersubject factor. A significance level of $p<.001$ was set to determine differences across the evaluation moments.

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7.3 Results

In order to meet the study objectives, a detailed analysis was conducted to compare the performance of Group A (EC+) and Group B (SymboTalk ®) participants across the three evaluation moments (pre-intervention assessment, intermediate and post-intervention assessment) using the Vineland-3 Scale. For a more detailed overview of the scores obtained in the evaluated areas, see Appendix E of the thesis.

7.3.1 Communicative Range evaluation

The Communicative Range was analyzed across the three evaluation moments, measuring an individual's ability to understand spoken language and their capacity to express themselves both verbally and non-verbally. The results revealed statistically significant differences between the groups, with a large effect size: $F_{(1.86)}=747.11$, $p<.001$, $\eta^2=.958$, $\beta\text{-}1=1$. Specific comparisons between moments showed notable improvements: (a) at Moment 1, the mean difference was 10.11 ($t=29.75$, $p<.001$); (b) at Moment 2, the difference increased to 17.37 ($t=39.16$, $p<.001$); (c) at Moment 3, the mean difference reached 27.80 ($t=49.61$, $p<.001$). Subsequently, the average differences between Group A and Group B were examined (Figure 22).

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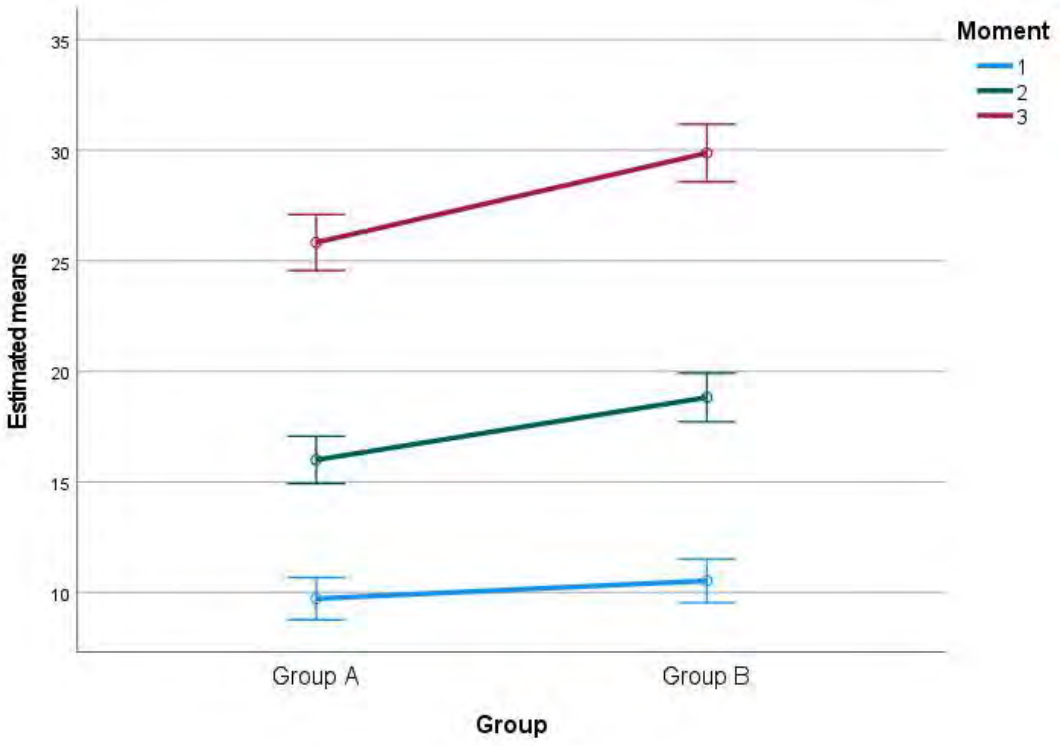


Figure 22: Comparison of Communicative Range in the EC+ vs. SymboTalk – AAC Talker ® study

Group comparisons revealed that Group A improved by 16.11 points (SD=3.16) whereas Group B demonstrated a significantly greater improvement of 19.35 points (SD=1.93). Table 19 presents the variations between participants' initial and final assessments. The findings suggest that while the EC+ intervention was effective in enhancing communication skills, its impact in the final assessment was not as statistically significant as that of the SymboTalk ® intervention.

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Table 19

Communicative Range in the EC+ vs. SymboTalk – AAC Talker ® study

		Group A			Group B		
		Moment 1	Moment 2	Moment 3	Moment 1	Moment 2	Moment 3
Mean		9.72	16.00	25.83	10.53	18.82	29.88
Standard deviation		1.96	2.44	3.16	2.03	1.97	1.93
Standard error mean		.46	.57	.74	.49	.47	.46
95% Confidence Interval	Lower Limit	8.76	14.92	24.56	9.54	17.72	28.72
	Upper Limit	10.68	17.07	27.10	11.51	19.92	31.18
RS rec (mean and standard deviation)		49.33 (8.69)	55.72 (8.07)	68.22 (4.98)	48.82 (4.85)	59.82 (4.82)	73.00 (2.29)
RS exp (mean and standard deviation)		69.17 (12.23)	73.33 (10.83)	83.78 (7.35)	71.00 (8.50)	75.82 (6.44)	86.59 (4.79)
RS wrn (mean and standard deviation)		10.83 (7.80)	12.11 (7.38)	16.22 (8.15)	10.12 (5.62)	13.65 (6.12)	20.47 (7.03)

Note. RS rec: Raw Score Receptive; RS exp: Raw Score Expressive; RS wrn: Raw Score Written.

7.3.2 Social Range evaluation

The Social Range assessed an individual's ability to engage in interactions with the communication partners, recognize and respond to social cues, participate in shared activities, and demonstrate appropriate social behaviors. The results revealed statistically significant differences between the groups, with a large effect size: $F_{(1.79)}=295.91$, $p<.001$, $\eta^2=.900$, $\beta\text{-}1=1$. Specific comparisons between moments showed notable improvements: (a) at Moment 1, the mean difference was 14.05 ($t=28.68$, $p<.001$); (b) at Moment 2, the difference increased to 21.42 ($t=26.98$, $p<.001$); (c) at Moment 3, the mean difference reached 30.88

(t=50.93, p<.001). Next, the average differences between Group A and Group B were examined (Figure 23).

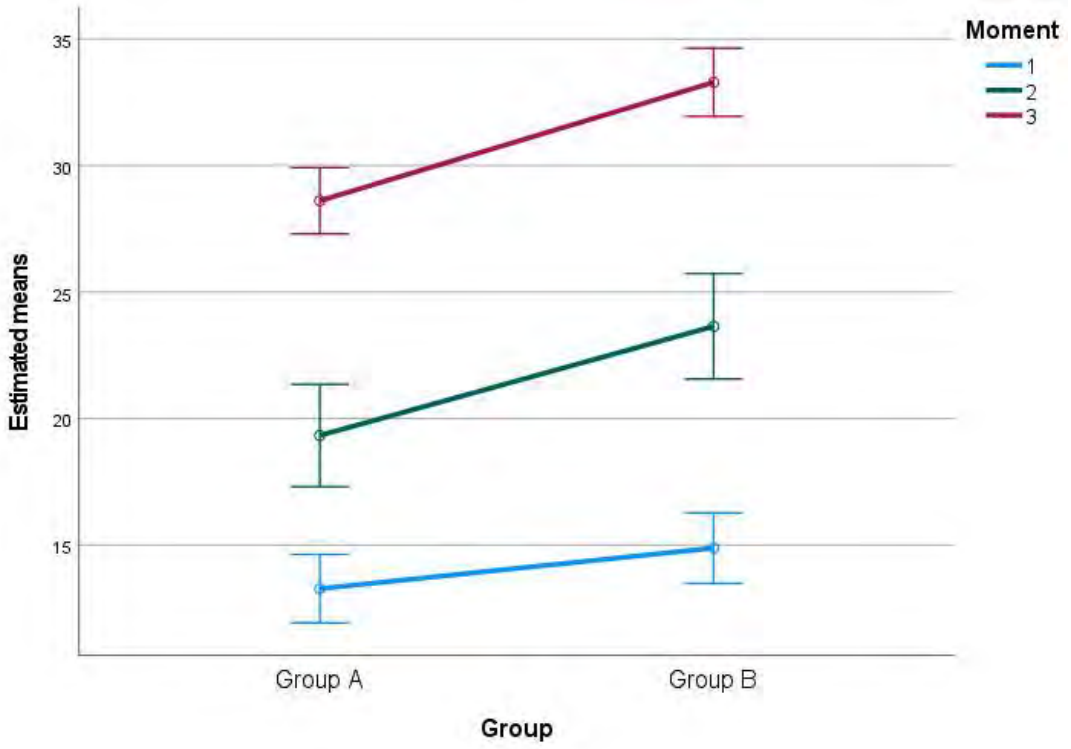


Figure 23: Comparison of Social Range in the EC+ vs. SymboTalk – AAC Talker ® study

Group comparisons revealed that Group A improved by 15.23 points (SD=2.54) whereas Group B demonstrated a significantly greater improvement of 18.41 points (SD=2.91). Table 20 presents the variations between participants' initial and final assessments. The findings suggest that while both AAC+a supports contributed to improvements in social skills, Group B achieved a more substantial gain. This indicates that SymboTalk – AAC Talker ® may have been more effective in enhancing social skills within the evaluated timeframe.

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Table 20

Social Range in the EC+ vs. SymboTalk – AAC Talker ® study

		Group A			Group B		
		Moment 1	Moment 2	Moment 3	Moment 1	Moment 2	Moment 3
Mean		13.28	19.33	28.61	14.88	23.65	33.29
Standard deviation		3.34	4.88	2.54	2.14	3.37	2.91
Standard error mean		.78	1.15	.60	.52	.81	.70
95% Confidence Interval	Lower Limit	11.92	17.30	27.30	13.48	21.56	31.94
	Upper Limit	14.63	21.35	29.92	16.27	25.73	34.64
RS ipr (mean and standard deviation)		35.56 (8.31)	40.78 (9.74)	57.61 (9.33)	41.94 (8.99)	56.53 (8.75)	70.06 (5.71)
RS pla (mean and standard deviation)		26.22 (7.80)	34.83 (10.82)	45.17 (9.01)	25.88 (8.03)	37.41 (5.76)	52.24 (6.39)
RS cop (mean and standard deviation)		2.11 (1.36)	8.11 (5.58)	22.11 (10.04)	2.41 (1.22)	11.12 (7.20)	24.71 (11.88)

Note. RS ipr: Raw Score Interpersonal Relationships; RS pla: Raw Score Play and Leisure; RS cop: Raw Score Coping Skills.

7.3.3 Behavioral Range evaluation

The Behavioral Range, focusing on the occurrence and frequency of disruptive behaviors that might hinder the development of other skills, was analyzed across three evaluation moments. Statistically significant differences were observed at all moments, with a large effect size: $F_{(2.00)}=239.28$, $p<.001$, $\eta^2=.879$, $\beta\text{-}1=1$. The following mean differences were recorded: (a) at Moment 1, the mean difference was 28.02 ($t=39.31$, $p<.001$); (b) at Moment 2, the difference decreased to 19.42 ($t=19.95$, $p<.001$); and (c) at Moment 3, the difference further declined to 9.74

(t=17.99, p<.001). The average differences between Group A and Group B were also examined (Figure 24).

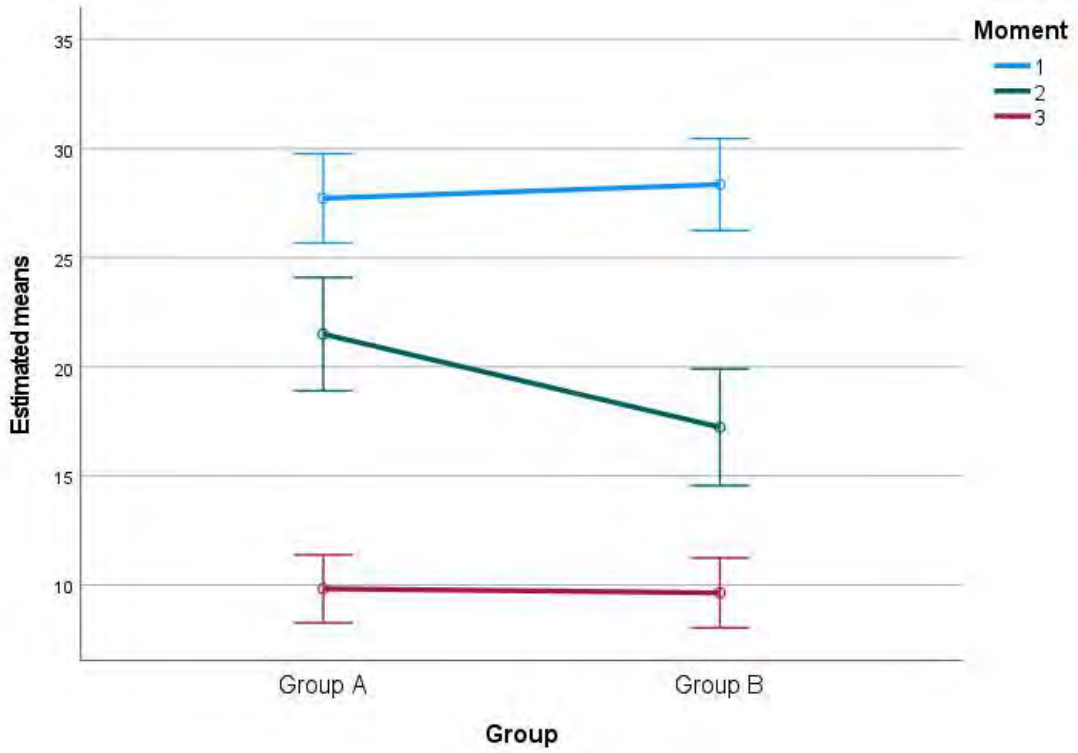


Figure 24: Comparison of Behavioral Range in the EC+ vs. SymboTalk – AAC Talker ® study

Comparing Groups A and B, the aided augmented input combinate with both AAC+a supports resulted in significant reductions in disruptive behaviors. Group A showed an improvement of 17.89 points (SD=3.43), while Group B demonstrated a comparable improvement of 18.70 points (SD=3.04). These results, outlined in Table 21, indicate a consistent trend of reduced disruptive behaviors across both groups. The findings from the final assessment revealed no statistically significant differences between the EC+ and SymboTalk ® interventions in terms of reducing disruptive behaviors. This suggests that both tools were equally effective in addressing behavioral challenges, underscoring their utility as part of a comprehensive intervention strategy for children with complex communication and behavioral needs.

Table 21

Behavioral Range in the EC+ vs. SymboTalk – AAC Talker ® study

		Group A			Group B		
		Moment 1	Moment 2	Moment 3	Moment 1	Moment 2	Moment 3
Mean		27.72	21.50	9.83	28.35	17.24	9.65
Standard deviation		5.05	6.29	3.43	3.23	4.30	3.04
Standard error mean		1.19	1.48	.80	.78	1.04	.73
95% Confidence Interval	Lower Limit	25.67	18.90	8.27	26.24	14.56	8.04
	Upper Limit	29.77	24.09	11.39	30.46	19.91	11.25
Section A (mean and standard deviation)		7.94 (2.41)	6.94 (2.64)	3.11 (1.53)	9.88 (2.11)	7.59 (1.77)	4.24 (1.64)
Section B (mean and standard deviation)		7.33 (2.05)	6.39 (2.38)	3.33 (1.74)	7.65 (.99)	4.29 (1.26)	2.71 (1.10)
Section C (mean and standard deviation)		12.44 (2.14)	8.28 (2.16)	3.44 (2.03)	10.82 (1.66)	5.35 (3.10)	2.71 (.84)

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7.4 Discussion

The present study aimed to analyze intervention based on aided augmented input strategy from two different AAC+a supports to determine which option provided more benefits for communicative, social and behavioral skills: EC+ (Group A) versus SymboTalk – AAC Talker ® (Group B). Over time, the use of SymboTalk ® proved to be more effective in developing receptive and expressive language skills. However, this finding partially contradicts the initial hypothesis, which anticipated greater benefits from the multimodal presentation offered by EC+. The results indicated that EC+ also provided notable improvements in

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participants' communication abilities, with no significant differences observed between the two groups in terms of behavioral development. Nevertheless, overall, participants in Group B showed slightly greater improvements.

Children with ASD often prefer visually presented stimuli over auditory information (Lorah et al., 2022). This preference can lead to better vocabulary comprehension when most information is consolidated into a single panel, as observed with SymboTalk ® (Lozano Martínez et al., 2016). AAC employs signs that connect a perceptible signifier with a mental meaning. However, the ability to understand these signs is not innate, making their level of iconicity a critical factor in effectively representing both concrete and abstract concepts. This is especially important when aiming to expand communication opportunities for people with ASD (Pereira et al., 2020). The default pictograms used in SymboTalk ® are part of the extensive repertoire provided by ARASAAC. These pictograms are specifically designed to meet the needs of this population, offering several advantages. Their high level of iconicity makes them easier to interpret, facilitating comprehension and use, even for users with limited cognitive or language skills (Hervás et al., 2020). This can be corroborated by the results of the previous chapter.

The larger improvement observed in Group B may be linked to SymboTalk's structured communication board design, which emphasizes clear visual representations and structured navigation, potentially enhancing comprehension and language processing for participants when combined with the intervention strategy (Chung & Son, 2020). These characteristics not only help reduce cognitive load but also enhance comprehension and language processing. When combined with the intervention strategy, they support vocabulary retention by providing consistent visual cues that are complemented by oral input.

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The increase in expressive and receptive competence through study strategy also contributed to behavioral improvements (Bamicha & Drigas, 2022). Both types of support had a significant impact on the participants, leading to a notable increase in their interactions with the environment, people, and surrounding elements. This can be attributed to the higher level of engagement required by these supports and the attractive characteristics of the materials, which captured the participants' attention and motivated them to interact with these tools and the interlocutor (Gallardo-Montes et al., 2022). Overall, these AAC+a supports provide a controlled, organized, and structured environment that facilitates interaction for ASD users. They create comprehensible and individualized scenarios, reducing potential frustration and enhancing the anticipation of stimuli (Camargo et al., 2016; Guzmán et al., 2017; Urrea et al., 2024; Valencia et al., 2019).

In addition, by displaying each item in an organized and visually accessible manner, the board assists users in associating symbols with their meanings, thereby enhancing recognition memory. This type of memory enables individuals to identify verbal or visual stimuli they have previously encountered (Semino et al., 2021). In this context, SymboTalk ® arranges elements in a consistent spatial layout, allowing users to learn through automation and visual processing—crucial components for effective learning (Hervás et al., 2020; Rutherford et al., 2020; Zhang et al., 2020).

Moreover, the structured nature of SymboTalk ® aligns with insights from visual cognitive neuroscience, as discussed by Jagaroo and Wilkinson (2008). Their work highlights the importance of leveraging stable and predictable visual displays to optimize information processing for AAC users. The use of a consistent spatial arrangement in communication boards like SymboTalk ® not only facilitates motor learning but also aligns with the principles of motion perception

systems, which play a significant role in maximizing visual display design for effective communication (Wilkinson & Mitchell, 2014).

This study has certain limitations that should be considered, similar to those in previous studies, such as the sample size. However, it is important to note that comparable sample sizes have been used in similar studies while still meeting the statistical requirements of the analyses conducted. Secondly, adapting contexts to the aided augmented input strategy may create artificial or unnatural situations. Therefore, it is crucial to consider each participant's individual preferences, vocabulary, and characteristics to minimize such occurrences. To address this, the situations presented in this study were carefully controlled to ensure their coherence and relevance. In this regard, the built-in editing features of SymboTalk ® have made it easier to add new ARASAAC pictograms to the communication board, allowing for real-time vocabulary updates as needed in each case.

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7.5 Conclusions

This study provides evidence describing and to some extent explaining the utility of this intervention approach, examining the varying effects based on the mode of presentation. The targeted teaching of strategies and technology tools like SymboTalk – AAC Talker ® (communication board) and EC+ (multimodal list-form) combined with aided augmented input can address speech and language pathology by mitigating communicative deficits, thereby preventing disruptive behaviors and increasing social situations in children with ASD Level 3 with complex communication needs. Moreover, integrating the aided augmented input strategy while accounting for differences in presentation and the options provided by AAC+a supports can enhance recognition memory, sustained engagement and interactions between the interlocutor and the user. This approach may deepen

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the learning experience and should be carefully considered when implementing such tools.

The research ultimately fulfills specific objective 6, as presented in Section 1.2 of Chapter 1 of the thesis.

7.6 References

Agius, M. M., Stansfield, J., & Murray, J. (2024). A comparison of differing organizational formats for teaching requesting skills to children with autism. *Augmentative and Alternative Communication*, 1-12. https://doi.org/10.1080/07434618.2024.2370825

Alzrayer, N.M., Banda, D.R., & Koul, R.K. (2019). The effects of systematic instruction in teaching multistep social-communication skills to children with autism spectrum disorder using an iPad. *Developmental Neurorehabilitation*, 22(6), 415-429. https://doi.org/10.1080/17518423.2019.1604578

American Psychiatric Association (APA) (2013). Diagnostic and statistical manual of mental disorders (5th ed.). *Washington, DC: American Psychiatric Publishing.* https://doi.org/10.1176/appi.books.9780890425596

Aspiranti, K. B., Larwin, K. H., & Schade, B. P. (2020). iPads/tablets and students with autism: A meta-analysis of academic effects. *Assistive Technology*, 32(1), 23–30. https://doi.org/10.1080/10400435.2018.1463575

Bamicha, V., & Drigas, A. (2022). ToM & ASD: The interconnection of Theory of Mind with the social-emotional, cognitive development of children with Autism Spectrum Disorder. The use of ICTs as an alternative form of intervention in ASD. *Technium Social Sciences Journal*, 33, 42-72. https://doi.org/10.47577/tssj.v33i1.6845

Baxter, S., Enderby, P., Evans, P., & Judge, S. (2012). Interventions using high-technology communication devices: a state of the art review. *Folia Phoniatrica et Logopaedica*, *64*(3), 137-144. https://doi.org/10.1159/000338250

UNIVERSIDAD DE MÁLAGA

Brady, N. C., Storkel, H. L., Bushnell, P., Barker, R. M., Saunders, K., Daniels, D., & Fleming, K. (2015). Investigating a multimodal intervention for children with limited expressive vocabularies associated with autism. *American Journal of Speech-Language Pathology*, 24(3), 438-459. https://doi.org/10.1044/2015_AJSLP-14-0093

Calculator, S., & Luchko, C. D. A. (1983). Evaluating the effectiveness of a communication board training program. *Journal of speech and Hearing Disorders*, *48*(2), 185-191.

Calleja Reina, M., Luque, M.L., & Rodríguez Santos, J.M. (2021). Protocolo de Valoración del Perfil Comunicativo Lingüístico de personas con necesidades complejas de comunicación y discapacidad intelectual (PCL-DIS-NCC). In M. Calleja Reina (Eds.), *Necesidades Complejas de Comunicación y Enfermedades Minoritarias* (pp. 30-35). McGraw Hill Education.

Camargo, S. P. H., Rispoli, M., Ganz, J., Hong, E. R., Davis, H., & Mason, R. (2016). Behaviorally based interventions for teaching social interaction skills to children with ASD in inclusive settings: A meta-analysis. *Journal of Behavioral Education*, 25, 223-248. https://doi.org/10.1007/s10864-015-9240-1

Campos, V. M., Asunción, M. M., & Cerezuela, G. P. (2020). Semantic processing in children with autism spectrum disorder. *Revista INFAD de Psicología. International Journal of Developmental and Educational Psychology*, 1(2), 165-174. https://doi.org/10.17060/ijodaep.2020.n2.v1.1968

Castillo Roch, A. & Grau Rubio, C. (2016). Conductas disruptivas en el alumnado con TEA: estudio de un caso. Ensayos: *Revista de la Escuela Universitaria de Formación del Profesorado de Albacete*.

Chicano, F., & Luque, G. (2017). A mobile application and academic portal to support professionals working with people having severe intellectual or developmental disabilities. *Procedia-Social and Behavioral Sciences*, 237, 568-575. https://doi.org/10.1016/j.sbspro.2017.02.108

UNIVERSIDAD DE MÁLAGA

Chung, S., & Son, J. W. (2020). Visual perception in autism spectrum disorder: a review of neuroimaging studies. *Journal of the Korean Academy of Child and Adolescent Psychiatry*, 31(3), 105. https://doi.org/10.5765/jkacap.200018

Cipta, D. A. S., Avianty, D., & Kurniawati, A. (2019). Communication board as a Montessori apparatus in teaching mathematics to autism students. *Ukrainian Journal of Educational Studies and Information Technology*, 7(3), 25-31. https://doi.org/10.32919/uesit.2019.03.03

De Pimentel, G. U. A. (2024). Autism Spectrum Disorder (ASD): A major problem to address. *Horizonte Médico (Lima)*, 24(1), e2631–e2631. https://doi.org/10.24265/horizmed.2024.v24n1.00

Donato, C., Spencer, E., & Arthur-Kelly, M. (2018). A critical synthesis of barriers and facilitators to the use of AAC by children with autism spectrum disorder and their communication partners. *Augmentative and Alternative Communication*, *34*(3), 242-253. https://doi.org/10.1080/07434618.2018.1493141

Fombonne, E., MacFarlane, H., & Salem, A. C. (2021). Epidemiological surveys of ASD: advances and remaining challenges. *Journal of Autism and Developmental Disorders*, 51, 4271-4290. https://doi.org/10.1007/s10803-021-05005-9

Fried-Oken, M., Daniels, D., Ettinger, O., Mooney, A., Noethe, G., & Rowland, C. (2015). What's on your mind? Conversation topics chosen by people with degenerative cognitive-linguistic disorders for communication boards. *American Journal of Speech-Language Pathology*, *24*(2), 272-280. https://doi.org/10.1044/2015_AJSLP-14-0057

Gallardo-Montes, C. D. P., Caurcel Cara, M. J., & Rodríguez Fuentes, A. (2022). Technologies in the education of children and teenagers with autism: evaluation and classification of apps by work areas. *Education and Information Technologies*, 27(3), 4087-4115. https://doi.org/10.1007/s10639-021-10773-z

UNIVERSIDAD DE MÁLAGA

Gallardo-Montes, C. D. P., Caurcel Cara, M. J., Crisol Moya, E., & Jarque Fernández, S. (2021). Assessment of apps aimed at developing basic instrumental skills in autistic children and teenagers. *Mathematics*, 9(9), 1032. https://doi.org/10.3390/math9091032

Ganz, J. B., Boles, M. B., Goodwyn, F. D., & Flores, M. M. (2014). Efficacy of handheld electronic visual supports to enhance vocabulary in children with ASD. *Focus on Autism and Other Developmental Disabilities*, *29*(1), 3-12. https://doi.org/10.1177/1088357613504991

Garcia, L. F., de Oliveira, L. C., & de Matos, D. M. (2016). Evaluating pictogram prediction in a location-aware augmentative and alternative communication system. *Assistive Technology*, 28(2), 83-92. https://doi.org/10.1080/10400435.2015.1092181

Gobierno de Aragón (2007). *Portal Aragonés de la Comunicación Aumentativa y Alternativa, ARASAAC*. Author of pictograms: Sergio Palao. Retrieved from: ARASAAC (http://www.arasaac.org). Licenced by: CC (BY-NC-SA).

Gómez, M. Y. M., Reyes, G. V. P., Rojas, E. G., Ruiz, M. L. R., Antolínez, A. C. V., & Medina, N. A. Z. (2023). Validación de un tablero de comunicación en el contexto hospitalario. *Revista Perspectivas*, *8*(S2), 15-40. https://doi.org/10.22463/25909215.4596

Guzmán, G., Putrino, N., Martínez, F., & Quiroz, N. (2017). Nuevas tecnologías: Puentes de comunicación en el trastorno del espectro autista (TEA). *Terapia Psicológica*, 35(3), 247-258. https://doi.org/10.4067/s0718-48082017000300247

Harris, A. D., McGregor, J. C., Perencevich, E. N., Furuno, J. P., Zhu, J., Peterson, D. E., & Finkelstein, J. (2006). The use and interpretation of quasi-experimental studies in medical informatics. *Journal of the American Medical Informatics Association*, 13(1), 16-23. https://doi.org/10.1197/jamia.M1749

UNIVERSIDAD DE MÁLAGA

Hassan, A., Pinkwart, N., & Shafi, M. (2021). Serious games to improve social and emotional intelligence in children with autism. *Entertainment Computing*, 38, 100417. https://doi.org/10.1016/j.entcom.2021.100417

Hervás, R., Bautista, S., Méndez, G., Galván, P., & Gervás, P. (2020). Predictive composition of pictogram messages for users with autism. *Journal of Ambient Intelligence and Humanized Computing*, 11, 5649-5664. https://doi.org/10.1007/s12652-020-01925-z

Holland, C. M., Blanche, E. I., & Thompson, B. L. (2020). Quantifying therapists' activities during sensory integration treatment for young children with autism. *Physical & Occupational Therapy in Pediatrics*, 41(3), 284-299. https://doi.org/10.1080/01942638.2020.1847235

Jacob, U. S., Edozie, I. S., & Pillay, J. (2022). Strategies for enhancing social skills of individuals with intellectual disability: A systematic review. *Frontiers in Rehabilitation Sciences*, 3. https://doi.org/10.3389/fresc.2022.968314

Jagaroo, V., & Wilkinson, K. (2008). Further considerations of visual cognitive neuroscience in aided AAC: The potential role of motion perception systems in maximizing design display. *Augmentative and Alternative Communication*, 24(1), 29-42. https://doi.org/10.1080/07434610701390673

Jeong, B. Y., Choi, S., & Park, K. (2021). Heuristic Evaluation for Augmentative and Alternative Communication Application: A Case Study. In *2021 International Conference on Information and Communication Technology Convergence (ICTC)* (pp. 1240-1243). IEEE.

Kidder, J. E., & McDonnell, A. P. (2017). Visual aids for positive behavior support of young children with autism spectrum disorders. *Young Exceptional Children*, 20(3), 103-116. https://doi.org/10.1177/1096250615586029

King, M., Romski, M., & Sevcik, R. A. (2020). Growing up with AAC in the digital age: a longitudinal profile of communication across contexts from toddler to teen.

UNIVERSIDAD DE MÁLAGA

Augmentative and Alternative Communication, 36(2), 128–141. https://doi.org/10.1080/07434618.2020.1782988

Kumm, A. J., Viljoen, M., & de Vries, P. J. (2022). The digital divide in technologies for autism: feasibility considerations for low-and middle-income countries. *Journal of Autism and Developmental Disorders*, 1-14. https://doi.org/10.1007/s10803-021-05084-8

Lesser, J., & Ebert, K. D. (2020). Examining social communication effects of a picture communication board in a child with autism. *Perspectives of the ASHA Special Interest Groups*, *5*(2), 492-505. https://doi.org/10.1044/2020_PERSP-19-00113

Lima, S. M., & Laplane, A. L. F. D. (2016). Escolarização de alunos com autismo [Schooling for students with autism]. *Revista Brasileira de Educação Especial*, 22, 269-284. https://doi.org/10.1590/S1413-65382216000200009

Logan, K., Iacono, T. & Trembath, D. (2017). A Systematic Review of Research into Aided AAC to Increase Social-Communication Functions in Children with Autism Spectrum Disorder. *Augmentative and Alternative Communication*, 33(1), 51-64. https://doi.org/10.1080/07434618.2016.1267795

López Gonzalo, C. (2019). T*ablero de comunicación configurable basado en pictogramas*. Universidad Compútense de Madrid.

Lorah, E. R., Holyfield, C., Miller, J., Griffen, B., & Lindbloom, C. (2022). A systematic review of research comparing mobile technology speech-generating devices to other AAC modes with individuals with autism spectrum disorder. *Journal of Developmental and Physical Disabilities*, 34(2), 187-210. https://doi.org/10.1007/s10882-021-09803-y

Lozano Martínez, J., Ballesta Pagán, F.J., Alcaraz García, S., & Cerezo Máiquez, M.C. (2016). Las tecnologías de la información y comunicación (TIC) en el proceso de enseñanza y aprendizaje del alumnado con trastorno del espectro autista (TEA). *Revista Fuentes*, 14, 193–208.

UNIVERSIDAD DE MÁLAGA

Luque P. G., Postigo Pinazo, E., Calleja Reina, M., & Chicano, F. (2018). *EC+* (1.0) [App]. Google Play. https://bit.ly/3ravvgV

Martin, R., & Wilkins, J. (2022). Creating visually appropriate classroom environments for students with autism spectrum disorder. *Intervention in School and Clinic*, 57(3), 176–181. https://doi.org/10.1177/10534512211014882

Montenegro, A. C. D. A., Leite, G. A., Moura, D. A. A. D., Silva, A. G. S., Xavier, I. A. D. L. N., & Lima, R. A. (2023). Development of communication skills in an adolescent with autism, using alternative communication: a case report. *Revista CEFAC*, 25, e11122. https://doi.org/10.1590/1982-0216/202325311122

Muttiah, N., Drager, K. D., Beale, B., Bongo, H., & Riley, L. (2022). The effects of an intervention using low-tech visual scene displays and aided modeling with young children with complex communication needs. *Topics in Early Childhood Special Education*, 42(1), 91-104. https://doi.org/10.1177/0271121419844825

Pepperdine, C. R., & McCrimmon, A. W. (2018). Test review: Vineland Adaptive Behavior Scales, (Vineland-3) by Sparrow, SS, Cicchetti, DV, & Saulnier, CA. *Canadian Journal of School Psychology*. https://doi.org/10.1177/0829573517733845

Pereira, E. T., Montenegro, A., Rosal, A., & Walter, C. (2020). Augmentative and Alternative Communication on Autism Spectrum Disorder: *Impacts on Communication. CoDAS*, 32(6). https://doi.org/10.1590/2317-1782/20202019167

Roselló, B., Berenguer, C. & Baixauli, I. (2018). El funcionamiento adaptativo de niños con trastorno del espectro autista: impacto de los síntomas y de los problemas comportamentales y emocionales. *International Journal of Developmental and Educational Psychology*, 3(1), 247-257. https://doi.org/10.17060/ijodaep.2018.n1.v3.1268

Rutherford, M., Baxter, J., Grayson, Z., Johnston, L., & O'Hare, A. (2020). Visual supports at home and in the community for individuals with autism spectrum

UNIVERSIDAD DE MÁLAGA

disorders: A scoping review. *Autism*, 24(2), 447-469. https://doi.org/10.1177/1362361319871756

Sauer, A. K., Stanton, J. E., Hans, S. & Grabrucker, A. M. (2021). Autism Spectrum Disorders: Etiology and Pathology. *Exon Publications*, 1-15. https://doi.org/10.36255/exonpublications.autismspectrumdisorders.2021.etiology

Semino, S., Zanobini, M., & Usai, M. C. (2021). Visual memory profile in children with high functioning autism. *Applied Neuropsychology: Child*, 10(1), 26-36. https://doi.org/10.1080/21622965.2019.1594231

Sparrow, S.S., Cicchetti, D.V. & Saulnier, C.A. (2016). *Vineland Adaptive Behavior Scales, Third Edition (Vineland-3).* San Antonio, TX: Pearson. https://doi.org/10.1177/0829573517733845

Suha, S. A., Islam, M. N., Akter, S., Bhowmick, M. C., & Halder, R. (2022). Assessing usability of mobile applications developed for autistic users through heuristic and semiotic evaluation. In *Proceedings of International Joint Conference on Advances in Computational Intelligence: IJCACI 2021* (pp. 25-39). Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-19-0332-8_3

Talantseva, O. I., Romanova, R. S., Shurdova, E. M., Dolgorukova, T. A., Sologub, P. S., Titova, O. S., ... & Grigorenko, E. L. (2023). The global prevalence of autism spectrum disorder: A three-level meta-analysis. *Frontiers in Psychiatry*, 14, 1071181. https://doi.org/10.3389/fpsyt.2023.1071181

Urrea, A. L., Fernández-Torres, V., Rodriguez-Ortiz, I. R., & Saldaña, D. (2024). The use of technology-assisted intervention in vocabulary learning for children with autism spectrum disorder: a systematic review. *Frontiers in Psychology*, 15, 1370965. https://doi.org/10.3389/fpsyg.2024.1370965

UNIVERSIDAD DE MÁLAGA

UNIVERSIDAD DE MÁLAGA

Valencia, K., Rusu, C., Quiñones, D., & Jamet, E. (2019). The impact of technology on people with autism spectrum disorder: a systematic literature review. *Sensors*, 19(20), 4485. https://doi.org/10.3390/s19204485

Velarde-Incháustegui, M., Ignacio-Espíritu, M. E., & Cárdenas-Soza, A. (2021). Diagnóstico de Trastorno del Espectro Autista-TEA, adaptándonos a la nueva realidad, Telesalud. *Revista de Neuro-Psiquiatría*, 84(3), 175-182. http://dx.doi.org/10.20453/rnp.v84i3.4034

Wilkinson, K. M., & Mitchell, T. (2014). Eye tracking research to answer questions about augmentative and alternative communication assessment and intervention. *Augmentative and Alternative Communication*, 30(2), 106-119. https://doi.org/10.3109/07434618.2014.904435

Zhang, M., Jiao, J., Hu, X., Yang, P., Huang, Y., Situ, M., ... & Huang, Y. (2020). Exploring the spatial working memory and visual perception in children with autism spectrum disorder and general population with high autism-like traits. *PLoS One*, 15(7), e0235552. https://doi.org/10.1371/journal.pone.0235552

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8

Main findings and conclusions

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This thesis aims to contribute to the advancement of scientific knowledge regarding intervention for children with ASD and complex communication needs (in this case, those diagnosed with Level 3) when implementing the aided augmented input strategy using different AAC resources and supports. The ultimate goal is to enhance the most affected areas in this population: communication, social skills, and behavior.

First, detailed information about ASD has been presented, defining its core characteristics and key aspects to consider, such as intervention, assessment, and development, culminating in an overview of the communicative traits observed in these cases. Additionally, a review of the most relevant theoretical and practical aspects was conducted to highlight the importance of aided augmented input, with a particular focus on the role of different AAC resources available today, their main features, and the possibilities offered by both technology-based and paper-based supports.

The experimental work presented in Chapters 5, 6 and 7 of this thesis aimed to fulfill the six specific objectives outlined in Section 1.2 of Chapter 1.

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8.1 Main findings

The experimental studies presented in this research focused on aided augmented input as the central intervention strategy, yielding differentiated outcomes depending on the type of AAC support or resource used. This variability in findings has been analyzed in detail across the three studies conducted, whose results suggest the most effective ways to implement aided augmented input:

- The use of the multimodal application EC+, examined in the study presented in Chapter 5, which produced results comparable to those obtained with AAC-a resources.

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- The use of paper-based pictograms from the ARASAAC system, evaluated in the study presented in Chapter 6.
- Finally, the implementation of the AAC+a communication board through the SymboTalk – AAC Talker ® application, analyzed in the study presented in Chapter 7.

To draw solid conclusions and facilitate the comparison of these three key variables, Figure 25 illustrates the participants' progress based on the tool used in the Communicative Range.

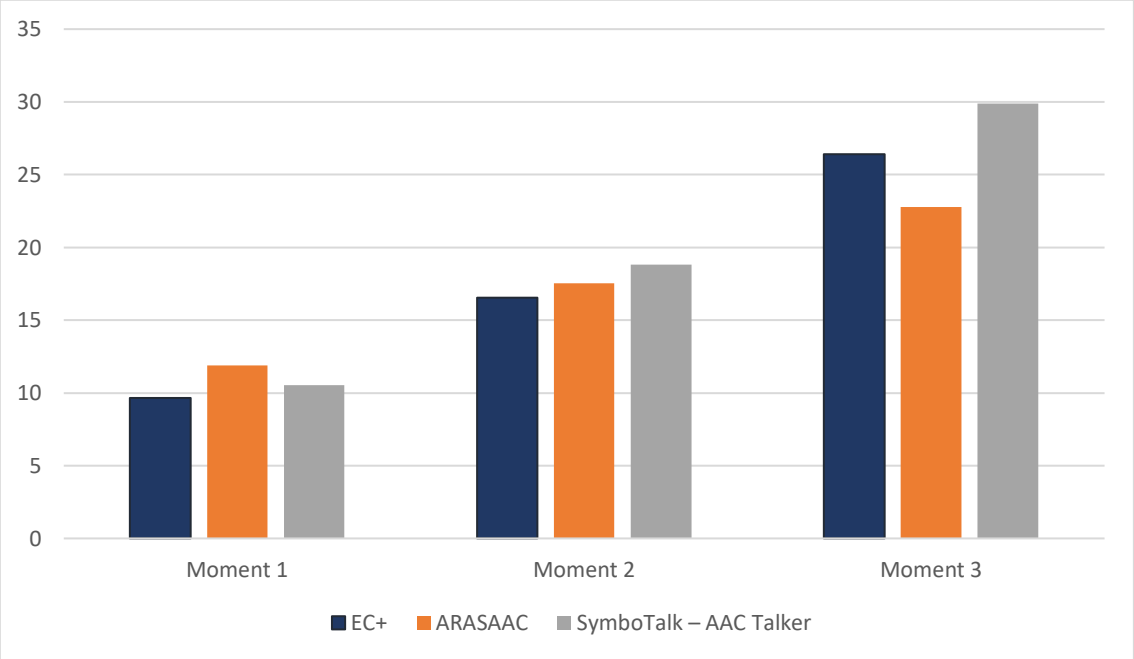


Figure 25: Communicative Range results

Below are the most notable results obtained from the corresponding subtests of the Vineland-3 scale:

- Receptive skills, which involve listening and understanding, showed a significant increase. This suggests that participants looked at the interlocutor more frequently when hearing their voice, followed the interlocutor's gaze or pointing gestures more consistently, followed instructions more easily, pointed at objects, understood a greater

number of words and their meanings, and demonstrated an improved ability to differentiate between “yes” and “no”.

- Expressive skills, which encompass both verbal and non-verbal communication, showed the greatest improvement among the evaluated communication skills. This was reflected in participants' increased communicative intent, such as how they interacted with their surroundings and the interlocutor—producing meaningful sounds or gestures (e.g., happy sounds, gestures to gain attention, or signals indicating the continuation or end of an activity). Additionally, participants showed an increase in babbling and vocalizations, attempted to repeat words after hearing them alongside their visual representation, requested objects or actions, appropriately expressed “yes” and “no”, and, in some cases, began to name familiar words.
- Writing skills, which also include reading, showed the least improvement by the end of the study. This could be attributed to the complexity of these actions for children with Level 3 ASD, who experience severe impairments. Some participants were able to recognize a few additional symbols or simple signs (e.g., a red cross for “no”, a green checkmark for “yes”, or a stop sign), but continued to struggle with recognizing their own written name, identifying letters of the alphabet, holding a book correctly, or understanding the left-to-right writing direction in Spanish. Although all pictograms used in the studies—regardless of the medium—were consistently accompanied by written words, the written component was not prioritized in an aided augmented input approach, which focuses primarily on spoken language and visual representation. For it to be considered a suitable

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strategy for teaching literacy skills, certain adaptations would be necessary.

On the other hand, the graph in Figure 26 shows the participants' progress based on the tool used in the Social Range.

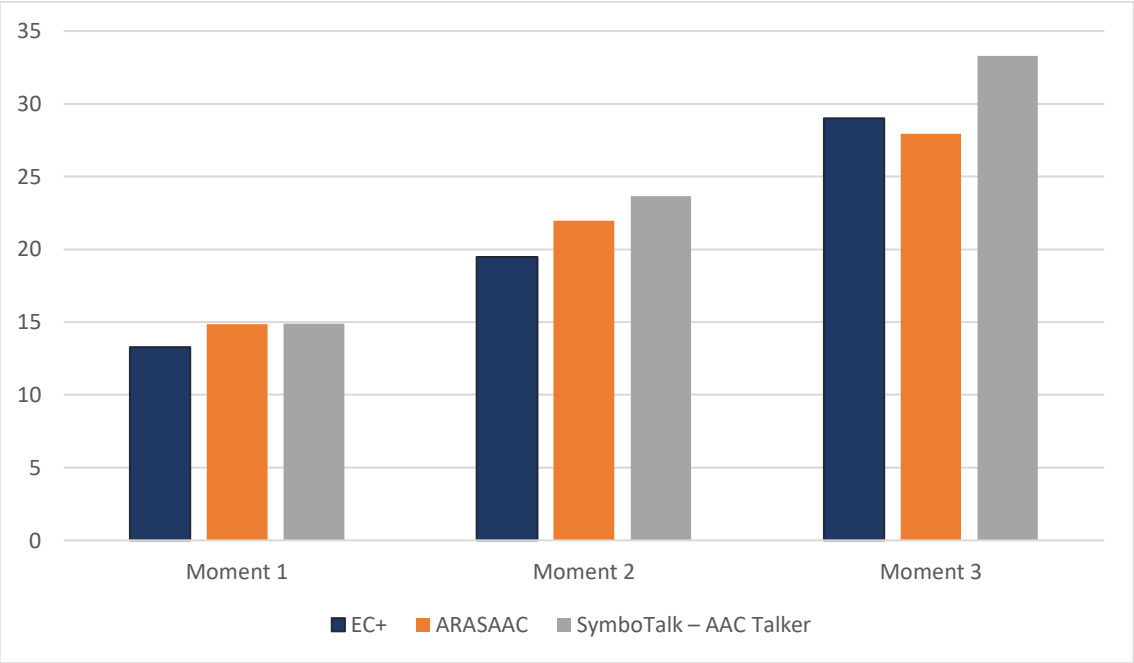


Figure 26: Social Range results

Below are the most notable results obtained from the corresponding subtests of the Vineland-3 scale:

- Interpersonal relationships was the area that showed the greatest improvement in social skills, regardless of the AAC support or resource used. This improvement is reflected in the children's increased recognition of the interlocutor, their efforts to interact with the person, and their more natural eye contact or facial engagement. They also exhibited more emotional responses (happiness, surprise, displeasure, affection), smiled when praised or complimented after completing a task or behaving well, recognized when the interlocutor expressed emotions such as happiness (when something is right) or anger (when

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misbehavior occurs, prompting them to stop), and attempted to imitate or mirror the emotions of the interlocutor and the pictogram representing them.

- Play and leisure skills also increased. Participants showed more interest in their surroundings, responded when the interlocutor acted playfully, shared toys when asked, played with another person for at least five minutes independently (though with some supervision), and demonstrated greater respect for turn-taking during activities.
- Coping skills was the area with the least improvement within the social domain. However, participants showed a more noticeable effort to seek comfort from the interlocutor when feeling sad or upset, adapted more easily when transitioning from one activity to another, attempted to ask for help when they were unsure how to do something, adjusted relatively easily to the routine established during the sessions, and recovered more quickly when something did not go as expected (for example, when they did not get what they wanted or when an activity ended before they desired). Many of these skills are characteristic of people with severe ASD.

Lastly, the graph in Figure 27 illustrates the participants' progress based on the tool used in the Behavioral Range.

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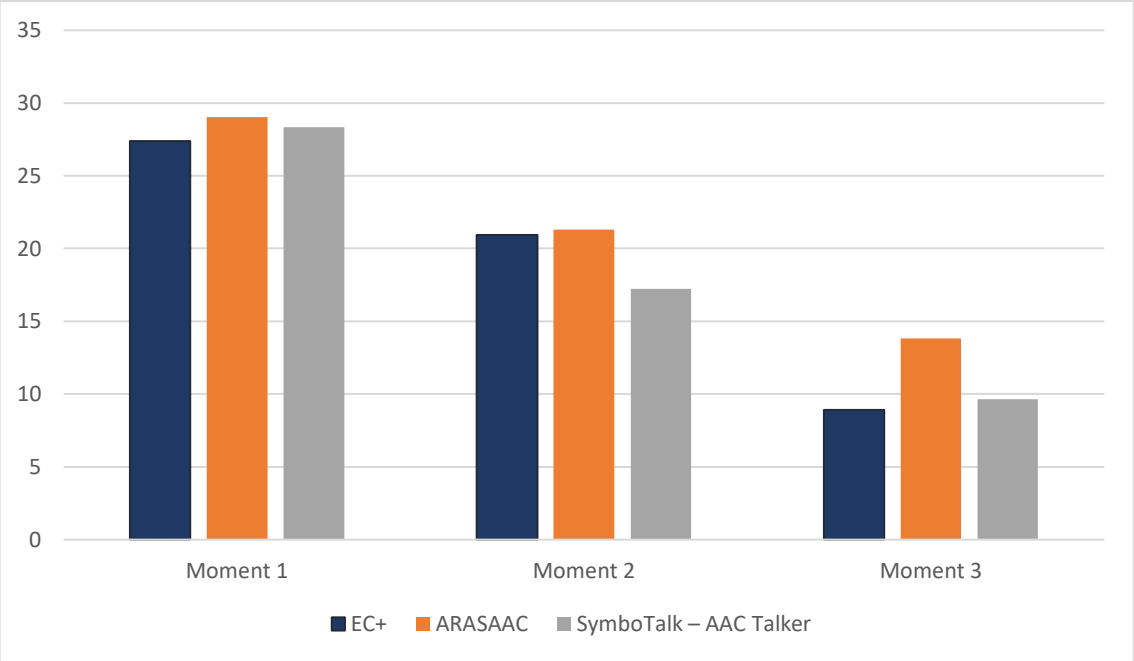


Figure 27: Behavioral Range results

Below are the most notable results obtained from the corresponding subtests of the Vineland-3 scale:

- Section A showed a significant reduction across all study groups. Initially, participants exhibited high levels of dependence, struggling with daily routines, refusing to attend school or speech therapy sessions, and often displaying excessive anxiety or nervousness. Many were irritable or temperamental, cried or became sad without a clear reason, avoided interactions with the interlocutor, and showed little interest in activities they typically enjoyed. Over the course of the study, these behaviors significantly decreased.
- A similar pattern was observed in Section B, where participants frequently engaged in tantrums (yelling, crying, kicking), displayed defiant behavior, and in some cases, exhibited physical aggression (hitting, kicking, biting). Some participants intentionally damaged their belongings or those of others, including paper-based pictograms

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or toys. These disruptive behaviors were noticeably reduced within the therapy setting.

- Section C also demonstrated a similar downward trend. Initially, participants showed obsessive behaviors toward objects or specific parts of objects. Some engaged in self-injurious behaviors (e.g., head-banging, hitting, or biting themselves when frustrated), repeated physical movements persistently (stereotypies) in response to distress or agitation, exhibited compulsive behaviors, or had difficulties with toileting, such as accidents due to not requesting to use the restroom. Additionally, some participants engaged in wandering behaviors or struggled to remain seated during intervention sessions. Over time, these behaviors were significantly reduced.

It is important to highlight that, in all the studies included in this thesis, some participants were already receiving therapy before their inclusion in the research, and some had previously used other forms of AAC in their interventions. However, none of the children had prior experience with the specific supports evaluated. This initial exposure to AAC is not considered a limitation but rather a reflection of a naturalistic context in which children were already benefiting from communication aids.

The research's focus on the implementation of new supports and the intervention strategy allows for the assessment of their specific impact while also acknowledging that prior AAC use may have facilitated a foundational understanding of communication tools, potentially contributing to improved outcomes.

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8.2 Conclusions of the thesis

The main conclusions derived from the experimental studies, in which the intervention strategy and various resources were tested, can be summarized as follows:

- Aided augmented input, combining oral input (the natural speech of the interlocutor) with visual input (AAC tools), proves to be an effective intervention strategy for children with Level 3 ASD and complex communication needs in a Spanish-speaking context. This aligns with previous studies that support the thesis.
- Regarding the study participants, the intervention strategy successfully improves their communication skills, which is its primary objective. However, beyond communication, it also leads to progress in other affected areas, such as social and behavioral skills.
- The AAC+a and AAC-a resources analyzed have distinct characteristics, each offering specific advantages. All of them, to varying degrees, contributed to improvements among participants. This can be a crucial aid for professionals selecting the most appropriate AAC resources for ASD cases, highlighting three viable options: paper-based pictograms, multimodal list-based ICT formats, or communication boards.
- Implementing aided augmented input in the presented studies requires a structured and controlled environment, ensuring all necessary resources and activities are prepared in advance. This is essential for presenting oral and visual input as naturally as possible. Structuring was more evident when using printed pictograms, such as ARASAAC, which required selecting, printing, laminating, and organizing pictograms. In contrast, storing them on a technological device (e.g.,

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tablet apps) provided a faster, more intuitive, and streamlined alternative.

- The proposed intervention strategy is appropriate for the studied cases. Not only did its implementation lead to progress in participants, but the Vineland-3 scale (Spanish version) also stood out as a suitable exploratory assessment tool for this type of research. Focused on adaptive behavior, this scale allowed for a straightforward and practical evaluation of communication, social, and behavioral domains across the three assessment moments, making it a valuable tool for therapeutic implementation.

Regarding the suitability of aided augmented input with different AAC supports and tools for developing communication skills (expressed as the Communicative Range) in participants with ASD, this thesis concludes that:

- Aided augmented input is an ideal intervention strategy for developing expressive and receptive skills, as it naturally integrates oral and visual input simultaneously. However, a different approach would be necessary for targeting literacy skills.
- Among all the elements used in the study, ARASAAC pictograms proved to be the most effective, both when compared to other paper-based pictograms and when used within SymboTalk ® (a communication board app with preloaded ARASAAC pictograms), yielding the best results.
- Using ICT-based AAC support enhances outcomes, as demonstrated by EC+ and SymboTalk ®, which outperformed paper-based ARASAAC pictograms. This could be attributed to the tablet's role as a therapeutic tool, which captures participants' attention, boosts motivation and concentration, reinforces direct interactions with the

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interlocutor, and reduces cognitive load due to its mode of presentation.

- Among the AAC+a and AAC-a supports and tools evaluated, SymboTalk – AAC Talker ® produced the best results.

Regarding the impact of the intervention strategy on social skills (expressed as the Social Range) in participants with ASD, this thesis concludes that:

- Alongside improvements in communication skills, aided augmented input, combined with AAC tools and supports, has led to a significant enhancement in interpersonal relationships and play and leisure skills. This suggests that both the intervention strategy and the session structure have fostered more frequent, natural, and appropriate interactions between the interlocutor and the participant, strengthening their connection. However, coping skills have shown less improvement in comparison, highlighting the need for a complementary intervention strategy specifically targeting these abilities.
- ICT-based supports have once again yielded the best results. The tablet increases social engagement opportunities by making interaction more dynamic, reinforcing turn-taking, and encouraging joint attention through a more stimulating and responsive medium.
- As in the communicative domain, ARASAAC pictograms, whether in paper format or used with a tablet-based communication board, have contributed to enhancing social skills, thanks to their versatility and clear visual representation.
- Among the AAC+a and AAC-a tools assessed, SymboTalk – AAC Talker ® has produced the best results in improving social interactions among participants.

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Finally, after demonstrating that aided augmented input improves both communicative and social skills, these effects are also observed in the participants' behavioral skills (expressed as the Behavioral Range). This thesis concludes that:

- Aided augmented input facilitates a natural and fluid communicative exchange between the interlocutor and the participant. These interactions help to significantly reduce disruptive behaviors observed during intervention sessions, serving as an appropriate model for presenting words, activities, games, establishing work routines, and improving children's behavioral flexibility.
- The AAC+a and AACa supports used in the study are effective for conducting activities that directly target behavior, whether by enabling emotional expression or helping participants differentiate between right and wrong behaviors.
- The multimodal EC+ application has produced the best results among the participants. Data also show that SymboTalk – AAC Talker ® has performed similarly to EC+, demonstrating its effectiveness as well.

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All of this was made possible through the activities and intervention model implemented, which aligned with the analyzed intervention strategy. Throughout the studies, various activities shared by participants were described, but the most essential ones are summarized below. Some activities focused on enhancing environmental awareness and recognizing and imitating emotions—key aspects for socioemotional development. Semantic categorization was also incorporated, grouping concepts such as vehicles, food, clothing, animals, household items, and colors. This approach facilitated a clearer understanding of the surrounding world through structured visual representations. Additionally, object discrimination and association exercises were introduced to strengthen recognition and conceptual comprehension. Participants also practiced direct request formulas using

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pictographic resources, providing a visual tool to express their needs while fostering both expressive and receptive communication, as well as greater autonomy. To support social and adaptive behaviors, visual schedules and graphic organizers were utilized. These simple yet effective tools improved task comprehension and activity tracking, enhancing environmental predictability and organization. This, in turn, helped prevent disruptive behaviors such as self-injury, damage to surroundings or materials, and learning difficulties.

8.3 Future works

This thesis explores aspects related to intervention in children with ASD Level 3 who have complex communication needs. Understanding this field is essential for improving such an important process, which can be complex due to the characteristics of autism and the wide variety of intervention strategies and AAC resources available.

Therefore, several research topics are proposed to continue advancing the overall goal of this thesis. First, experimental research must take into account the wide range of AAC supports and resources currently available on the market, as each offers different options and has its own advantages and disadvantages. It is necessary to further explore how aided augmented input adapts to new AAC-a approaches with different formats and AAC-a+ by testing new applications or technological resources from a therapeutic perspective.

It is important to emphasize that all studies were conducted in a clinical context, specifically in the speech therapist's office, to facilitate the intervention process, the acquisition of resources and reinforcers, and to maintain a controlled environment free from distractions. However, for intervention with ASD, it is crucial to generalize the skills obtained across the various natural contexts in

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which the child participates. Therefore, the goal is to implement the aided augmented input strategy in two specific scenarios:

- The school, where the child's teachers will need to integrate aided augmented input within the classroom setting. This would involve tailoring the intervention to the daily routines and communication needs of the child, ensuring the strategy fits seamlessly into the educational context.
- The home, where children spend most of their time. In this case, parents or legal caregivers should adapt their routines and communication styles based on the proposed intervention strategy.

For this, the speech therapist must coordinate with and explain to the relevant individuals how to implement aided augmented input in a way that it can be adjusted and applied in these contexts. The aim is to expand the procedure used in the speech therapy office and create a natural setting with interlocutors who engage with the participant on a daily basis.

Future research should also consider existing evaluation systems and procedures. Although in this thesis all children had been previously diagnosed with ASD prior to the study, other evaluation tools could be used alongside the Vineland-3 scale to measure other areas or complement the results of this scale, such as the ADOS-2 scale. Additionally, it would be valuable to conduct interviews with parents or caregivers and with professionals working with the participants to gather their perspectives on the effects of aided augmented input and the chosen AAC resource.

Furthermore, the study population should be expanded, and results should be compared across different contexts. In this case, it is important to compare the performance of communicative, social, and behavioral skills in a Spanish-

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speaking population with one from an English or Portuguese-speaking population, as norms and communication methods can vary depending on the language used, especially considering the high heterogeneity of ASD. A comparison could also be made with other populations, such as people with Down syndrome, among others. Variables such as the participants' gender or level of schooling could also be considered.

Finally, to further deepen understanding of ASD, the idea arises to implement the intervention strategy with AAC resources in an adult ASD population and, conversely, in a preschool-aged population to see how it affects their skills with early intervention. This would provide valuable information on the understanding of of this pathology, taking age-related variables into account.

Ultimately, the model of aided augmented input presented in this thesis will serve as a critical strategy to study its effects on communication, social skills, and behavior, providing valuable information to guide the selection of AAC supports or resources and improve intervention outcomes.

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APPENDIX A

Results of Chapter 4

Table A.1

Characteristics of the studies

	Design	Sample	Characteristics of the experimental group	Intervention tolos	Follow-up
Allen et al. (2021)	Controlled within-subjects design.	*n*=11	Moderate to severe ASD, comorbidity with intellectual deficit.	Images, real objects, and videos with iPad™.	No tracking
Brady et al. (2015)	Controlled within-subjects design.	*n*=10	ASD with limited expressive vocabulary.	Multimodal elements with iPad™ or computer.	Between 2 and 40 sessions
Dorney & Erickson (2019)	Mixed methods experimental design.	*n*=13	ASD with limited expressive vocabulary.	Communication matrix and AAC classroom elements (PCS and PECS).	No tracking
Emerson & Dearden (2013)	Controlled single-case design.	*n*=1	ASD with restricted receptive language and basic verb comprehension.	Images and words paired.	Several weeks (unspecified)
Finke et al. (2017)	Controlled within-subjects design.	*n*=6	ASD with experience using AAC.	Multimodal communication strategies, including high-tech AAC, sign language, gestures, and speech.	3 months
Harjusola-Webb & Robbins (2012)	Controlled within-subjects design.	*n*=3	ASD capable of communicating with gestures and vocalizations.	Teacher training package on naturalistic intervention.	No tracking

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Hassim (2019)	Experimental crossover design between subjects.	n=21	ASD able to recognize objects and prepositions.	ICT support for iPad™, real color photographs, and assisted symbols.	Several weeks (unspecified)
Kasari et al. (2014)	Randomized longitudinal regression models.	n=61	Minimally verbal ASD.	Naturalistic speech and communication-generating device.	3 months
Laher & Dada (2023)	Alternative treatment design (randomized)	n=6	Children with complex communication needs, including ASD.	Facilitating boards with 12 PCS symbols	3 weeks
Lorah et al. (2015)	Multiple baseline design.	n=2	ASD with an absent or weak verbal repertoire.	ICT support with voice generator; experimenter vocally presented stimuli.	21 sessions
McFadden et al. (2014)	Multiple baseline design.	n=4	ASD with severe social functioning deficits.	Peer networks and fundamental response training.	Several weeks (unspecified)
Muttiah et al. (2022)	Single-case multiple probe across participants.	n=3	ASD with a presymbolic level or lower on communication and developmental delay.	Low-tech VSDs and aided modeling	No tracking
Ngwira (2019)	Quasi-experimental design.	n=17	ASD with deficits in receptive language skills.	12 verbal instructions combined with pictograms presented on iPad™.	No tracking
Park et al. (2023)	Randomized controlled trial design.	n=5	ASD with moderate involvement and intellectual disability.	Parent-Assisted Social Skills Training Program.	Weekly tasks

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Remner et al. (2016)	Controlled within-subjects design.	n=10	Moderate to severe ASD with object recognition skills.	Wooden blocks, jewelry boxes, communication board, and iPad™.	No tracking
Schlosser et al. (2013)	Randomized controlled within-subjects.	n=9	ASD with interests in electronic tools.	Directives, figures, other accessories, and iPad™.	No tracking
Trottier et al. (2011)	Multiple baseline design.	n=2	ASD capable of making requests with at least 10 pictograms.	Games tailored to individual interests and abilities.	No tracking

Note. PCS: Pictographic Communication System; PECS: Image Exchange Communication System; AAC: Augmentative and Alternative Communication; ICT: Information and Communications Technologies; VSDs: Visual Scene Displays.

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Table A.2

Synthesis of interventions and results

	Intervention	Frequency and duration	Summary of results
Allen et al. (2021)	EG: Spoken directives, dynamic (video) and static (image) scene cues.	Intervention sessions (unspecified)	Greater precision in following directives (comprehension).
Brady et al. (2015)	EG: Interactive routines, physical prompts, and corrective feedback.	17-76 sessions 45-60 minutes	Increased production of spoken words.
Dorney & Erickson (2019)	EG: PCS. CG: PECS system.	5 days x 7 months 15-45 minutes	Abstract graphic symbols increased social engagement and information sharing.
Emerson & Dearden (2013)	EG: Identification of elements and opportunities for social participation and responding by pointing.	32 sessions 20 months 20-30 minutes	Improved understanding of complex language and literacy skills.
Finke et al. (2017)	EG: Communication screens with multi-symbol messages based on favorite books.	14 weeks	Improved language and communication to meet daily needs.
Harjusola-Webb & Robbins (2012)	EG: Strategies to promote communication (commenting, labeling, modeling, and reinforcement).	Daily sessions 18 weeks 30 minutes	Increased functional skills without interrupting classroom activities.
Hassim (2019)	EG: 60% aided augmented input level. CG: 20% aided augmented input level.	Intervention sessions (unspecified) 20 minutes	60% aided augmented input produced greater response accuracy and increased communication modes.
Kasari et al. (2014)	EG: JASP+EMT+SGD. CG: JASP+EMT.	24 sessions 6 months 60 minutes	Significant advances in spontaneous communication through joint participation, play skills, and SGD use.
Laher & Dada (2023)	EG: Aided augmented input with 70% dose. CG: Aided augmented input with 40% dose.	10 sessions 10 days 20 minutes	Using a low-tech AAC board at a 70% dose increased receptive vocabulary and language skills.
Lorah et al. (2015)	EG: Instructions represented with three specific symbols and two distractor symbols.	2 sessions 12 weeks 2 hours	Responded to three intraverbal statements and acquired skills rapidly.

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McFadden et al. (2014)	EG: Bringing participants and peers together for interactive games and activities.	17-37 sessions 7 months 20-30 minutes	Significant increases in social communication with peers and generalization of these skills.
Muttiah et al. (2022)	EG: VSDs with interactive "hotspots" for people, objects, and events, combined with aided modeling in natural contexts.	1-2 times per week 2-4 weeks 10-15 minutes	Significant increases in communication turns and unique semantic concepts; supported preliminary efficacy for communicative engagement.
Ngwira (2019)	EG: 75% aided augmented input level. CG: 25% aided augmented input level.	Intervention sessions (unspecified) 15 minutes	Aided augmented input benefitted participants in both conditions.
Park et al. (2023)	EG: Developmentally appropriate social skills with parent involvement and behavioral strategies integrated into play-based activities.	5 days 16 weeks 15-20 minutes	Improvements in social responsiveness, cognition, motivation, and reductions in restricted, repetitive behaviors.
Remner et al. (2016)	EG1: Verbal speech combined with static scene (image). EG2: Verbal speech with dynamic scene (video). CG: verbal discourse.	Intervention sessions (unspecified) 30 minutes	Visual aids (static or dynamic) improved children's ability to follow verbal directives (comprehension).
Schlosser et al. (2013)	EG1: Dynamic scene (video). EG2: Static scene (image). CG: Spoken interaction.	6 months	Combining static and dynamic scene cues with speech was more effective than using speech alone.
Trottier et al. (2011)	EG: SGD devices to engage in peer interactions in school.	13 sessions 86-130 minutes	Improvements in social interactions after AAC instruction.

Note. EG: Experimental Group; CG: Control Group; EMT: Enhanced Milieu Teaching; JASP: Joint Attention Symbolic Play Engagement and Regulation; SGD: Speech-Generating Device; PCS: Pictographic Communication System; PECS: Picture Exchange Communication System; AAC: Augmentative and Alternative Communication; VSDs: Visual Scene Displays.

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APPENDIX B

List of pictograms

To support the implementation of the strategy intervention, a comprehensive list of pictograms was created and divided into two primary groups: (1) core vocabulary items included from the outset, and (2) additional items introduced incrementally each week.

Vocabulary was selected based on developmental relevance, communicative intent, and contextual utility for the target population—school-aged children (ages 6–12) diagnosed with Level 3 ASD, requiring substantial support and presenting significant expressive communication challenges. The words were chosen to cover essential semantic categories (e.g., food, emotions, actions, people, places), providing a meaningful foundation for both requesting and commenting behaviors, as well as social interaction and emotional expression.

This list was consistently used across the studies presented in Chapters 5, 6, and 7 of this dissertation. However, adaptations were made when specific words were not available in the AAC systems or visual resources at the time of implementation. In such cases, alternative pictograms with equivalent meanings were selected (e.g., “CONTENTO” – “FELICIDAD”), even if labeled differently. Moreover, the selected pictograms were adapted to meet the individual characteristics and needs of each child. As a result, in some cases, not all items from the original list were used, while in others, additional pictograms had to be incorporated to better support the child’s communication goals.

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Table B.1

List of pictograms used in the intervention

	Category	Pictograms
Original set example	Basic Concepts	Yo, más, terminar, sí, no, bien, mal
	Food	Agua, galletas, zumo, pan, pizza, hamburguesa, macarrones, tomate
	Emotions	Contento/Felicidad, triste/tristeza, enfadado/ira
	Colors	Rojo, verde, azul
	Places	Casa, colegio/aula, baño, silla, mesa
	Personal Hygiene	Lavarse las manos, cepillo de dientes, peinarse
	Actions	Jugar, sentarse, mirar, coger, comer, beber
	People	Mamá, papá, hermano/hermana, abuelo/abuela
	Clothing	Camiseta, pantalón, zapatos
	Body Parts	Cabeza, mano, pies
	Animals	Perro, gato, pájaro, pez
	Transportation	Coche, barco, avión
	Toys	Pelota, bloques, lápices
	Others	Por favor, gracias, hola, adiós
Weekly additions example	Basic Concepts	Arriba, abajo, dentro, fuera, gustar, abrir, cerrar
	Food	Manzana, pera, leche, yogurt, queso, jamón, limón, huevo, pollo
	Emotions	Asustado/miedo, amor, dolor, cansado
	Colors	Amarillo, naranja, rosa, blanco, negro
	Places	Calle, cocina, salón, dormitorio/cuarto, parque
	Actions	Silencio, dibujar, encender, apagar, silencio, esperar/stop, querer, andar
	People	Maestro/profe, maestra/seño, logopeda
	Clothing	Calcetines, gafas, gorra, chaqueta, paraguas

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Body Parts	Boca, lengua, ojos
Animals	Vaca, mariposa, pato, conejo
Transportation	Moto, tren, bicicleta, autobús
Toys	Puzle, peluche, música, juegos

Note. The examples are presented in Spanish, as this was the language used in the context of the studies.

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APPENDIX C

Results of Chapter 5

The results obtained using the Vineland-3 scale in the study presented in Chapter 5 are shown below. This study consists of 15 participants in Group A (EC+) and 15 participants in Group B (paper-based pictograms from ARASAAC).

The Vineland-3 scale was used to calculate the Raw Score for all participants. Once this score was obtained, it was converted into the v-Scale Score based on the test's normative data. Finally, the Age Equivalent (AE) and Growth Scale Value (GSV) were determined, the latter being a measure that provides a more precise representation of a participant's developmental progress over time. The normal probability of the Raw Scores was also analyzed to justify the statistical methods applied in this chapter. This analysis ensures that the chosen statistical tests are appropriate for the data distribution.

The analyzed scores include receptive, expressive, and written communication to determine the Communicative Range; interpersonal relationships, play and leisure, and coping skills to assess the Social Range; and the three sections related to disruptive behaviors to evaluate the Behavioral Range.

Throughout the study, the participants' chronological age was taken into account, as the normative data varies accordingly. It is important to note that the study lasted a total of 16 weeks, during which participants naturally continued to develop. Therefore, the time factor was considered when conducting assessments at the three established evaluation moments, ensuring that the appropriate norms were applied in each case.

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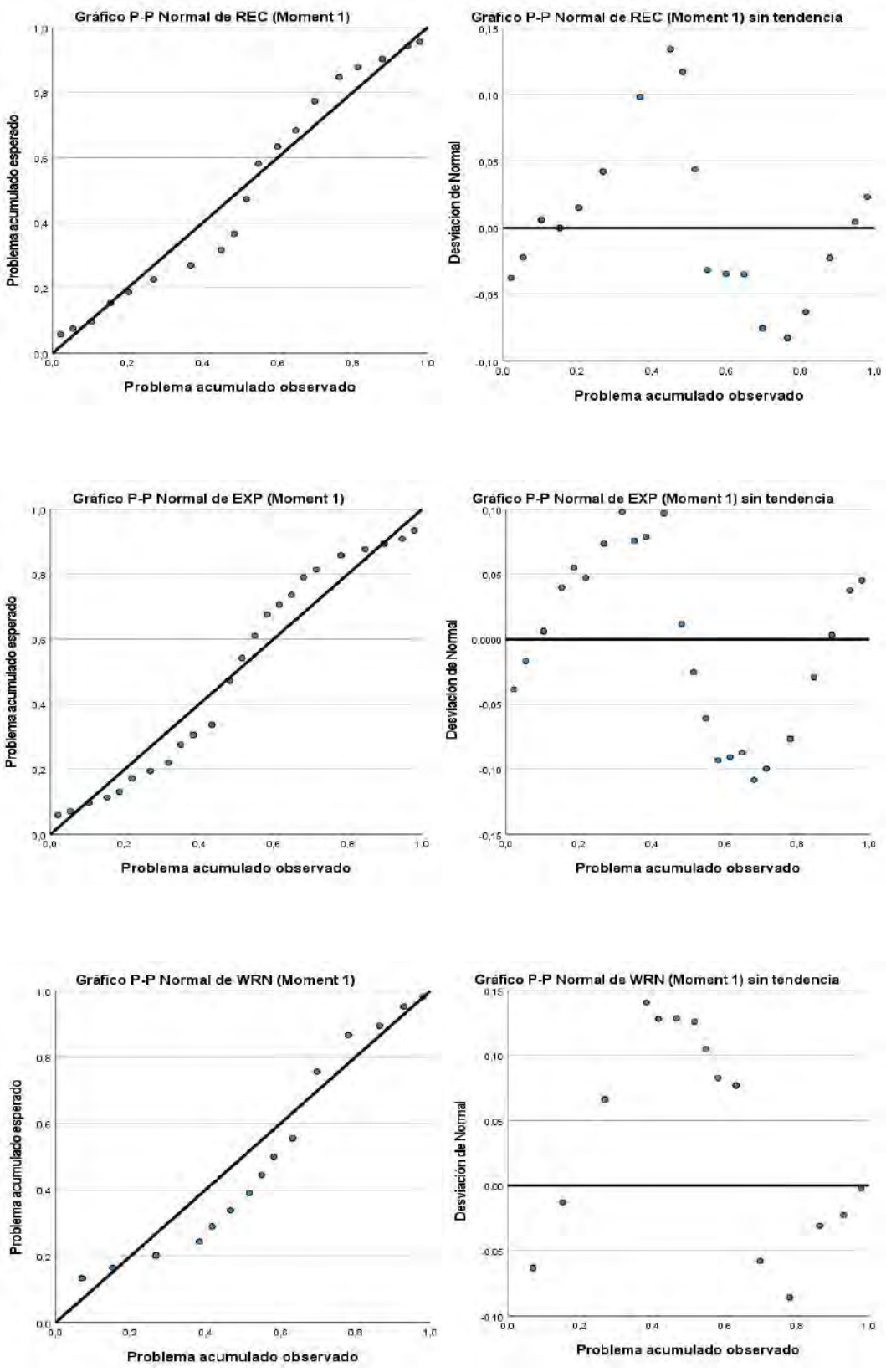
Table C.1

Communicative Range results (Moment 1)

	Participants	Receptive (rec)				Expressive (exp)				Written (wrn)				Communication (COM)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (EC+)	5 (6 years)	36	4	1:04	80	49	2	1:10	76	2	2	<3:0	26	8
	19 (7 years)	44	5	1:08	87	60	2	2:02	82	1	1	<3:0	20	8
	29 (10 years)	55	6	2:03	96	79	3	3:03	92	17	2	3:10	54	11
	12 (6 years)	38	4	1:05	82	50	2	1:10	77	1	1	<3:0	20	7
	27 (9 years)	53	5	2:01	94	77	3	3:02	91	14	2	3:06	50	10
	17 (6 years)	37	4	1:04	81	52	2	1:11	78	1	1	<3:0	20	7
	25 (7 years)	43	5	1:07	86	61	2	2:03	82	1	1	<3:0	20	8
	1 (11 years)	57	6	2:05	98	81	3	3:05	94	21	2	4:02	58	11
	4 (12 years)	60	7	2:08	101	84	5	3:08	96	24	2	4:05	61	14
	14 (11 years)	57	6	2:05	98	82	4	3:06	94	21	2	4:02	58	12
	7 (10 years)	56	6	2:04	97	79	3	3:03	92	17	2	3:10	54	11
	26 (8 years)	49	5	1:10	91	70	2	2:08	87	6	1	<3:0	37	8
	21 (9 years)	51	5	1:11	93	74	2	2:11	89	10	1	3:01	44	8
	11 (6 years)	38	4	1:05	82	53	2	1:11	78	9	6	3:00	42	12
	24 (7 years)	45	5	1:08	88	62	2	2:04	83	6	3	<3:0	37	10
Group B (ARASAAC)	9 (10 years)	55	6	2:03	96	79	3	3:03	92	17	2	3:10	57	11
	20 (7 years)	43	5	1:07	86	62	3	2:04	83	4	2	<3:0	32	10
	2 (8 years)	50	6	1:11	92	73	4	2:10	88	10	3	3:01	44	13
	16 (6 years)	42	5	1:07	85	57	3	2:01	80	3	2	<3:0	30	10
	30 (6 years)	41	5	1:06	84	54	3	1:11	79	3	2	<3:0	30	10
	3 (8 years)	50	6	1:11	92	72	4	2:10	88	8	2	<3:0	41	12
	23 (6 years)	40	5	1:06	84	56	4	2:00	80	3	2	<3:0	30	11
	8 (10 years)	57	7	2:05	98	81	5	3:05	94	18	3	3:11	55	15
	6 (6 years)	42	5	1:07	85	57	3	2:01	80	3	2	<3:0	30	10
	28 (6 years)	41	5	1:06	84	58	3	2:22	81	3	2	<3:0	30	10
	22 (7 years)	43	5	1:07	86	66	5	2:06	85	5	3	<3:0	35	13
	18 (7 years)	47	6	1:09	89	68	4	2:07	86	7	3	<3:0	39	13
	10 (10 years)	59	8	2:07	100	80	4	3:04	93	18	3	3:11	55	15
	13 (6 years)	43	6	1:07	86	52	2	1:11	78	3	2	<3:0	30	10
	15 (9 years)	53	6	2:01	94	76	4	3:01	90	14	3	3:06	50	13

Note. RS: Raw Score; V-S: v-Scale Score; AE: Age Equivalent; GSV: Growth Scale Value.

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Note. REC: Receptive; EXP: Expressive; WRN: Written.

Figure C.1: Normal probability plot of the Communicative Range (Moment 1)

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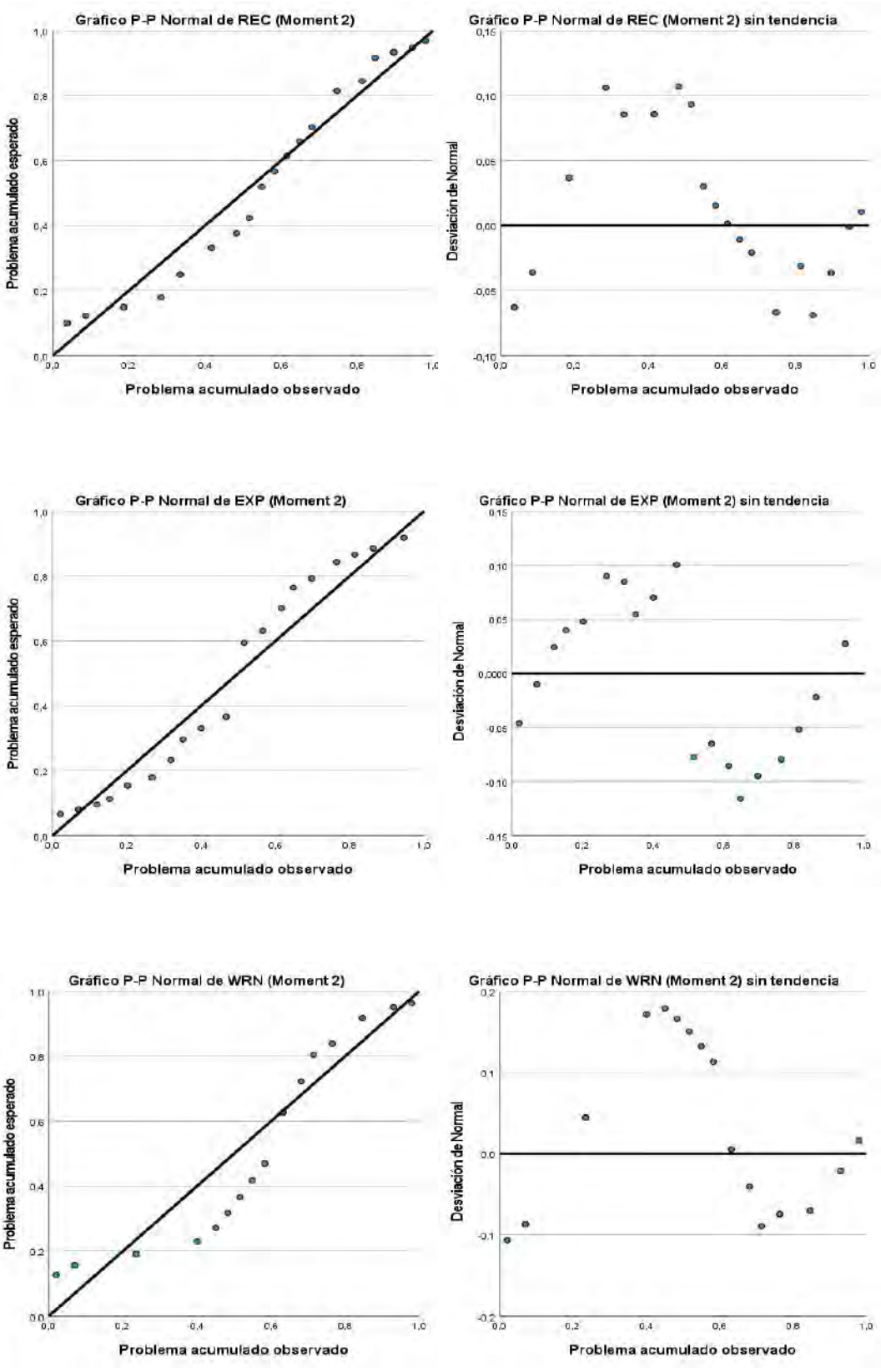
Table C.2

Communicative Range results (Moment 2)

	Participants	Receptive (rec)				Expressive (exp)				Written (wrn)				Communication (COM)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (EC+)	5 (6 years)	44	7	1:08	87	57	5	2:01	80	2	2	<3:0	26	14
	19 (7 years)	51	8	1:11	93	66	5	2:06	85	4	2	<3:0	32	15
	29 (10 years)	62	9	2:10	103	82	6	3:06	94	18	3	3:11	55	18
	12 (6 years)	46	7	1:09	88	58	5	2:22	81	4	4	<3:0	32	16
	27 (9 years)	58	8	2:06	99	80	6	3:04	93	15	3	3:07	51	17
	17 (6 years)	45	7	1:08	88	56	4	2:00	80	3	2	<3:0	30	13
	25 (7 years)	52	8	2:00	94	67	5	2:06	85	4	2	<3:0	32	15
	1 (11 years)	68	10	3:10	111	86	7	3:11	98	21	2	4:02	58	19
	4 (12 years)	70	11	4:04	114	86	7	3:11	98	24	2	4:05	61	20
	14 (11 years)	67	10	3:08	109	86	7	3:11	98	23	4	4:04	60	21
	7 (10 years)	63	9	3:00	104	83	6	3:07	95	18	3	3:11	55	18
	26 (8 years)	56	8	2:04	97	75	5	3:00	90	9	2	3:00	42	15
	21 (9 years)	57	8	2:05	98	79	6	3:03	92	13	2	3:04	48	16
	11 (6 years)	46	7	1:09	88	57	4	2:01	80	8	6	<3:0	41	17
	24 (7 years)	49	7	1:10	91	68	5	2:07	86	5	2	<3:0	35	14
Group B (ARASAAC)	9 (10 years)	62	9	2:10	103	82	6	3:06	94	21	4	4:02	58	19
	20 (7 years)	51	8	1:11	93	67	5	2:06	85	5	3	<3:0	35	16
	2 (8 years)	59	9	2:07	100	77	6	3:02	91	13	4	3:04	48	19
	16 (6 years)	46	7	1:09	88	61	5	2:03	82	4	3	<3:0	32	15
	30 (6 years)	47	7	1:09	89	62	6	2:04	83	3	2	<3:0	30	15
	3 (8 years)	55	8	2:03	96	75	6	3:00	90	10	4	3:01	44	18
	23 (6 years)	44	6	1:08	87	62	6	2:04	83	4	3	<3:0	32	15
	8 (10 years)	66	10	3:06	108	84	7	3:08	96	21	5	4:02	58	22
	6 (6 years)	46	7	1:09	88	64	6	2:04	84	4	3	<3:0	32	16
	28 (6 years)	46	7	1:09	88	61	5	2:03	82	4	3	<3:0	32	15
	22 (7 years)	51	8	1:11	93	68	6	2:07	86	6	4	<3:0	37	18
	18 (7 years)	53	8	2:01	94	74	7	2:11	89	7	3	<3:0	39	18
	10 (10 years)	67	10	3:08	109	84	7	3:08	96	23	5	4:04	60	22
	13 (6 years)	49	8	1:10	91	59	4	2:02	81	4	3	<3:0	32	15
	15 (9 years)	62	9	2:10	103	80	6	3:04	93	17	4	3:10	54	19

Note. RS: Raw Score; V-S: v-Scale Score; AE: Age Equivalent; GSV: Growth Scale Value.

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Note. REC: Receptive; EXP: Expressive; WRN: Written.

Figure C.2: Normal probability plot of the Communicative Range (Moment 2)

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Table C.3

Communicative Range results (Moment 3)

	Participants	Receptive (rec)				Expressive (exp)				Written (wrn)				Communication (COM)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (EC+)	5 (6 years)	65	12	3:04	107	77	10	3:02	91	7	5	<3:0	39	27
	19 (7 years)	64	11	3:02	105	79	9	3:03	92	9	5	3:00	42	25
	29 (10 years)	72	12	5:03	117	90	10	4:06	103	23	5	4:04	60	27
	12 (6 years)	57	10	2:05	98	69	8	2:08	86	6	5	<3:0	37	23
	27 (9 years)	70	11	4:04	114	87	9	4:00	99	17	3	3:10	54	23
	17 (6 years)	65	12	3:04	107	78	10	3:02	92	5	4	<3:0	35	26
	25 (7 years)	70	13	4:04	114	85	11	3:10	97	11	6	3:02	46	30
	1 (11 years)	76	15	11:00	129	95	12	8:03	113	31	6	5:01	67	33
	4 (12 years)	67	11	3:08	109	89	9	4:04	101	28	5	4:10	65	25
	14 (11 years)	73	12	6:03	119	93	10	5:06	108	23	5	4:04	60	27
	7 (10 years)	75	14	8:06	125	94	12	6:09	110	26	6	4:07	63	32
	26 (8 years)	64	10	3:02	105	81	8	3:05	94	15	5	3:07	51	23
	21 (9 years)	68	11	3:10	111	86	9	3:11	98	16	4	3:08	52	24
	11 (6 years)	62	11	2:10	103	70	8	2:09	87	6	5	<3:0	37	24
	24 (7 years)	67	12	3:08	109	83	10	3:07	95	10	5	3:01	44	27
Group B (ARASAAC)	9 (10 years)	67	10	3:08	109	85	8	3:10	97	25	6	4:06	62	24
	20 (7 years)	56	9	2:04	97	72	7	2:10	88	7	4	<3:0	39	20
	2 (8 years)	63	10	3:00	104	81	8	3:05	94	13	4	3:04	48	22
	16 (6 years)	65	12	3:04	107	80	10	3:04	93	9	6	3:00	42	28
	30 (6 years)	58	10	2:06	99	72	8	2:10	88	5	4	<3:0	35	22
	3 (8 years)	59	9	2:07	100	81	8	3:05	94	11	4	3:02	46	21
	23 (6 years)	49	8	1:10	91	67	7	2:06	85	4	3	<3:0	32	18
	8 (10 years)	71	11	4:08	115	88	9	4:02	100	24	5	4:05	61	25
	6 (6 years)	54	9	2:02	95	69	7	2:08	86	5	4	<3:0	35	20
	28 (6 years)	58	10	2:06	99	72	8	2:10	88	6	4	<3:0	37	22
	22 (7 years)	57	9	2:05	98	75	8	3:00	90	7	4	<3:0	39	21
	18 (7 years)	57	9	2:05	98	81	9	3:05	94	8	3	<3:0	41	21
	10 (10 years)	69	11	4:00	112	87	9	4:00	99	22	5	4:03	59	25
	13 (6 years)	62	11	2:10	103	81	10	3:05	94	5	4	<3:0	35	25
	15 (9 years)	61	9	2:09	102	86	9	3:11	98	16	4	3:08	52	22

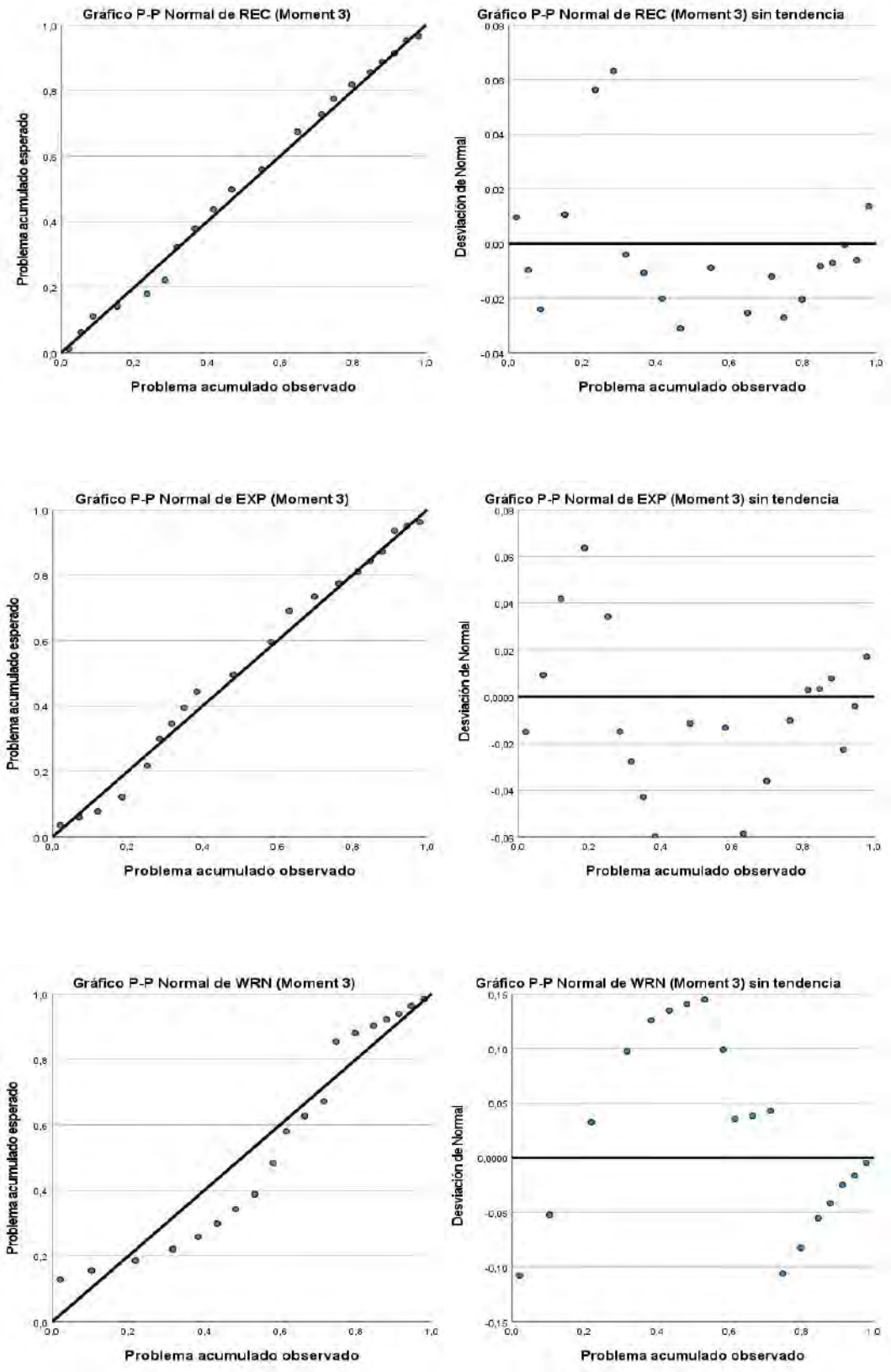
Note. RS: Raw Score; V-S: v-Scale Score; AE: Age Equivalent; GSV: Growth Scale Value.

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Note. REC: Receptive; EXP: Expressive; WRN: Written.

Figure C.3: Normal probability plot of the Communicative Range (Moment 3)

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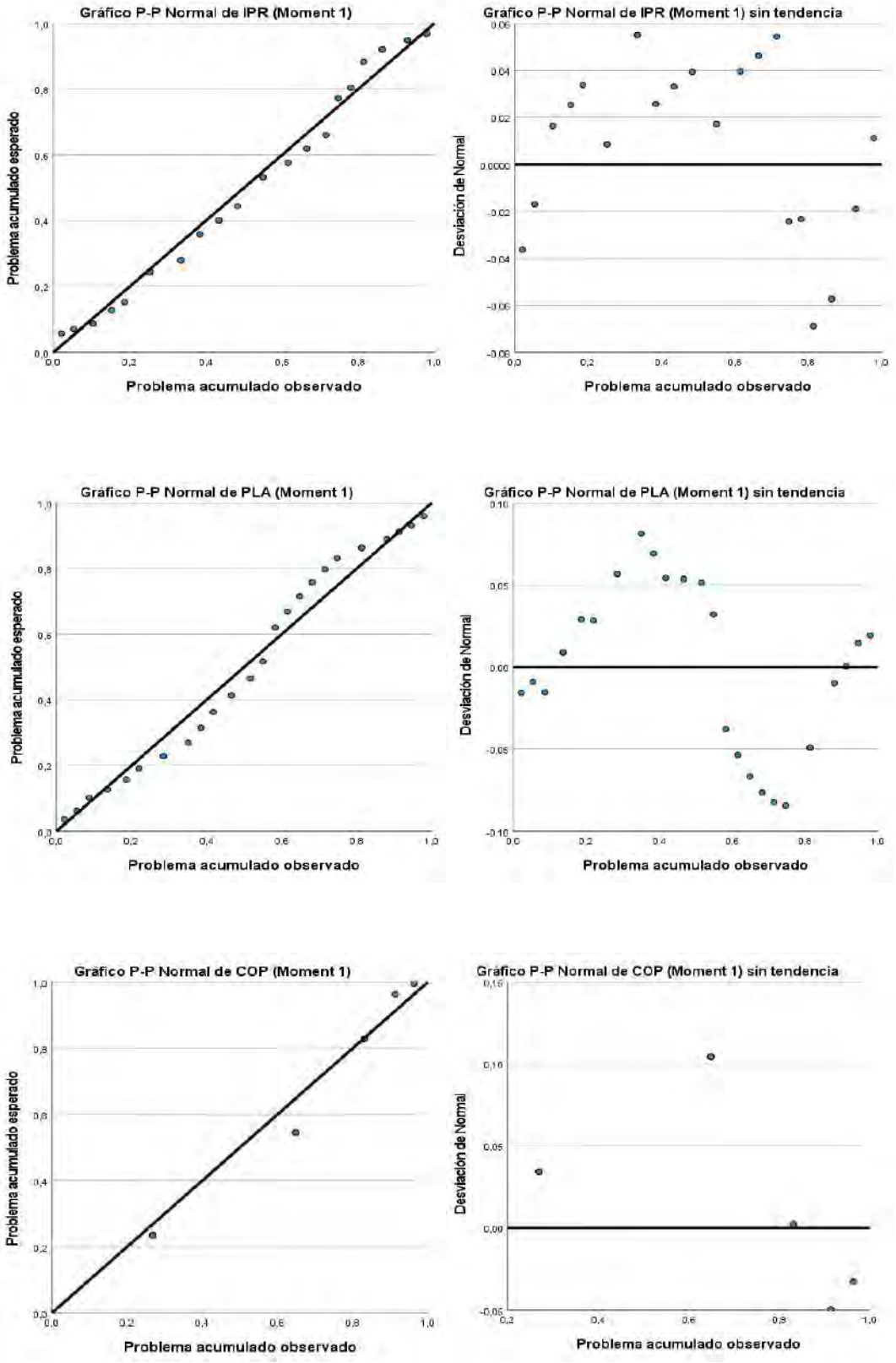
Table C.4

Social Range results (Moment 1)

	Participants	Interpersonal Relationships (ipr)				Play and Leisure (pla)				Coping Skills (cop)				Socialization (SOC)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (EC+)	5 (6 years)	26	5	0:10	64	21	7	1:06	59	1	4	<2:0	21	16
	19 (7 years)	22	3	0:07	60	18	5	1:04	56	1	3	<2:0	21	11
	29 (10 years)	30	2	1:00	67	30	4	2:01	66	1	2	<2:0	21	8
	12 (6 years)	35	7	1:04	70	26	8	1:09	63	1	4	<2:0	21	19
	27 (9 years)	44	6	1:10	76	28	4	1:11	64	1	2	<2:0	21	12
	17 (6 years)	31	6	1:01	68	12	4	0:09	50	1	4	<2:0	21	14
	25 (7 years)	37	7	1:05	72	19	5	1:04	57	1	3	<2:0	21	15
	1 (11 years)	38	4	1:06	72	35	5	2:06	69	2	2	<2:0	28	11
	4 (12 years)	43	5	1:09	76	37	5	2:08	70	5	2	<2:0	38	12
	14 (11 years)	34	3	1:04	70	33	4	2:04	68	2	2	<2:0	28	9
	7 (10 years)	51	7	2:05	81	32	5	2:03	67	2	3	<2:0	28	15
	26 (8 years)	53	9	2:08	82	31	7	2:02	66	5	5	<2:0	38	21
	21 (9 years)	30	3	1:00	67	27	4	1:10	64	2	3	<2:0	28	10
	11 (6 years)	24	4	0:09	62	10	3	0:07	48	1	4	<2:0	21	11
	24 (7 years)	34	6	1:04	70	20	5	1:05	58	3	4	<2:0	32	15
Group B (ARASAAC)	9 (10 years)	49	7	2:02	80	32	5	2:03	67	3	3	<2:0	32	15
	20 (7 years)	30	5	1:00	67	18	5	1:04	56	1	3	<2:0	21	13
	2 (8 years)	39	6	3:01	72	24	4	1:08	61	1	3	<2:0	21	13
	16 (6 years)	40	8	1:07	74	15	5	1:00	54	1	3	<2:0	21	16
	30 (6 years)	31	6	1:01	68	22	7	1:07	60	1	4	<2:0	21	16
	3 (8 years)	33	5	1:03	69	23	4	1:08	61	3	3	<2:0	32	12
	23 (6 years)	23	4	0:08	61	14	5	0:11	53	1	4	<2:0	21	13
	8 (10 years)	49	7	2:02	80	32	5	2:03	67	2	3	<2:0	28	15
	6 (6 years)	24	4	0:09	62	15	5	1:00	54	1	3	<2:0	21	12
	28 (6 years)	27	5	0:10	64	18	6	1:04	56	2	4	<2:0	28	14
	22 (7 years)	37	7	1:05	72	16	4	1:02	55	2	4	<2:0	28	15
	18 (7 years)	39	7	1:06	73	22	5	1:07	60	1	3	<2:0	21	15
	10 (10 years)	37	4	1:05	72	29	3	2:00	65	3	3	<2:0	32	10
	13 (6 years)	47	9	2:00	78	17	6	1:03	56	1	4	<2:0	21	19
	15 (9 years)	51	8	2:05	81	34	7	2:05	68	4	4	<2:0	35	19

Note. RS: Raw Score; V-S: v-Scale Score; AE: Age Equivalent; GSV: Growth Scale Value.

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Note. IPR: Interpersonal Relationships; PLA: Play and Leisure; COP: Coping Skills.

Figure C.4: Normal probability plot of the Social Range (Moment 1)

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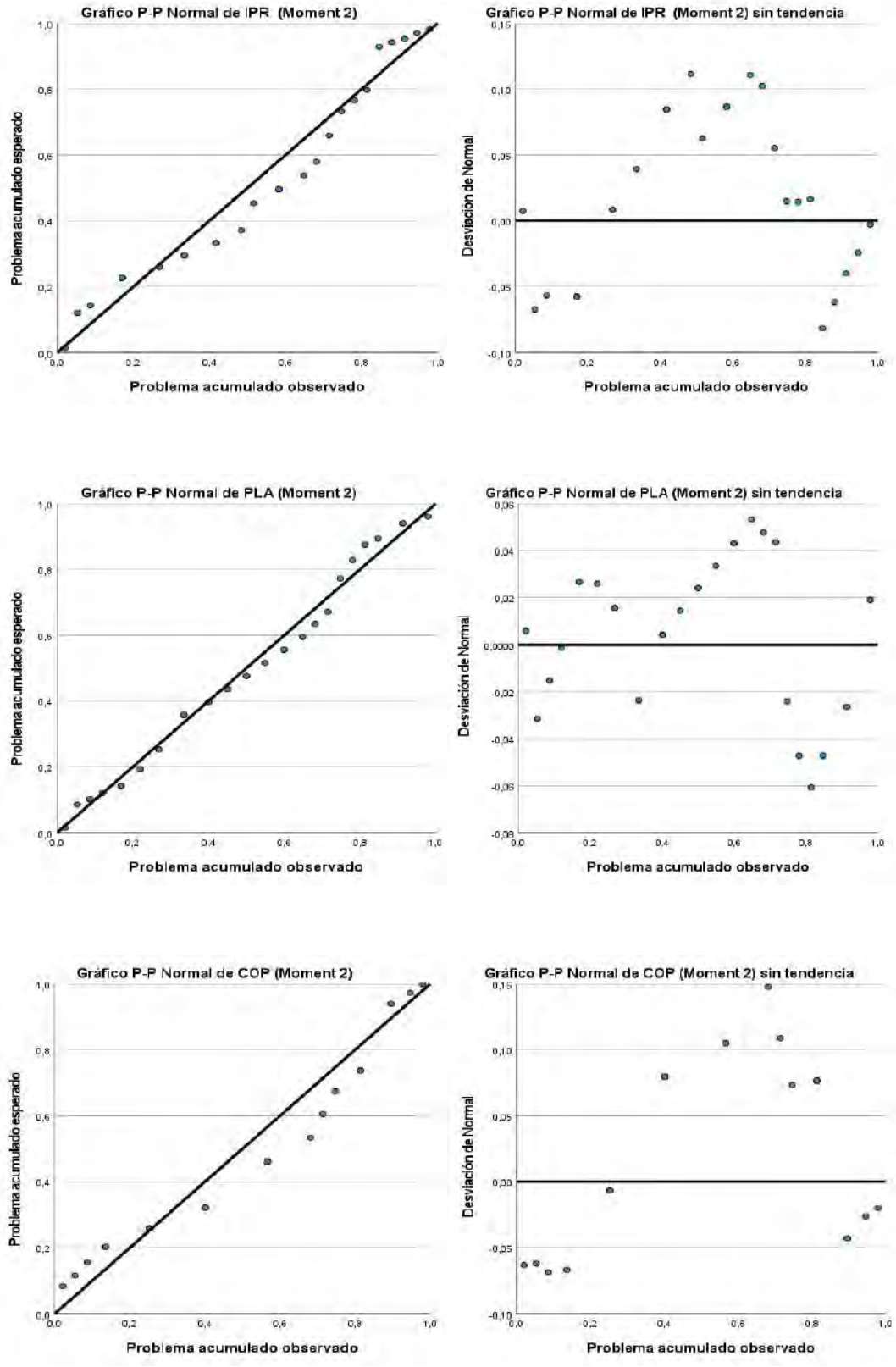
Table C.5

Social Range results (Moment 2)

	Participants	Interpersonal Relationships (ipr)				Play and Leisure (pla)				Coping Skills (cop)				Socialization (SOC)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (EC+)	5 (6 years)	34	7	1:04	70	31	9	2:02	66	5	6	<2:0	38	22
	19 (7 years)	37	7	1:05	75	35	9	2:06	69	5	6	<2:0	38	22
	29 (10 years)	34	3	1:04	70	30	4	2:01	66	2	3	<2:0	28	10
	12 (6 years)	45	9	1:11	77	45	12	3:09	76	6	6	<2:0	40	27
	27 (9 years)	43	6	1:09	76	37	7	2:10	70	9	6	<2:0	45	19
	17 (6 years)	36	7	1:05	71	27	8	1:10	64	4	6	<2:0	35	21
	25 (7 years)	30	5	1:00	67	21	6	1:06	59	6	6	<2:0	40	17
	1 (11 years)	56	8	2:11	84	51	10	4:08	81	8	5	<2:0	43	23
	4 (12 years)	57	8	3:00	85	49	9	4:04	79	26	8	<2:0	62	25
	14 (11 years)	34	3	1:04	70	33	4	2:04	68	6	4	<2:0	40	11
	7 (10 years)	55	8	2:10	84	46	9	3:10	77	11	6	<2:0	47	23
	26 (8 years)	49	8	2:02	80	49	11	4:04	79	8	6	<2:0	43	25
	21 (9 years)	38	5	1:06	72	32	6	2:03	67	8	6	<2:0	43	17
	11 (6 years)	20	3	0:05	59	12	4	0:09	50	1	4	<2:0	21	11
	24 (7 years)	34	6	1:04	70	20	5	1:05	58	12	8	<2:0	49	19
Group B (ARASAAC)	9 (10 years)	41	5	1:08	75	36	6	2:08	70	8	6	<2:0	43	17
	20 (7 years)	42	8	1:08	75	35	9	2:06	69	5	6	<2:0	38	23
	2 (8 years)	48	8	2:01	79	41	9	3:04	73	17	8	<2:0	54	25
	16 (6 years)	36	7	1:05	71	23	7	1:08	61	8	7	<2:0	43	21
	30 (6 years)	41	8	1:08	75	31	9	2:02	66	17	6	<2:0	54	23
	3 (8 years)	41	7	1:08	75	34	8	2:05	68	10	7	<2:0	46	22
	23 (6 years)	40	8	1:07	74	33	9	2:04	68	12	8	<2:0	49	25
	8 (10 years)	59	9	3:03	87	49	10	4:04	79	19	8	<2:0	56	27
	6 (6 years)	37	7	1:05	72	22	7	1:07	60	5	6	<2:0	38	20
	28 (6 years)	31	6	1:01	68	23	7	1:08	61	6	6	<2:0	40	19
	22 (7 years)	37	7	1:05	72	30	8	2:01	66	5	6	<2:0	38	21
	18 (7 years)	35	6	1:04	70	25	6	1:09	62	4	5	<2:0	35	17
	10 (10 years)	61	9	3:06	88	38	7	3:00	71	12	6	<2:0	49	22
	13 (6 years)	35	7	1:04	70	27	8	1:10	64	3	5	<2:0	32	20
	15 (9 years)	47	7	2:00	78	43	9	3:06	74	8	6	<2:0	43	22

Note. RS: Raw Score; V-S: v-Scale Score; AE: Age Equivalent; GSV: Growth Scale Value.

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Note. IPR: Interpersonal Relationships; PLA: Play and Leisure; COP: Coping Skills.

Figure C.5: Normal probability plot of the Social Range (Moment 2)

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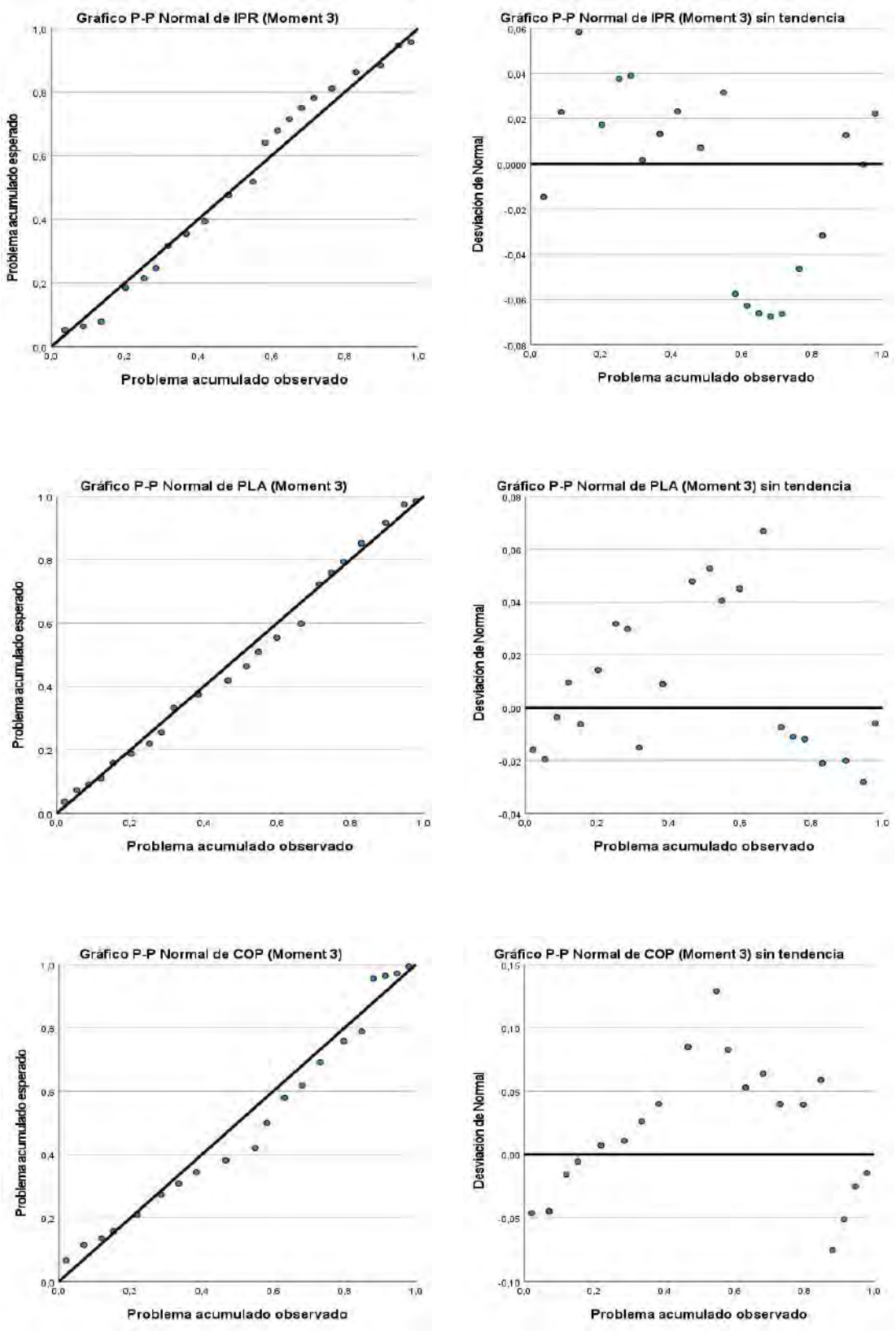
Table C.6

Social Range results (Moment 3)

	Participants	Interpersonal Relationships (ipr)				Play and Leisure (pla)				Coping Skills (cop)				Socialization (SOC)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (EC+)	5 (6 years)	47	9	2:00	78	40	11	3:02	72	22	10	<2:0	59	30
	19 (7 years)	60	11	3:04	87	41	10	3:04	73	17	9	<2:0	54	30
	29 (10 years)	72	12	5:06	97	53	11	5:00	82	45	12	5:00	78	35
	12 (6 years)	40	8	1:07	74	31	9	2:02	66	16	9	<2:0	53	26
	27 (9 years)	59	9	3:03	87	49	10	4:04	79	25	9	<2:0	61	28
	17 (6 years)	52	10	2:06	82	42	11	3:05	74	22	10	<2:0	59	31
	25 (7 years)	55	10	2:10	84	41	10	3:04	73	23	10	<2:0	60	30
	1 (11 years)	63	9	3:08	89	61	13	8:06	91	25	8	<2:0	61	30
	4 (12 years)	67	10	4:02	92	63	14	9:08	94	15	6	<2:0	52	30
	14 (11 years)	66	10	4:00	92	53	10	5:00	82	38	10	3:06	72	30
	7 (10 years)	66	10	4:00	92	50	10	4:06	80	27	9	<2:0	63	29
	26 (8 years)	55	9	2:10	84	46	10	3:10	77	27	10	<2:0	63	29
	21 (9 years)	52	8	2:06	82	36	9	2:08	70	18	8	<2:0	55	25
	11 (6 years)	40	8	1:07	74	32	9	2:03	67	12	8	<2:0	49	27
	24 (7 years)	51	9	2:05	81	37	9	2:10	70	10	7	<2:0	46	25
Group B (ARASAAC)	9 (10 years)	64	10	3:10	90	51	10	4:08	81	39	11	3:09	73	25
	20 (7 years)	61	11	3:06	87	45	11	3:09	76	12	8	<2:0	49	31
	2 (8 years)	67	12	4:02	92	56	13	6:00	85	28	10	2:00	64	35
	16 (6 years)	41	8	1:08	75	33	9	2:04	68	8	7	<2:0	43	24
	30 (6 years)	42	8	1:08	75	28	8	1:11	64	12	8	<2:0	49	24
	3 (8 years)	71	13	5:00	96	44	10	3:08	75	20	9	<2:0	57	32
	23 (6 years)	53	10	2:08	82	41	11	3:04	73	17	9	<2:0	54	30
	8 (10 years)	64	10	3:10	90	56	12	6:00	85	37	10	3:04	71	32
	6 (6 years)	42	8	1:08	75	35	9	2:06	69	9	7	<2:0	45	31
	28 (6 years)	48	9	2:01	79	38	10	3:00	71	5	6	<2:0	38	25
	22 (7 years)	49	9	2:02	80	36	9	2:08	70	8	7	<2:0	43	28
	18 (7 years)	56	10	2:11	84	43	10	3:06	74	14	8	<2:0	51	28
	10 (10 years)	55	8	2:10	84	46	9	3:10	77	15	7	<2:0	52	24
	13 (6 years)	47	9	2:00	78	42	11	3:05	74	17	9	<2:0	54	29
	15 (9 years)	62	10	3:07	89	45	9	3:09	76	17	8	<2:0	54	27

Note. RS: Raw Score; V-S: v-Scale Score; AE: Age Equivalent; GSV: Growth Scale Value.

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Note. IPR: Interpersonal Relationships; PLA: Play and Leisure; COP: Coping Skills.

Figure C.6: Normal probability plot of the Social Range (Moment 3)

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Table C.7

Behavioral Range results (Moment 1)

	Participants	Section A	Section B	Section C	Problematic behaviors
Group A (EC+)	5 (6 years)	7	8	10	25
	19 (7 years)	11	9	15	35
	29 (10 years)	9	9	16	34
	12 (6 years)	7	3	11	21
	27 (9 years)	8	9	14	31
	17 (6 years)	11	10	9	30
	25 (7 years)	10	9	14	33
	1 (11 years)	6	9	13	28
	4 (12 years)	3	7	10	20
	14 (11 years)	9	8	15	32
	7 (10 years)	4	8	14	26
	26 (8 years)	11	7	13	31
	21 (9 years)	9	5	11	25
	11 (6 years)	5	3	11	19
	24 (7 years)	6	6	9	21
Group B (ARASAAC)	9 (10 years)	10	5	10	25
	20 (7 years)	11	3	13	27
	2 (8 years)	6	9	15	30
	16 (6 years)	10	7	14	31
	30 (6 years)	9	8	11	28
	3 (8 years)	8	6	14	28
	23 (6 years)	8	7	16	31
	8 (10 years)	9	7	13	29
	6 (6 years)	10	8	13	31
	28 (6 years)	11	8	12	31
	22 (7 years)	9	9	12	30
	18 (7 years)	4	7	14	25
	10 (10 years)	7	7	11	25
	13 (6 years)	11	9	12	32
	15 (9 years)	10	8	13	31

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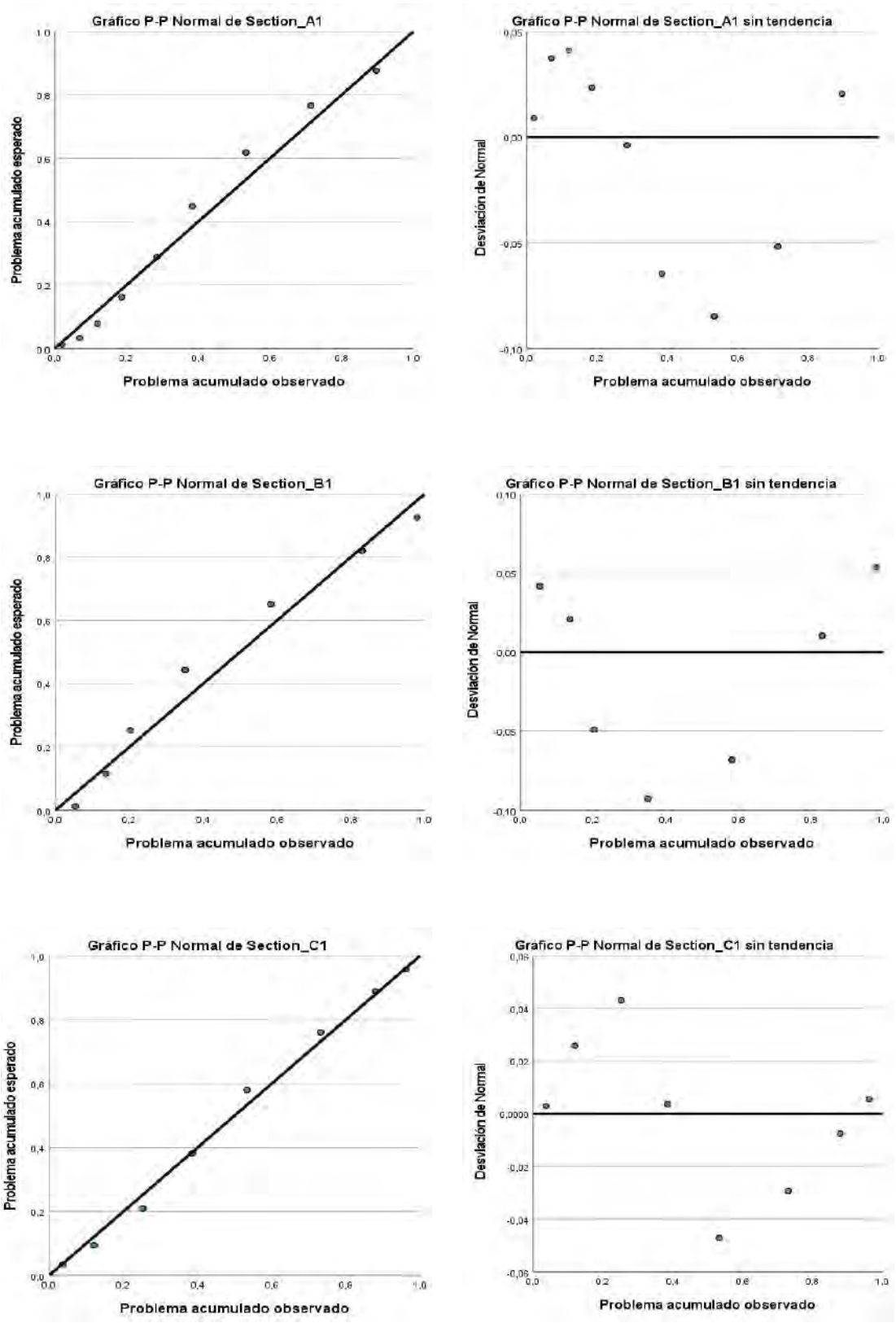


Figure C.7: Normal probability plot of the Behavioral Range (Moment 1)

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Table C.8

Behavioral Range results (Moment 2)

	Participants	Section A	Section B	Section C	Problematic behaviors
Group A (EC+)	5 (6 years)	5	4	6	15
	19 (7 years)	10	9	7	26
	29 (10 years)	9	9	10	28
	12 (6 years)	5	3	5	13
	27 (9 years)	10	9	14	33
	17 (6 years)	9	10	9	28
	25 (7 years)	10	9	8	27
	1 (11 years)	4	6	7	17
	4 (12 years)	3	5	8	16
	14 (11 years)	4	5	10	19
	7 (10 years)	4	6	7	17
	26 (8 years)	11	7	10	28
	21 (9 years)	5	2	5	12
	11 (6 years)	5	4	8	17
	24 (7 years)	6	5	7	18
Group B (ARASAAC)	9 (10 years)	7	5	6	18
	20 (7 years)	10	3	11	24
	2 (8 years)	6	6	6	18
	16 (6 years)	10	8	14	32
	30 (6 years)	5	4	8	17
	3 (8 years)	8	5	8	21
	23 (6 years)	8	7	10	25
	8 (10 years)	7	4	7	18
	6 (6 years)	9	6	5	20
	28 (6 years)	4	2	9	15
	22 (7 years)	6	7	5	18
	18 (7 years)	4	7	10	21
	10 (10 years)	7	7	12	26
	13 (6 years)	8	9	11	28
	15 (9 years)	7	8	8	23

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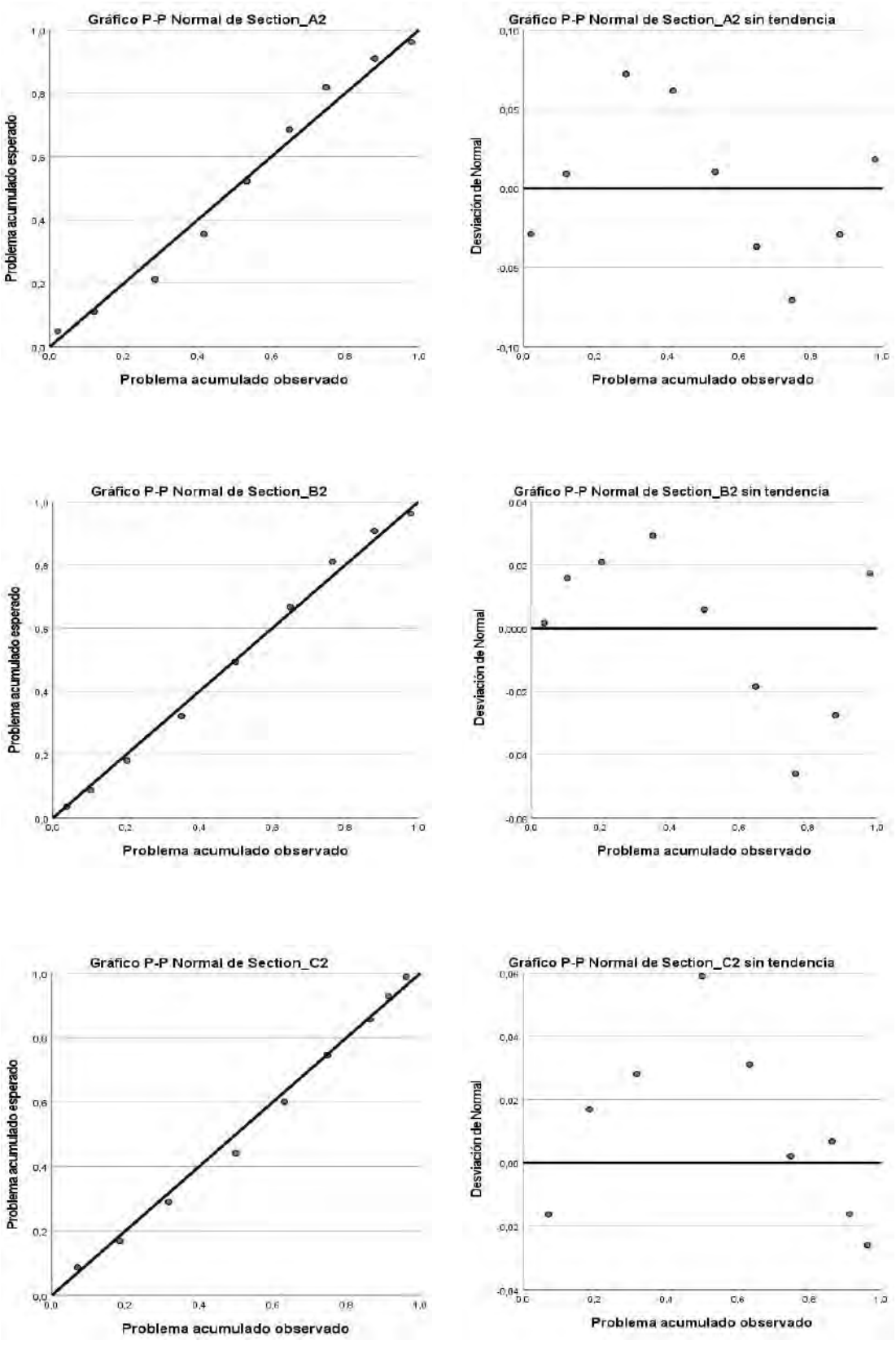


Figure C.8: Normal probability plot of the Behavioral Range (Moment 2)

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Table C.9

Behavioral Range results (Moment 3)

	Participants	Section A	Section B	Section C	Problematic behaviors
Group A (EC+)	5 (6 years)	3	1	3	6
	19 (7 years)	2	3	1	6
	29 (10 years)	2	5	4	11
	12 (6 years)	2	1	2	5
	27 (9 years)	5	1	4	10
	17 (6 years)	1	7	2	10
	25 (7 years)	5	2	8	15
	1 (11 years)	1	3	2	6
	4 (12 years)	2	5	3	10
	14 (11 years)	3	4	1	8
	7 (10 years)	3	3	6	12
	26 (8 years)	2	6	4	12
	21 (9 years)	3	2	1	6
	11 (6 years)	5	2	3	10
	24 (7 years)	2	3	2	7
Group B (ARASAAC)	9 (10 years)	6	3	2	11
	20 (7 years)	4	3	9	16
	2 (8 years)	6	4	6	16
	16 (6 years)	6	4	10	20
	30 (6 years)	5	2	8	15
	3 (8 years)	8	3	5	16
	23 (6 years)	6	6	10	22
	8 (10 years)	4	2	2	8
	6 (6 years)	9	4	5	18
	28 (6 years)	3	2	6	11
	22 (7 years)	6	3	2	11
	18 (7 years)	1	5	4	10
	10 (10 years)	2	7	4	13
	13 (6 years)	4	5	6	15
	15 (9 years)	4	8	2	14

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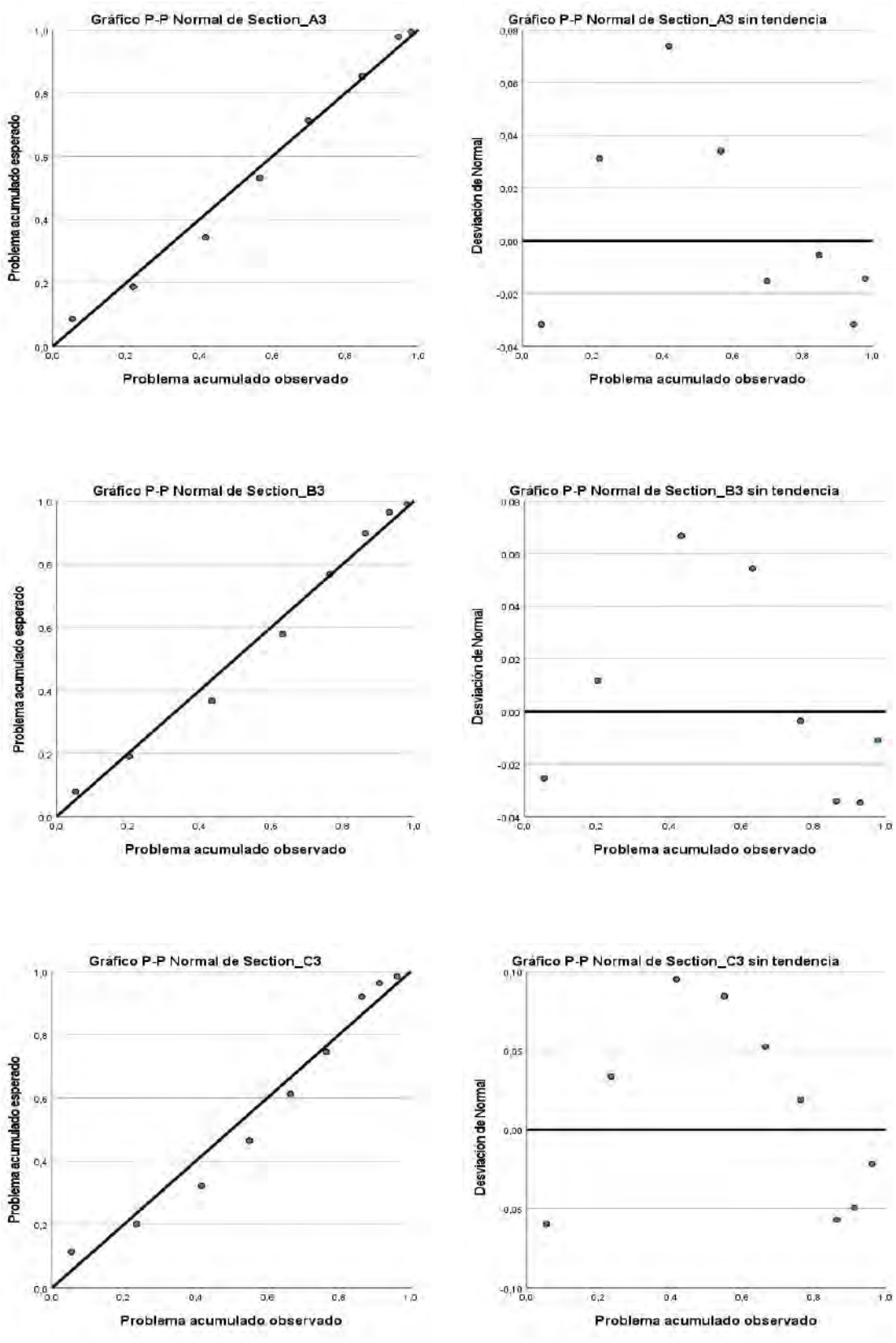


Figure C.9: Normal probability plot of the Behavioral Range (Moment 3

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APPENDIX D

Results of Chapter 6

The findings obtained from the Vineland-3 scale in the study outlined in Chapter 6 are presented below. This research involved 40 participants divided in Group A (ARASAAC) and Group B (Commercial pictograms).

The Vineland-3 scale was utilized to determine the Raw Score for each participant. After calculating this score, it was converted into the v-Scale Score using the test's standardized norms. Additionally, the AE and GSV were derived, with the GSV serving as an indicator of a participant's developmental progress over time. To ensure the validity of the statistical analyses conducted in this chapter, the normal probability of the Raw Scores was examined. This assessment was crucial for selecting the most suitable statistical tests based on the data distribution.

The evaluation focused on multiple domains: receptive, expressive, and written communication for the Communicative Range; interpersonal relationships, play and leisure, and coping skills for the Social Range; and disruptive behavior categories for the Behavioral Range.

Throughout the study, participants' chronological age was carefully considered, as the normative data is age-dependent. Given that the study spanned 16 weeks, natural developmental changes were expected. Consequently, the time factor was accounted for in the three assessment moments, ensuring that the corresponding norms were applied accurately at each stage.

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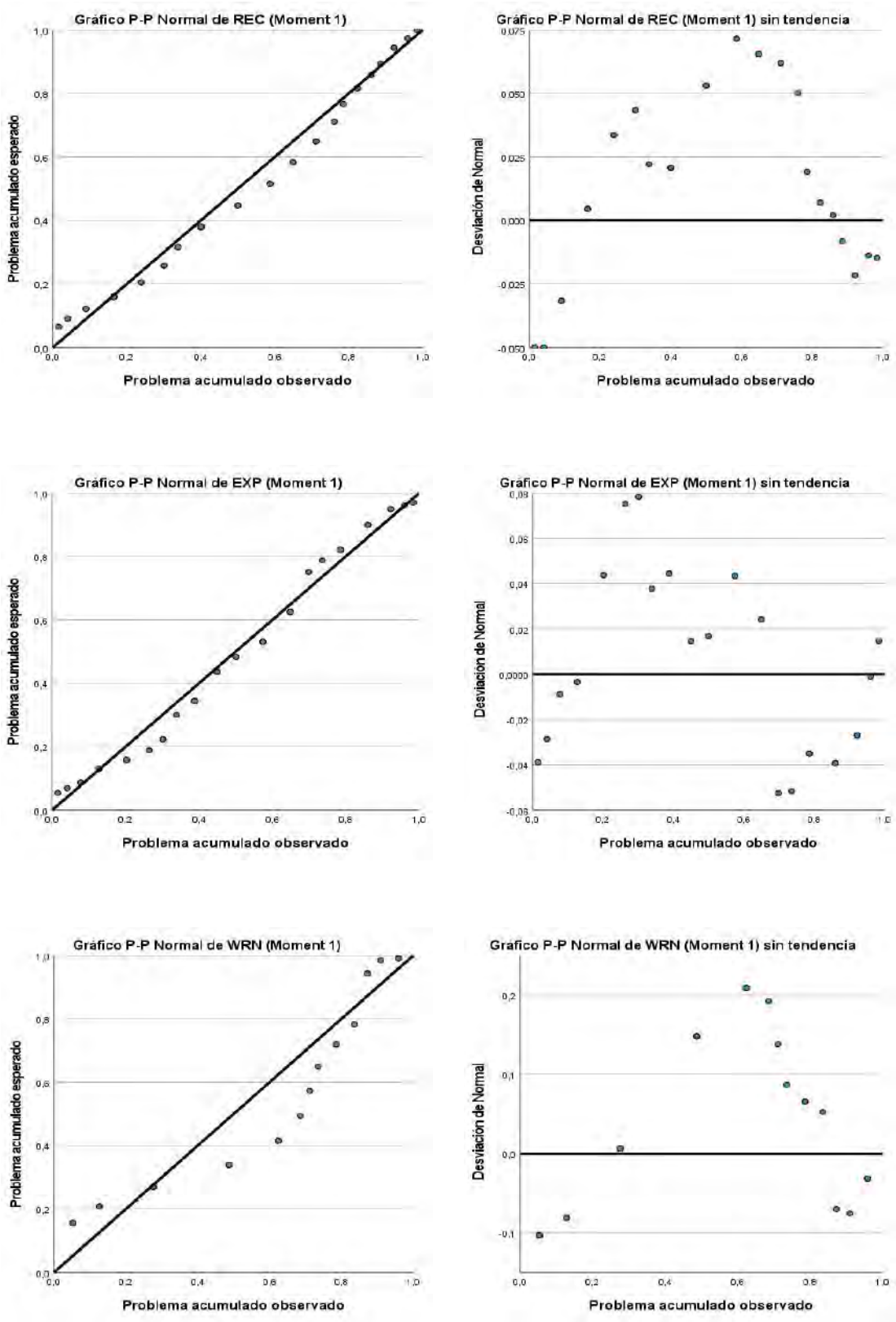
Table D.1

Communicative Range results (Moment 1)

	Participants	Receptive (rec)				Expressive (exp)				Written (wrn)				Communication (COM)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (ARASAAC)	32 (6 years)	42	6	1:07	85	56	4	2:00	80	3	2	<3:0	30	12
	51 (7 years)	44	5	1:08	87	62	3	2:04	83	4	2	<3:0	32	10
	42 (6 years)	46	7	1:09	88	59	4	2:02	81	4	3	<3:0	32	14
	31 (8 years)	49	6	1:10	91	73	5	2:10	88	9	3	3:00	42	14
	39 (6 years)	41	5	1:06	84	57	3	2:01	80	4	3	<3:0	32	11
	38 (8 years)	51	6	1:11	93	71	4	2:09	87	9	3	3:00	42	13
	9 (10 years)	55	6	2:03	96	79	3	3:03	92	17	2	3:10	54	11
	20 (7 years)	43	5	1:07	86	62	3	2:04	83	4	2	<3:0	32	10
	2 (8 years)	50	6	1:11	92	73	4	2:10	88	10	3	3:01	44	13
	16 (6 years)	42	5	1:07	85	57	3	2:01	80	3	2	<3:0	30	10
	30 (6 years)	41	5	1:06	84	54	3	1:11	79	3	2	<3:0	30	10
	3 (8 years)	50	6	1:11	92	72	4	2:10	88	8	2	<3:0	41	12
	23 (6 years)	40	5	1:06	84	56	4	2:00	80	3	2	<3:0	30	11
	8 (10 years)	57	7	2:05	98	81	5	3:05	94	18	3	3:11	55	15
	6 (6 years)	42	5	1:07	85	57	3	2:01	80	3	2	<3:0	30	10
	28 (6 years)	41	5	1:06	84	58	3	2:22	81	3	2	<3:0	30	10
	22 (7 years)	43	5	1:07	86	66	5	2:06	85	5	3	<3:0	35	13
	18 (7 years)	47	6	1:09	89	68	4	2:07	86	7	3	<3:0	39	13
	10 (10 years)	59	8	2:07	100	80	4	3:04	93	18	3	3:11	55	15
	13 (6 years)	43	6	1:07	86	52	2	1:11	78	3	2	<3:0	30	10
	15 (9 years)	53	6	2:01	94	76	4	3:01	90	14	3	3:06	50	13
Group B (Commercially pictograms)	37 (7 years)	48	7	1:10	90	65	4	2:05	84	4	2	<3:0	32	13
	54 (7 years)	44	5	1:08	87	66	4	2:06	85	2	1	<3:0	26	10
	36 (10 years)	66	6	3:06	108	79	3	3:03	92	18	3	3:11	55	12
	46 (6 years)	48	8	1:10	90	59	5	2:02	81	3	2	<3:0	30	15
	45 (9 years)	53	6	2:01	94	76	4	3:01	90	14	3	3:06	50	13
	55 (6 years)	47	8	1:09	89	53	4	1:11	78	1	1	<3:0	20	13
	49 (7 years)	46	6	1:09	88	66	4	2:06	85	5	2	<3:0	35	12
	35 (6 years)	50	8	1:11	92	61	4	2:03	82	1	1	<3:0	20	13
	52 (8 years)	49	6	1:10	91	73	5	2:10	88	3	1	<3:0	30	12
	53 (7 years)	46	6	1:09	88	62	3	2:04	83	4	2	<3:0	32	11
	34 (7 years)	57	9	2:05	98	66	4	2:06	85	1	1	<3:0	20	14
	47 (7 years)	45	6	1:08	88	65	4	2:05	84	5	3	<3:0	35	13
	50 (8 years)	47	5	1:09	89	71	4	2:09	87	6	1	<3:0	37	10
	43 (7 years)	47	6	1:09	89	64	3	2:04	84	5	2	<3:0	35	11
	48 (9 years)	54	6	2:02	95	76	4	3:01	90	9	1	3:00	42	11
	33 (7 years)	48	7	1:10	90	64	4	2:04	84	4	2	<3:0	32	13
	40 (7 years)	52	8	2:00	94	68	5	2:07	86	3	1	<3:0	30	14
	44 (6 years)	46	7	1:09	88	57	4	2:01	80	1	1	<3:0	20	12
	41 (6 years)	39	5	1:05	83	54	4	1:11	79	2	2	<3:0	26	11

Note. *RS*: *Raw Score; V-S: v-Scale Score; AE*: *Age Equivalent*; GSV*:* Growth Scale Value.

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Note. REC: Receptive; EXP: Expressive; WRN: Written.

Figure D.1: Normal probability plot of the Communicative Range (Moment 1)

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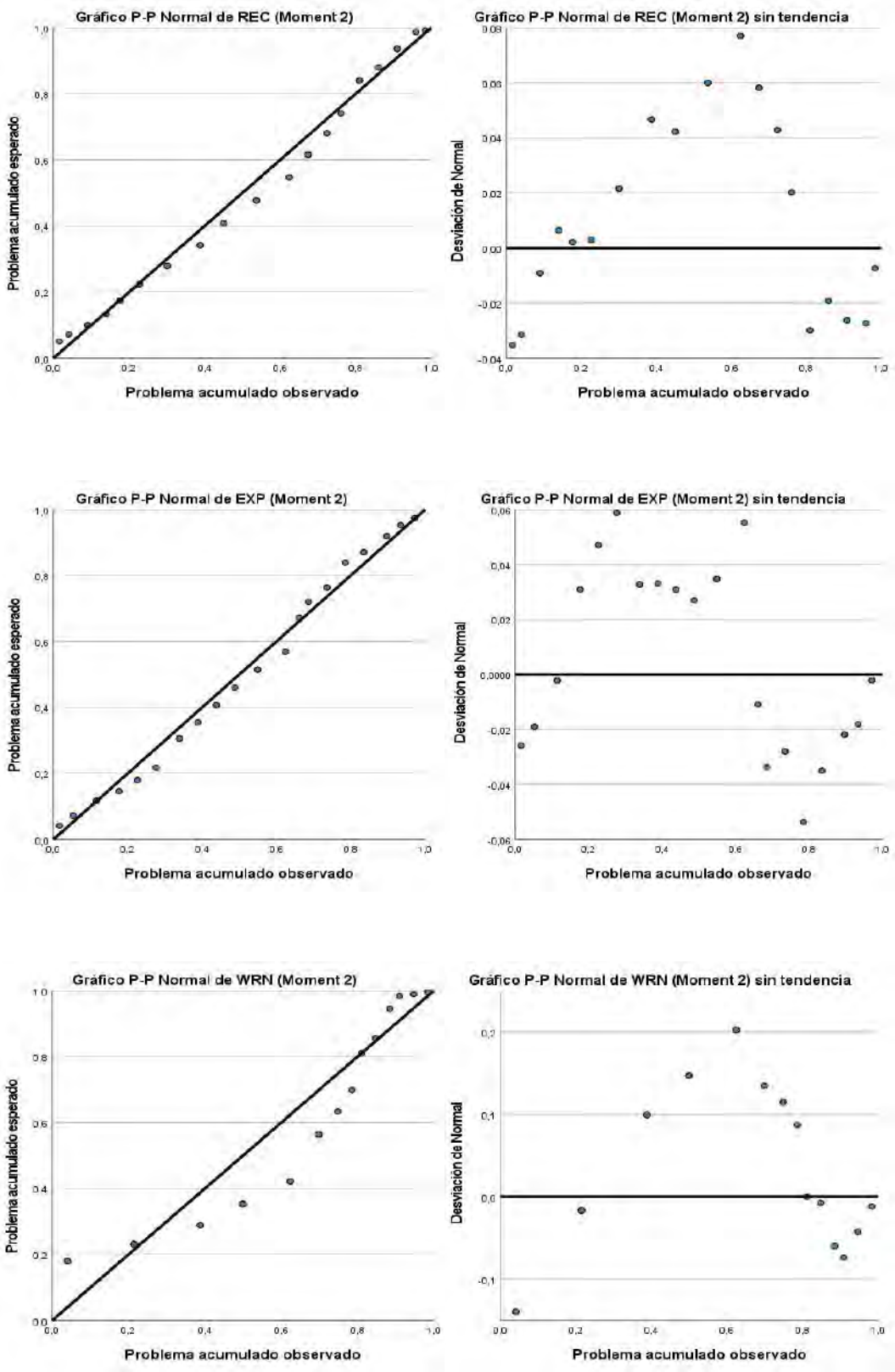
Table D.2

Communicative Range results (Moment 2)

	Participants	Receptive (rec)				Expressive (exp)				Written (wrn)				Communication (COM)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (ARASAAC)	32 (6 years)	53	9	2:01	94	61	5	2:03	82	4	3	<3:0	32	17
	51 (7 years)	60	10	2:08	101	70	6	2:08	87	6	3	<3:0	37	19
	42 (6 years)	50	8	1:11	92	63	5	2:04	83	4	3	<3:0	32	16
	31 (8 years)	59	9	2:07	100	78	7	3:02	92	11	4	3:02	46	20
	39 (6 years)	54	9	2:02	95	66	6	2:06	85	4	3	<3:0	32	18
	38 (8 years)	56	8	2:04	97	75	5	3:00	90	10	3	3:01	44	16
	9 (10 years)	62	9	2:10	103	82	6	3:06	94	21	4	4:02	58	19
	20 (7 years)	51	8	1:11	93	67	5	2:06	85	5	3	<3:0	35	16
	2 (8 years)	59	9	2:07	100	77	6	3:02	91	13	4	3:04	48	19
	16 (6 years)	46	7	1:09	88	61	5	2:03	82	4	3	<3:0	32	15
	30 (6 years)	47	7	1:09	89	62	6	2:04	83	3	2	<3:0	30	15
	3 (8 years)	55	8	2:03	96	75	6	3:00	90	10	4	3:01	44	18
	23 (6 years)	44	6	1:08	87	62	6	2:04	83	4	3	<3:0	32	15
	8 (10 years)	66	10	3:06	108	84	7	3:08	96	21	5	4:02	58	22
	6 (6 years)	46	7	1:09	88	64	6	2:04	84	4	3	<3:0	32	16
	28 (6 years)	46	7	1:09	88	61	5	2:03	82	4	3	<3:0	32	15
	22 (7 years)	51	8	1:11	93	68	6	2:07	86	6	4	<3:0	37	18
	18 (7 years)	53	8	2:01	94	74	7	2:11	89	7	3	<3:0	39	18
	10 (10 years)	67	10	3:08	109	84	7	3:08	96	23	5	4:04	60	22
	13 (6 years)	49	8	1:10	91	59	4	2:02	81	4	3	<3:0	32	15
	15 (9 years)	62	9	2:10	103	80	6	3:04	93	17	4	3:10	54	19
Group B (Commercially pictograms)	37 (7 years)	57	9	2:05	98	68	5	2:07	86	5	2	<3:0	35	16
	54 (7 years)	50	7	1:11	92	70	6	2:08	87	5	2	<3:0	35	15
	36 (10 years)	55	6	2:03	96	80	4	3:04	93	20	4	4:01	57	14
	46 (6 years)	50	8	1:11	92	64	5	2:04	84	4	3	<3:0	32	16
	45 (9 years)	62	9	2:10	103	78	4	3:02	92	14	2	3:06	50	15
	55 (6 years)	45	7	1:08	88	59	5	2:02	81	4	3	<3:0	32	15
	49 (7 years)	53	8	2:01	94	68	4	2:07	86	6	2	<3:0	37	14
	35 (7 years)	48	7	1:10	90	66	5	2:06	85	4	2	<3:0	32	14
	52 (8 years)	51	6	1:11	93	75	5	3:00	90	9	2	3:00	42	13
	53 (7 years)	49	7	1:10	91	70	6	2:08	87	6	3	<3:0	37	16
	34 (7 years)	54	8	2:02	95	71	5	2:09	87	7	2	<3:0	39	15
	47 (7 years)	50	7	1:11	92	66	4	2:06	85	6	3	<3:0	37	14
	50 (8 years)	59	9	2:07	100	73	4	2:10	88	9	2	3:00	42	15
	43 (7 years)	53	8	2:01	94	70	5	2:08	87	7	3	<3:0	39	16
	48 (9 years)	56	7	2:04	97	78	4	3:02	92	14	2	3:06	50	13
	33 (7 years)	53	8	2:01	94	69	5	2:08	86	6	3	<3:0	37	16
	40 (7 years)	52	7	2:00	94	71	5	2:09	87	7	2	<3:0	39	14
	44 (6 years)	52	8	2:00	94	63	5	2:04	84	3	2	<3:0	30	15
	41 (6 years)	48	8	1:10	90	57	4	2:01	80	3	2	<3:0	30	14

Note. *RS*: *Raw Score; V-S: v-Scale Score; AE*: *Age Equivalent*; GSV*:* Growth Scale Value.

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Note. REC: Receptive; EXP: Expressive; WRN: Written

Figure D.2: Normal probability plot of the Communicative Range (Moment 2)

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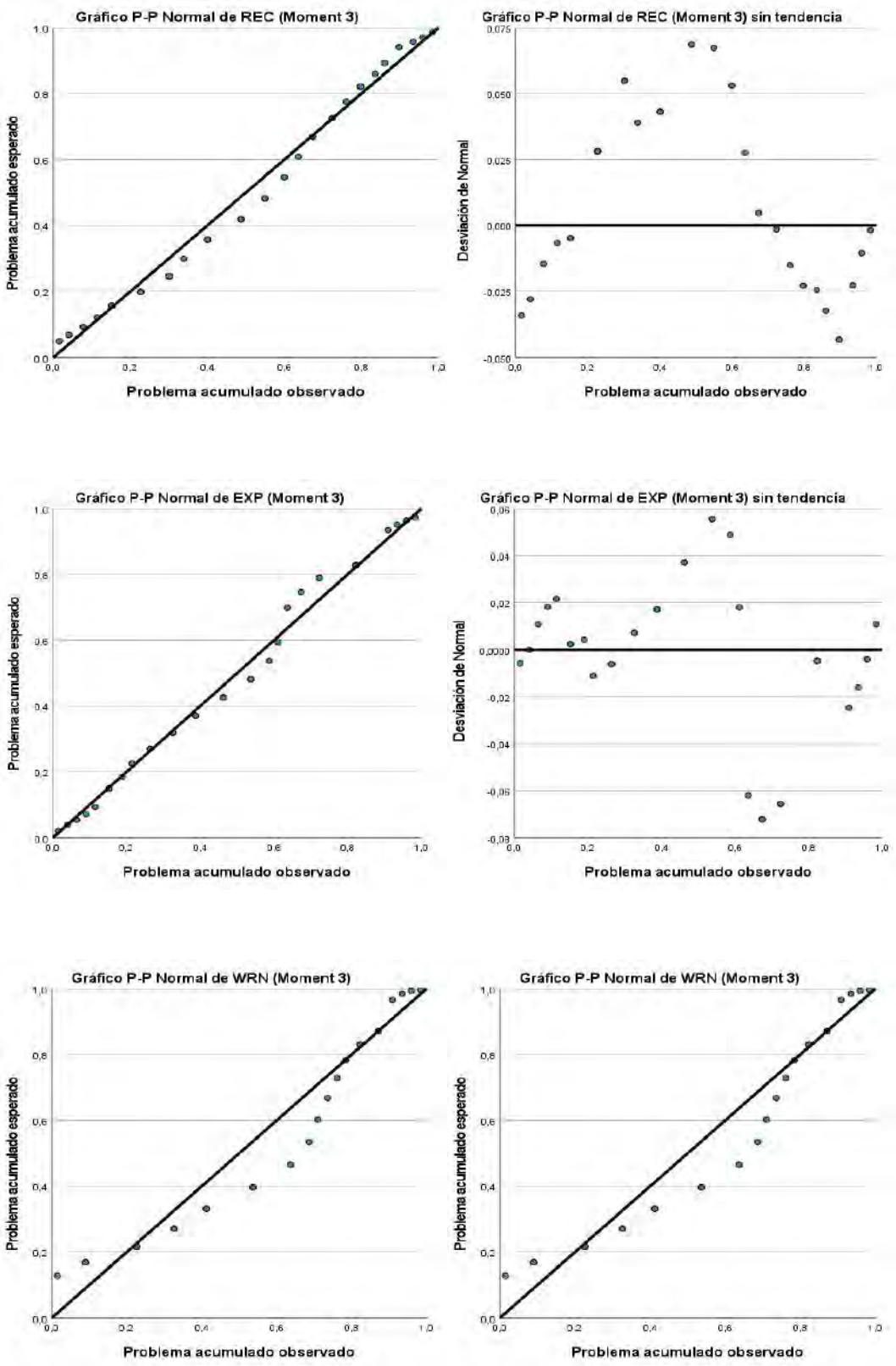
Table D.3

Communicative Range results (Moment 3)

	Participants	Receptive (rec)				Expressive (exp)				Written (wrn)				Communication (COM)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (ARASAAC)	32 (6 years)	65	12	3:04	107	70	7	2:08	87	5	4	<3:0	35	23
	51 (7 years)	64	11	3:02	105	74	7	2:11	89	9	4	3:00	42	22
	42 (7 years)	69	13	4:00	112	71	7	2:09	87	8	5	<3:0	41	25
	31 (8 years)	73	14	6:03	119	81	8	3:05	94	15	5	3:07	51	27
	39 (6 years)	60	11	2:08	101	63	7	2:04	83	3	3	<3:0	30	21
	38 (8 years)	70	12	4:04	114	79	7	3:03	92	16	5	3:08	52	24
	9 (10 years)	67	10	3:08	109	85	8	3:10	97	25	6	4:06	62	24
	20 (7 years)	56	9	2:04	97	72	7	2:10	88	7	4	<3:0	39	20
	2 (8 years)	63	10	3:00	104	81	8	3:05	94	13	4	3:04	48	22
	16 (6 years)	65	12	3:04	107	80	10	3:04	93	9	6	3:00	42	28
	30 (6 years)	58	10	2:06	99	72	8	2:10	88	5	4	<3:0	35	22
	3 (8 years)	59	9	2:07	100	81	8	3:05	94	11	4	3:02	46	21
	23 (6 years)	49	8	1:10	91	67	7	2:06	85	4	3	<3:0	32	18
	8 (10 years)	71	11	4:08	115	88	9	4:02	100	24	5	4:05	61	25
	6 (6 years)	54	9	2:02	95	69	7	2:08	86	5	4	<3:0	35	20
	28 (6 years)	58	10	2:06	99	72	8	2:10	88	6	4	<3:0	37	22
	22 (7 years)	57	9	2:05	98	75	8	3:00	90	7	4	<3:0	39	21
	18 (7 years)	57	9	2:05	98	81	9	3:05	94	8	3	<3:0	41	21
	10 (10 years)	69	11	4:00	112	87	9	4:00	99	22	5	4:03	59	25
	13 (6 years)	62	11	2:10	103	81	10	3:05	94	5	4	<3:0	35	25
	15 (9 years)	61	9	2:09	102	86	9	3:11	98	16	4	3:08	52	22
Group B (Commercially pictograms)	37 (7 years)	54	8	2:02	95	70	5	2:08	87	7	3	<3:0	39	16
	54 (7 years)	57	9	2:05	98	74	7	2:11	89	6	2	<3:0	37	18
	36 (10 years)	57	7	2:05	98	81	5	3:05	94	20	4	4:01	57	16
	46 (6 years)	52	8	2:00	94	64	5	2:04	84	4	3	<3:0	32	16
	45 (9 years)	66	10	3:06	108	80	6	3:04	93	15	3	3:07	51	19
	55 (6 years)	50	8	1:11	92	65	6	2:05	84	4	3	<3:0	32	17
	49 (7 years)	58	9	2:06	99	60	4	2:02	82	8	3	<3:0	41	16
	35 (7 years)	54	8	2:02	95	70	6	2:08	87	5	2	<3:0	35	16
	52 (8 years)	51	6	1:11	93	78	6	3:02	92	12	3	3:03	47	15
	53 (7 years)	53	8	2:01	94	73	6	2:10	88	7	3	<3:0	39	17
	34 (7 years)	60	9	2:08	82	73	6	2:10	88	4	1	<3:0	32	16
	47 (7 years)	51	7	1:11	93	68	4	2:07	86	8	4	<3:0	41	15
	50 (8 years)	63	10	3:00	104	76	5	3:01	90	10	2	3:01	44	17
	43 (7 years)	55	8	2:03	96	74	6	2:11	89	9	4	3:00	42	18
	48 (9 years)	62	9	2:10	103	79	5	3:03	92	14	2	3:06	50	16
	33 (7 years)	53	8	2:01	94	71	5	2:09	87	8	4	<3:0	41	17
	40 (7 years)	54	8	2:02	95	73	6	2:10	88	7	2	<3:0	39	16
	44 (6 years)	55	9	2:03	96	67	6	2:06	85	5	4	<3:0	35	19
	41 (6 years)	59	10	2:07	100	62	5	2:04	83	4	3	<3:0	30	18

Note. *RS*: *Raw Score; V-S: v-Scale Score; AE*: *Age Equivalent*; GSV*:* Growth Scale Value.

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Note. REC: Receptive; EXP: Expressive; WRN: Written.

Figure D.3: Normal probability plot of the Communicative Range (Moment 3)

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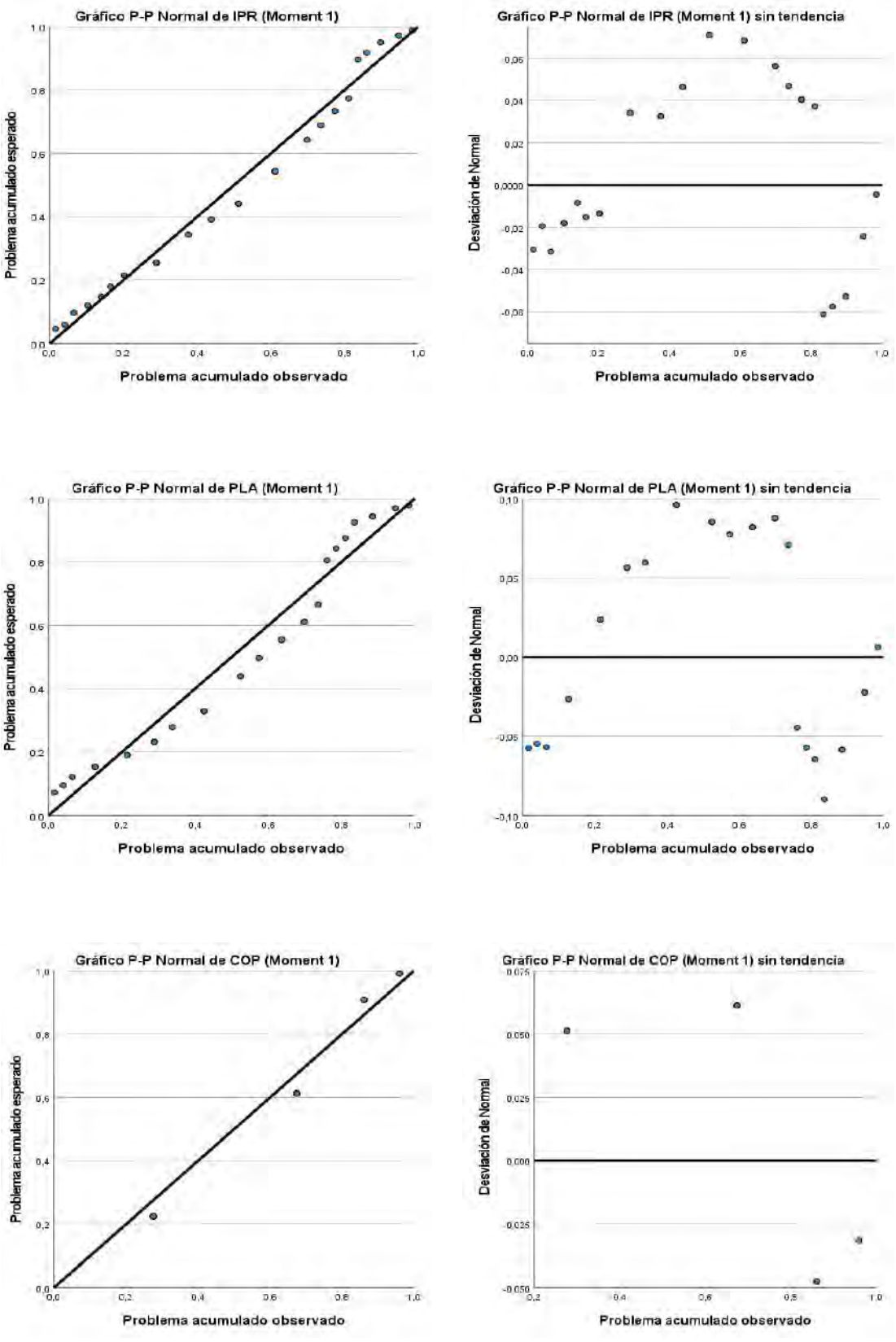
Table D.4

Social Range results (Moment 1)

	Participants	Interpersonal Relationships (ipr)				Play and Leisure (pla)				Coping Skills (cop)				Socialization (SOC)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (ARASAAC)	32 (6 years)	35	7	1:04	70	18	6	1:04	56	1	4	<2:0	21	17
	51 (7 years)	42	8	1:08	75	18	5	1:04	56	2	4	<2:0	28	17
	42 (6 years)	31	7	1:01	68	14	4	0:11	53	1	3	<2:0	21	14
	31 (8 years)	37	6	1:05	72	34	8	2:05	68	2	4	<2:0	28	18
	39 (6 years)	31	6	1:01	68	15	5	1:00	54	1	3	<2:0	21	14
	38 (8 years)	41	7	1:08	75	23	4	1:08	61	2	4	<2:0	28	15
	9 (10 years)	49	7	2:02	80	32	5	2:03	67	3	3	<2:0	32	15
	20 (7 years)	30	5	1:00	67	18	5	1:04	56	1	3	<2:0	21	13
	2 (8 years)	39	6	3:01	72	24	4	1:08	61	1	3	<2:0	21	13
	16 (6 years)	40	8	1:07	74	15	5	1:00	54	1	3	<2:0	21	16
	30 (6 years)	31	6	1:01	68	22	7	1:07	60	1	4	<2:0	21	16
	3 (8 years)	33	5	1:03	69	23	4	1:08	61	3	3	<2:0	32	12
	23 (6 years)	23	4	0:08	61	14	5	0:11	53	1	4	<2:0	21	13
	8 (10 years)	49	7	2:02	80	32	5	2:03	67	2	3	<2:0	28	15
	6 (6 years)	24	4	0:09	62	15	5	1:00	54	1	3	<2:0	21	12
	28 (6 years)	27	5	0:10	64	18	6	1:04	56	2	4	<2:0	28	14
	22 (7 years)	37	7	1:05	72	16	4	1:02	55	2	4	<2:0	28	15
	18 (7 years)	39	7	1:06	73	22	5	1:07	60	1	3	<2:0	21	15
	10 (10 years)	37	4	1:05	72	29	3	2:00	65	3	3	<2:0	32	10
	13 (6 years)	47	9	2:00	78	17	6	1:03	56	1	4	<2:0	21	19
	15 (9 years)	51	8	2:05	81	34	7	2:05	68	4	4	<2:0	35	19
Group B (Commercially pictograms)	37 (7 years)	37	7	1:05	72	18	5	1:04	56	1	3	<2:0	21	15
	54 (7 years)	34	6	1:04	70	20	5	0:05	59	1	3	<2:0	21	14
	36 (10 years)	54	8	2:09	83	35	6	2:06	69	4	4	<2:0	35	18
	46 (6 years)	31	6	1:01	68	14	5	0:11	53	2	5	<2:0	28	16
	45 (9 years)	46	7	1:11	78	31	6	2:02	66	3	4	<2:0	32	17
	55 (6 years)	26	5	0:10	64	11	4	0:08	49	1	4	<2:0	21	12
	49 (7 years)	35	6	1:04	70	22	5	1:07	60	1	3	<2:0	21	14
	35 (6 years)	28	5	0:11	65	14	4	0:11	53	2	4	<2:0	28	12
	52 (8 years)	41	7	1:08	75	27	6	1:10	64	2	4	<2:0	28	17
	53 (7 years)	33	6	1:03	69	18	5	1:04	56	1	3	<2:0	21	14
	34 (7 years)	34	6	1:04	70	21	5	1:06	59	1	3	<2:0	21	14
	47 (7 years)	30	5	1:00	67	16	4	1:02	55	1	3	<2:0	21	12
	50 (8 years)	37	6	1:05	72	28	6	1:11	64	3	4	<2:0	32	16
	43 (7 years)	34	6	1:04	70	20	5	1:05	58	1	3	<2:0	21	14
	48 (9 years)	51	8	2:05	81	32	6	2:03	67	4	4	<2:0	35	18
	33 (7 years)	31	5	1:01	68	16	4	1:02	55	1	3	<2:0	21	12
	40 (7 years)	35	6	1:04	70	21	5	1:06	59	1	3	<2:0	21	14
	44 (6 years)	27	5	0:10	64	12	4	0:09	50	1	4	<2:0	21	13
	41 (6 years)	29	5	1:00	66	13	5	0:10	52	2	5	<2:0	28	15

Note. *RS*: *Raw Score; V-S: v-Scale Score; AE*: *Age Equivalent*; GSV*:* Growth Scale Value.

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Note. IPR: Interpersonal Relationships; PLA: Play and Leisure; COP: Coping Skills.

Figure D.4: Normal probability plot of the Social Range (Moment 1)

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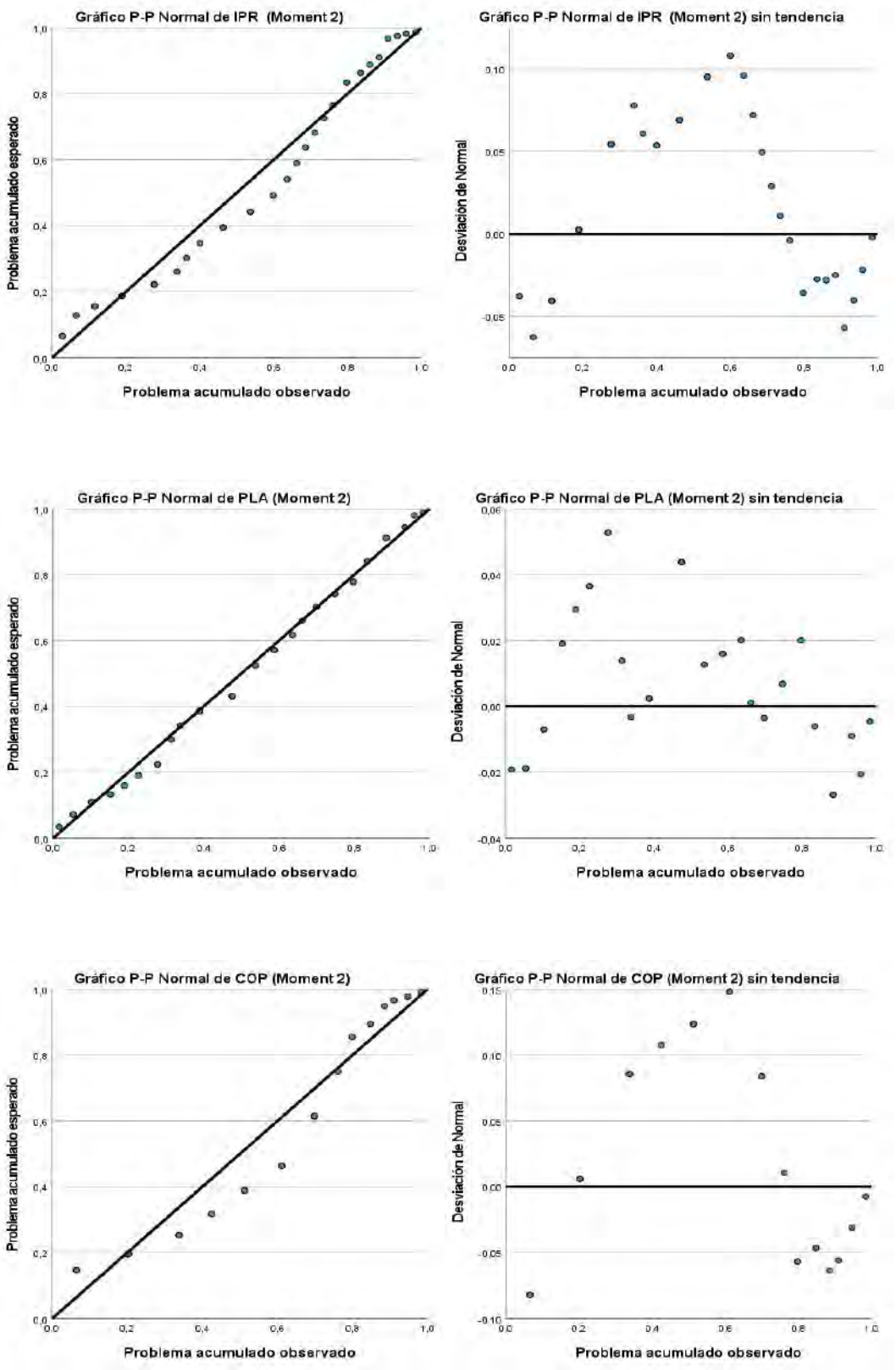
Table D.5

Social Range results (Moment 2)

	Participants	Interpersonal Relationships (ipr)				Play and Leisure (pla)				Coping Skills (cop)				Socialization (SOC)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (ARASAAC)	32 (6 years)	36	7	1:05	71	19	6	1:04	57	6	6	<2:0	40	19
	51 (7 years)	51	9	2:05	81	31	8	2:02	66	13	8	<2:0	50	25
	42 (6 years)	36	7	1:05	71	28	8	1:11	64	3	5	<2:0	32	20
	31 (8 years)	54	9	2:09	83	35	8	2:06	69	15	8	<2:0	52	25
	39 (6 years)	42	8	1:08	75	34	9	2:05	68	5	6	<2:0	38	23
	38 (8 years)	52	8	2:06	82	41	9	3:04	73	16	8	<2:0	53	25
	9 (10 years)	41	5	1:08	75	36	6	2:08	70	8	6	<2:0	43	17
	20 (7 years)	42	8	1:08	75	35	9	2:06	69	5	6	<2:0	38	23
	2 (8 years)	48	8	2:01	79	41	9	3:04	73	17	8	<2:0	54	25
	16 (6 years)	36	7	1:05	71	23	7	1:08	61	8	7	<2:0	43	21
	30 (6 years)	41	8	1:08	75	31	9	2:02	66	17	6	<2:0	54	23
	3 (8 years)	41	7	1:08	75	34	8	2:05	68	10	7	<2:0	46	22
	23 (6 years)	40	8	1:07	74	33	9	2:04	68	12	8	<2:0	49	25
	8 (10 years)	59	9	3:03	87	49	10	4:04	79	19	8	<2:0	56	27
	6 (6 years)	37	7	1:05	72	22	7	1:07	60	5	6	<2:0	38	20
	28 (6 years)	31	6	1:01	68	23	7	1:08	61	6	6	<2:0	40	19
	22 (7 years)	37	7	1:05	72	30	8	2:01	66	5	6	<2:0	38	21
	18 (7 years)	35	6	1:04	70	25	6	1:09	62	4	5	<2:0	35	17
	10 (10 years)	61	9	3:06	88	38	7	3:00	71	12	6	<2:0	49	22
	13 (6 years)	35	7	1:04	70	27	8	1:10	64	3	5	<2:0	32	20
	15 (9 years)	47	7	2:00	78	43	9	3:06	74	8	6	<2:0	43	22
Group B (Commercially pictograms)	37 (7 years)	49	9	2:02	80	28	7	1:11	64	2	4	<2:0	28	20
	54 (7 years)	43	8	1:09	76	27	7	1:10	64	2	4	<2:0	28	19
	36 (10 years)	51	7	2:05	81	47	9	4:00	77	5	4	<2:0	38	20
	46 (6 years)	42	8	1:08	75	20	6	1:05	58	2	4	<2:0	28	18
	45 (9 years)	58	9	3:02	86	28	4	1:11	64	13	7	<2:0	50	20
	55 (6 years)	35	7	1:04	70	17	6	1:03	56	1	4	<2:0	21	17
	49 (7 years)	44	8	1:10	76	20	4	1:05	58	6	6	<2:0	40	18
	35 (7 years)	38	7	1:06	72	19	5	1:04	57	1	3	<2:0	21	15
	52 (8 years)	53	9	2:08	82	32	7	2:03	67	2	4	<2:0	28	20
	53 (7 years)	34	6	1:04	70	31	8	2:02	66	2	4	<2:0	28	18
	34 (7 years)	46	8	1:11	78	26	6	1:09	63	3	4	<2:0	32	18
	47 (7 years)	39	7	1:06	73	21	5	1:06	59	1	3	<2:0	21	15
	50 (8 years)	43	7	1:09	76	41	9	3:04	73	3	4	<2:0	32	20
	43 (7 years)	40	7	1:07	74	22	5	1:07	60	8	6	<2:0	43	18
	48 (9 years)	60	9	3:04	87	36	7	2:08	70	4	4	<2:0	35	20
	33 (7 years)	31	5	1:01	68	28	7	1:11	64	1	3	<2:0	21	15
	40 (7 years)	45	8	1:11	77	27	6	1:10	64	2	4	<2:0	28	18
	44 (6 years)	37	7	1:05	72	17	5	1:03	56	1	3	<2:0	21	15
	41 (6 years)	37	7	1:05	72	14	5	0:11	53	3	5	<2:0	32	17

Note. *RS*: *Raw Score; V-S: v-Scale Score; AE*: *Age Equivalent*; GSV*:* Growth Scale Value.

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Note. IPR: Interpersonal Relationships; PLA: Play and Leisure; COP: Coping Skills.

Figure D.5: Normal probability plot of the Social Range (Moment 2)

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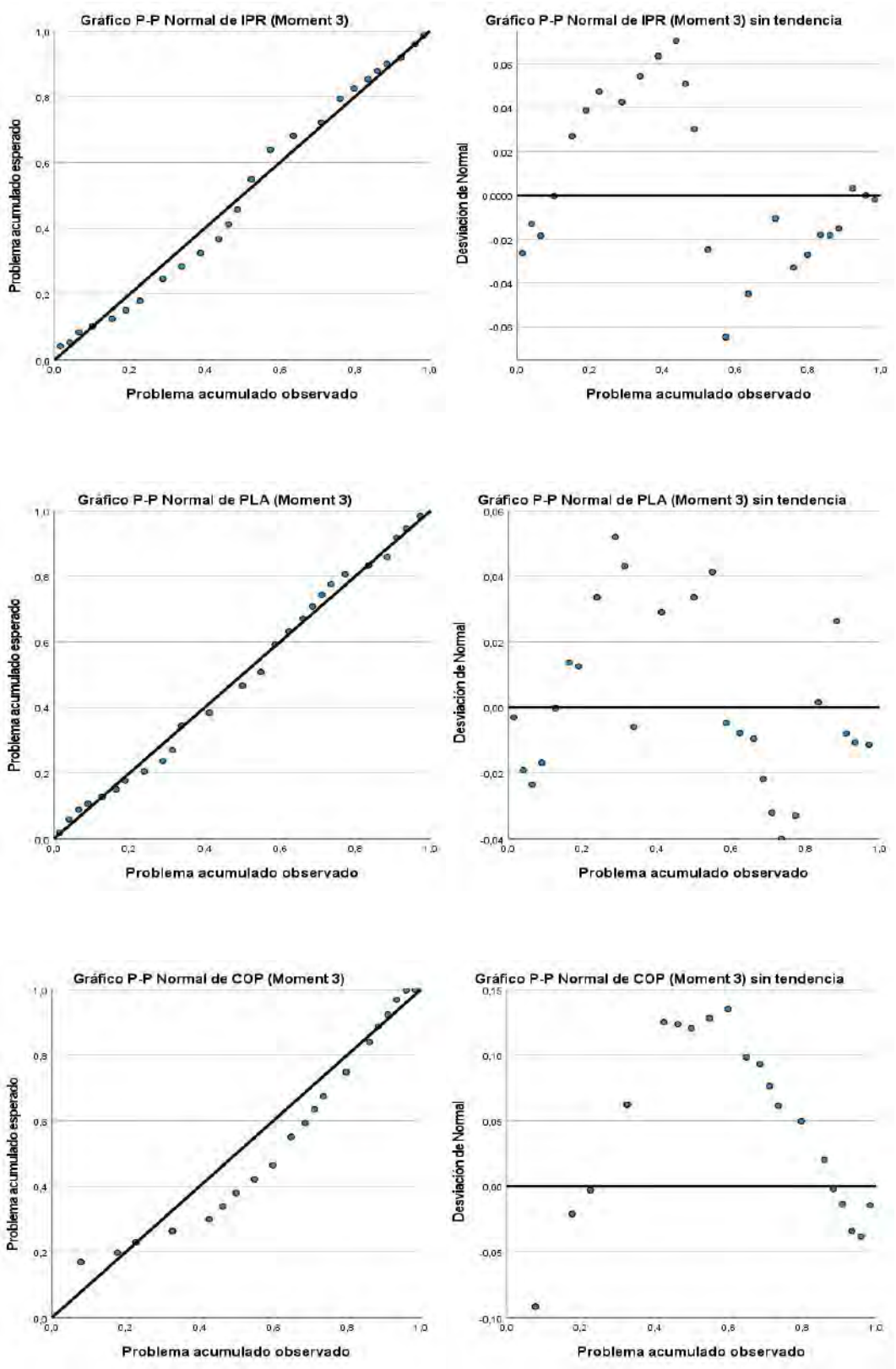
Table D.6

Social Range results (Moment 3)

	Participants	Interpersonal Relationships (ipr)				Play and Leisure (pla)				Coping Skills (cop)				Socialization (SOC)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (ARASAAC)	32 (6 years)	44	8	1:10	76	35	9	2:06	69	10	7	<2:0	46	24
	51 (7 years)	56	10	2:11	84	39	9	3:01	72	7	6	<2:0	42	25
	42 (7 years)	48	9	2:01	79	36	9	2:08	70	9	7	<2:0	45	25
	31 (8 years)	63	11	3:08	89	45	10	3:09	76	22	9	<2:0	59	30
	39 (6 years)	50	10	2:04	80	30	9	2:01	66	17	9	<2:0	54	28
	38 (8 years)	59	10	3:03	87	49	11	4:04	79	24	9	<2:0	61	30
	9 (10 years)	64	10	3:10	90	51	10	4:08	81	39	11	3:09	73	25
	20 (7 years)	61	11	3:06	87	45	11	3:09	76	12	8	<2:0	49	31
	2 (8 years)	67	12	4:02	92	56	13	6:00	85	28	10	2:00	64	35
	16 (6 years)	41	8	1:08	75	33	9	2:04	68	8	7	<2:0	43	24
	30 (6 years)	42	8	1:08	75	28	8	1:11	64	12	8	<2:0	49	24
	3 (8 years)	71	13	5:00	96	44	10	3:08	75	20	9	<2:0	57	32
	23 (6 years)	53	10	2:08	82	41	11	3:04	73	17	9	<2:0	54	30
	8 (10 years)	64	10	3:10	90	56	12	6:00	85	37	10	3:04	71	32
	6 (6 years)	42	8	1:08	75	35	9	2:06	69	9	7	<2:0	45	31
	28 (6 years)	48	9	2:01	79	38	10	3:00	71	5	6	<2:0	38	25
	22 (7 years)	49	9	2:02	80	36	9	2:08	70	8	7	<2:0	43	28
	18 (7 years)	56	10	2:11	84	43	10	3:06	74	14	8	<2:0	51	28
	10 (10 years)	55	8	2:10	84	46	9	3:10	77	15	7	<2:0	52	24
	13 (6 years)	47	9	2:00	78	42	11	3:05	74	17	9	<2:0	54	29
	15 (9 years)	62	10	3:07	89	45	9	3:09	76	17	8	<2:0	54	27
Group B (Commercially pictograms)	37 (7 years)	53	9	2:08	82	25	6	1:09	62	4	5	<2:0	35	20
	54 (7 years)	57	10	3:00	85	32	8	2:03	67	6	6	<2:0	40	24
	36 (10 years)	57	8	3:00	85	44	8	3:08	75	5	4	<2:0	38	20
	46 (6 years)	46	8	1:11	78	25	7	1:09	62	2	4	<2:0	28	19
	45 (9 years)	60	9	3:04	87	33	6	2:04	68	13	7	<2:0	50	22
	55 (6 years)	38	7	1:06	72	23	7	1:08	61	2	4	<2:0	28	18
	49 (7 years)	56	10	2:11	84	24	5	1:08	61	5	5	<2:0	38	20
	35 (7 years)	44	8	1:10	76	28	7	1:11	64	2	4	<2:0	28	19
	52 (8 years)	55	9	2:10	84	33	7	2:04	68	5	5	<2:0	38	21
	53 (7 years)	48	8	2:01	79	33	8	2:04	68	3	4	<2:0	32	20
	34 (7 years)	46	8	1:11	78	28	7	1:11	64	6	5	<2:0	40	20
	47 (7 years)	51	9	2:05	81	26	6	1:09	63	5	5	<2:0	38	20
	50 (8 years)	46	7	1:11	78	39	8	3:01	72	4	5	<2:0	35	20
	43 (7 years)	41	7	1:08	75	33	8	2:04	68	10	7	<2:0	46	22
	48 (9 years)	60	9	3:04	87	40	8	3:02	75	2	3	<2:0	28	20
	33 (7 years)	40	7	1:07	74	29	7	2:00	65	3	4	<2:0	32	18
	40 (7 years)	57	10	3:00	85	27	6	1:10	64	2	4	<2:0	28	20
	44 (6 years)	43	8	1:09	76	21	6	1:06	59	2	4	<2:0	28	18
	41 (6 years)	37	7	1:05	72	16	5	1:02	55	5	6	<2:0	38	18

Note. *RS*: *Raw Score; V-S: v-Scale Score; AE*: *Age Equivalent*; GSV*:* Growth Scale Value.

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Note. IPR: Interpersonal Relationships; PLA: Play and Leisure; COP: Coping Skills.

Figure D.6: Normal probability plot of the Social Range (Moment 3)

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Table D.7

Behavioral Range results (Moment 1)

	Participants	Section A	Section B	Section C	Problematic behaviors
Group A (ARASAAC)	32 (6 years)	7	9	13	29
	51 (7 years)	10	8	12	30
	42 (6 years)	7	8	13	28
	31 (8 years)	9	9	14	32
	39 (6 years)	7	6	14	27
	38 (8 years)	7	8	15	30
	9 (10 years)	10	5	10	25
	20 (7 years)	11	3	13	27
	2 (8 years)	6	9	15	30
	16 (6 years)	10	7	14	31
	30 (6 years)	9	8	11	28
	3 (8 years)	8	6	14	28
	23 (6 years)	8	7	16	31
	8 (10 years)	9	7	13	29
	6 (6 years)	10	8	13	31
	28 (6 years)	11	8	12	31
	22 (7 years)	9	9	12	30
	18 (7 years)	4	7	14	25
	10 (10 years)	7	7	11	25
	13 (6 years)	11	9	12	32
	15 (9 years)	10	8	13	31
Group B (Commercially pictograms)	37 (7 years)	10	9	15	34
	54 (7 years)	9	8	14	31
	36 (10 years)	7	8	15	30
	46 (6 years)	10	7	14	31
	45 (9 years)	7	8	10	25
	55 (6 years)	9	6	14	28
	49 (7 years)	10	9	13	32
	35 (7 years)	9	9	12	30
	52 (8 years)	10	9	14	33
	53 (7 years)	10	9	13	32
	34 (7 years)	9	8	14	31
	47 (7 years)	8	7	14	29
	50 (8 years)	6	7	10	23
	43 (7 years)	10	9	11	30
	48 (9 years)	9	8	11	28
	33 (7 years)	9	7	15	31
	40 (7 years)	10	8	14	32
	44 (6 years)	11	9	10	30
	41 (6 years)	9	8	12	29

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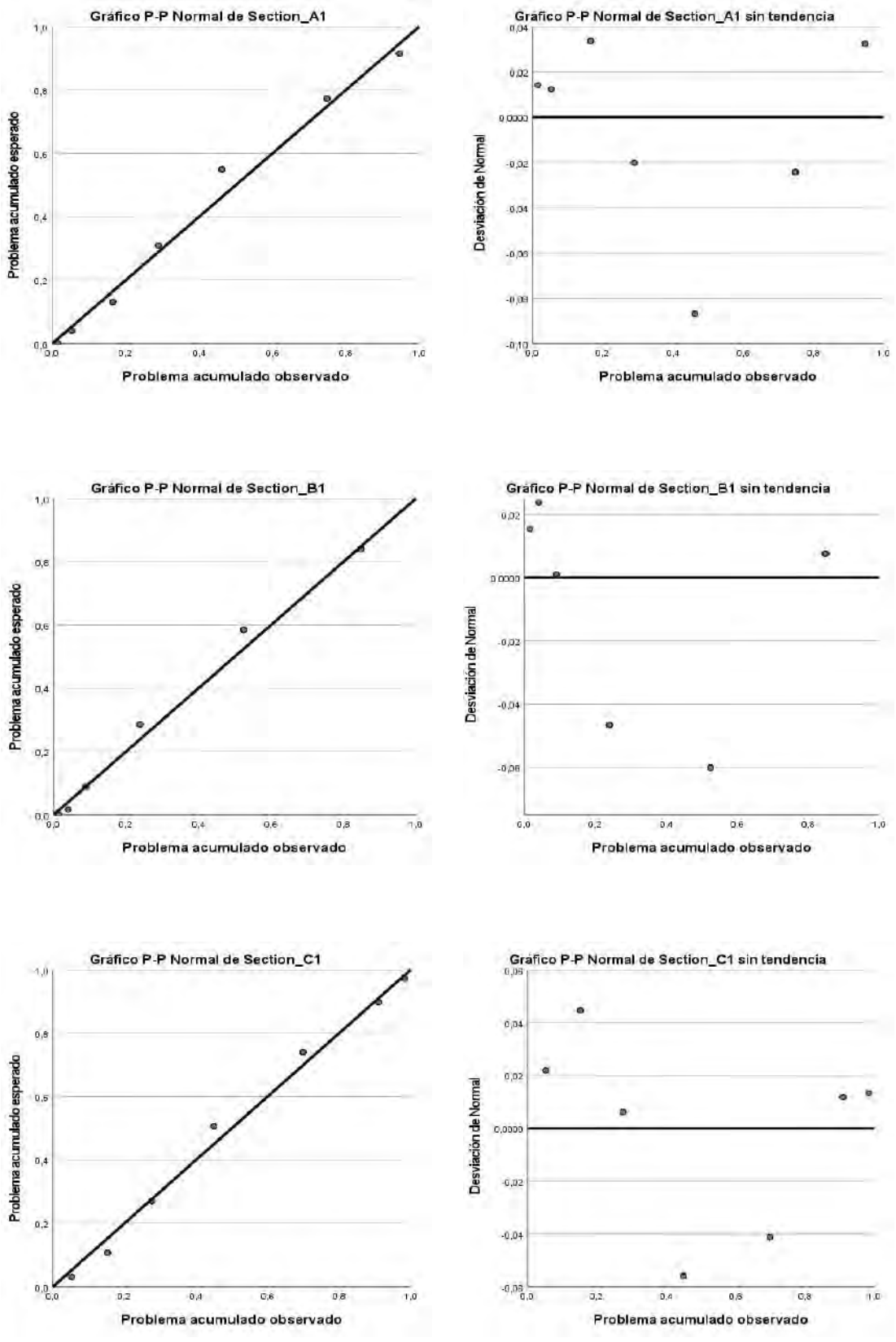


Figure D.7: Normal probability plot of the Behavioral Range (Moment 1)

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Table D.8

Behavioral Range results (Moment 2)

	Participants	Section A	Section B	Section C	Problematic behaviors
Group A (ARASAAC)	32 (6 years)	6	7	7	20
	51 (7 years)	9	5	8	22
	42 (6 years)	5	6	8	19
	31 (8 years)	5	7	10	22
	39 (6 years)	7	4	9	20
	38 (8 years)	5	8	7	20
	9 (10 years)	7	5	6	18
	20 (7 years)	10	3	11	24
	2 (8 years)	6	6	6	18
	16 (6 years)	10	8	14	32
	30 (6 years)	5	4	8	17
	3 (8 years)	8	5	8	21
	23 (6 years)	8	7	10	25
	8 (10 years)	7	4	7	18
	6 (6 years)	9	6	5	20
	28 (6 years)	4	2	9	15
	22 (7 years)	6	7	5	18
	18 (7 years)	4	7	10	21
	10 (10 years)	7	7	12	26
	13 (6 years)	8	9	11	28
	15 (9 years)	7	8	8	23
Group B (Commercially pictograms)	37 (7 years)	9	8	13	30
	54 (7 years)	8	7	12	27
	36 (10 years)	7	8	13	28
	46 (6 years)	9	7	10	26
	45 (9 years)	7	6	8	21
	55 (6 years)	8	5	12	25
	49 (7 years)	9	8	10	27
	35 (7 years)	8	9	8	25
	52 (8 years)	9	8	13	30
	53 (7 years)	7	9	11	27
	34 (7 years)	8	8	11	27
	47 (7 years)	7	6	12	25
	50 (8 years)	4	7	9	20
	43 (7 years)	8	9	10	27
	48 (9 years)	7	8	7	22
	33 (7 years)	6	7	12	25
	40 (7 years)	8	7	12	27
	44 (6 years)	10	6	9	25
	41 (6 years)	8	7	9	24

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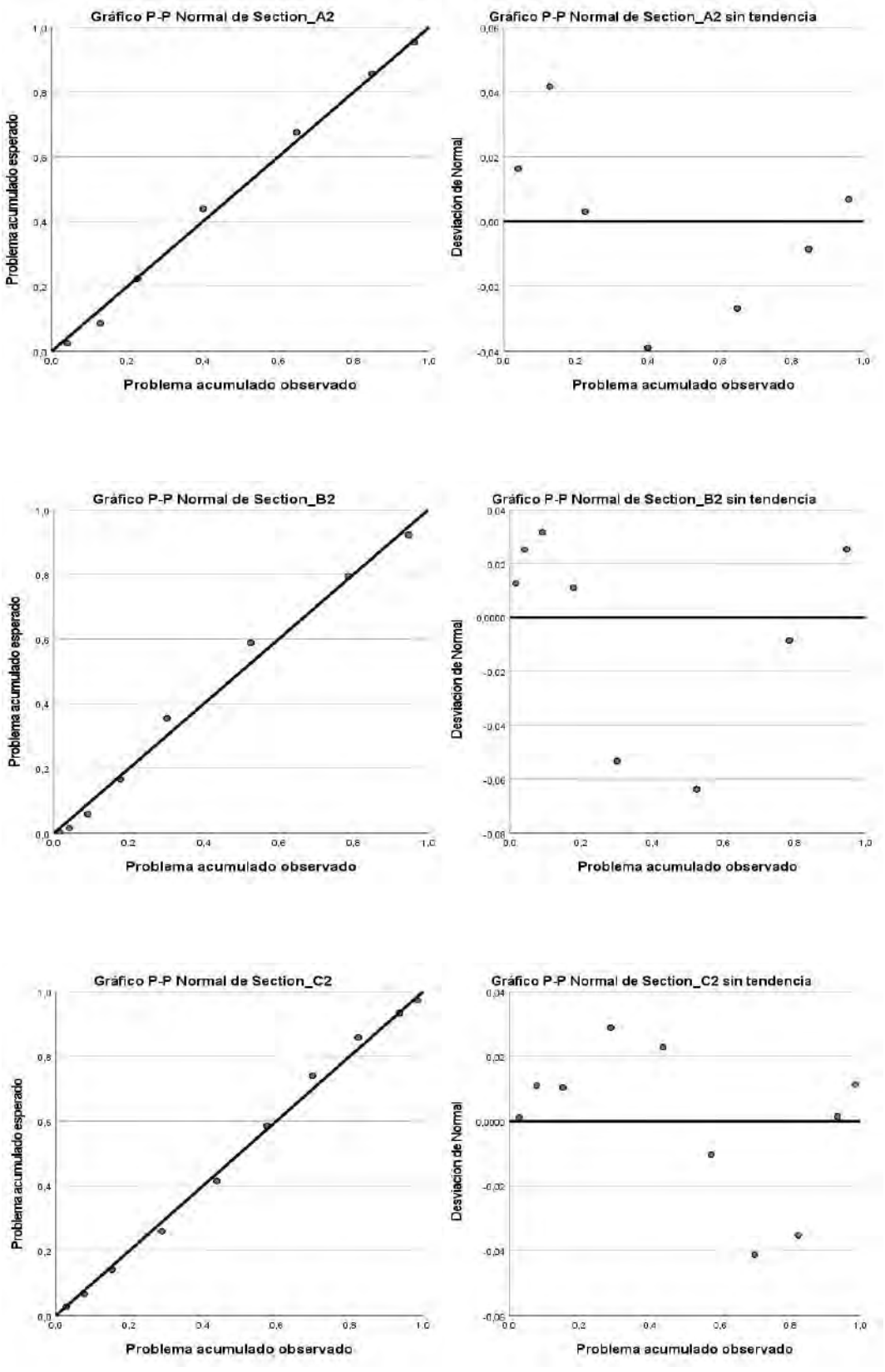


Figure D.8: Normal probability plot of the Behavioral Range (Moment 2)

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Table D.9

Behavioral Range results (Moment 3)

	Participants	Section A	Section B	Section C	Problematic behaviors
Group A (ARASAAC)	32 (6 years)	5	3	4	12
	51 (7 years)	3	4	3	10
	42 (7 years)	4	3	6	13
	31 (8 years)	4	3	5	12
	39 (6 years)	4	4	7	15
	38 (8 years)	2	6	4	12
	9 (10 years)	6	3	2	11
	20 (7 years)	4	3	9	16
	2 (8 years)	6	4	6	16
	16 (6 years)	6	4	10	20
	30 (6 years)	5	2	8	15
	3 (8 years)	8	3	5	16
	23 (6 years)	6	6	10	22
	8 (10 years)	4	2	2	8
	6 (6 years)	9	4	5	18
	28 (6 years)	3	2	6	11
	22 (7 years)	6	3	2	11
	18 (7 years)	1	5	4	10
	10 (10 years)	2	7	4	13
	13 (6 years)	4	5	6	15
	15 (9 years)	4	8	2	14
Group B (Commercially pictograms)	37 (7 years)	8	5	9	22
	54 (7 years)	7	6	7	20
	36 (10 years)	7	8	9	24
	46 (6 years)	5	7	8	20
	45 (9 years)	8	6	8	22
	55 (6 years)	4	5	9	18
	49 (7 years)	5	7	8	20
	35 (7 years)	4	5	9	18
	52 (8 years)	7	4	11	22
	53 (7 years)	5	9	9	20
	34 (7 years)	7	6	7	20
	47 (7 years)	5	4	9	18
	50 (8 years)	6	6	10	22
	43 (7 years)	4	6	10	20
	48 (9 years)	8	8	8	24
	33 (7 years)	3	5	10	18
	40 (7 years)	8	7	5	20
	44 (6 years)	8	4	6	18
	41 (6 years)	6	7	5	18

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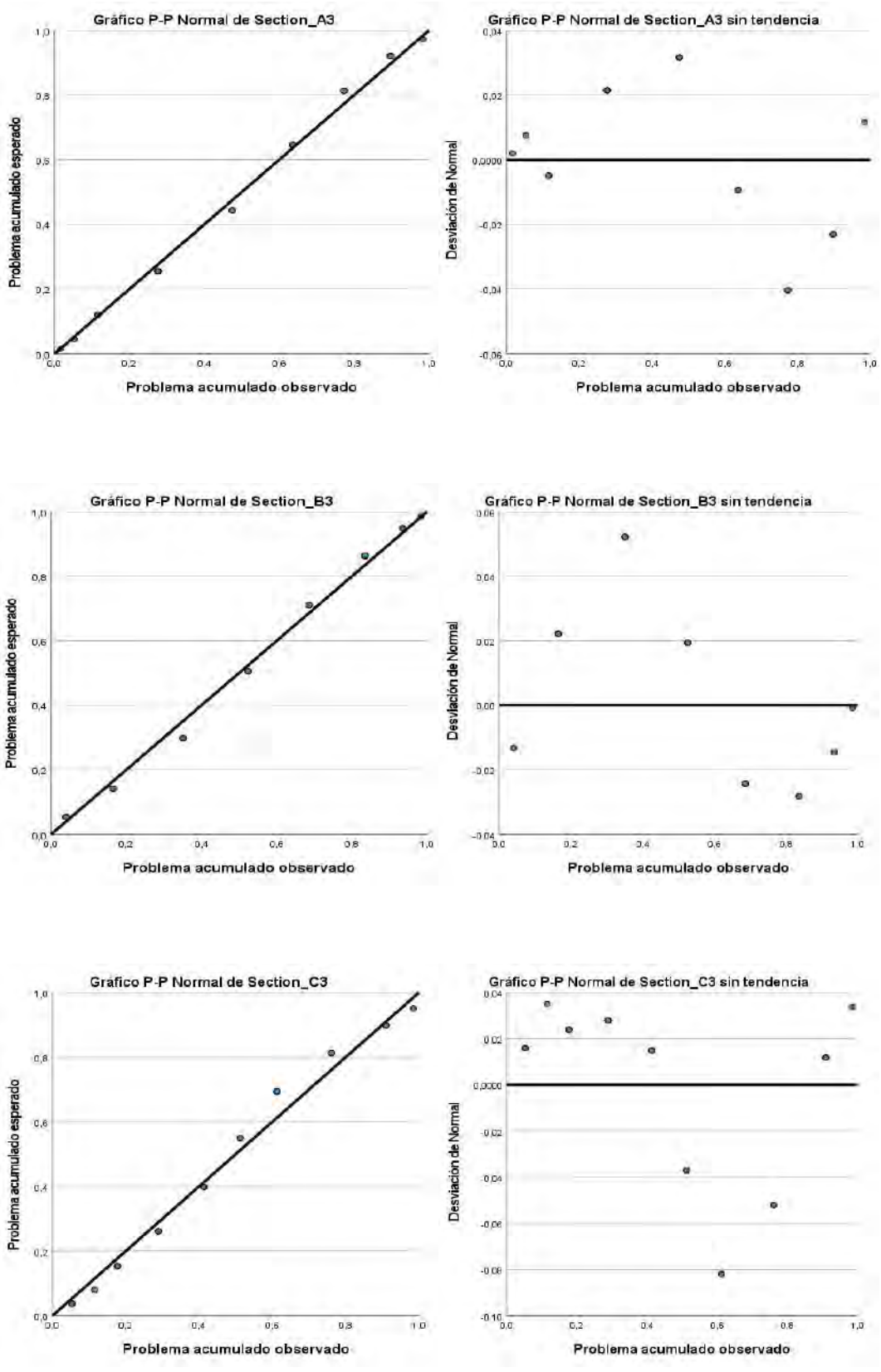


Figure D.9: Normal probability plot of the Behavioral Range (Moment 3)

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APPENDIX E

Results of Chapter 7

The results obtained from the Vineland-3 scale in the study described in Chapter 7 are presented below. This study included 35 participants, divided into Group A (EC+) and Group B (SymboTalk – AAC Talker ®).

To assess each participant's performance, the Vineland-3 scale was used to calculate the Raw Score. This score was then converted into the v-Scale Score using the test's standardized norms. Additionally, the AE and GSV were determined, with the GSV providing insight into each participant's developmental trajectory over time.

To ensure the appropriateness of the statistical methods used in this chapter, the normal probability of the Raw Scores was analyzed. This step was essential for selecting the most suitable statistical tests based on the distribution of the data.

The assessment covered various domains: receptive, expressive, and written communication for the Communicative Range; interpersonal relationships, play and leisure, and coping skills for the Social Range; and different aspects of disruptive behavior for the Behavioral Range.

Participants' chronological age was taken into account throughout the study, as normative data vary by age. Since the study lasted 16 weeks, natural developmental changes were expected. Therefore, the time factor was considered in the three evaluation moments, ensuring that the appropriate normative data were applied at each stage.

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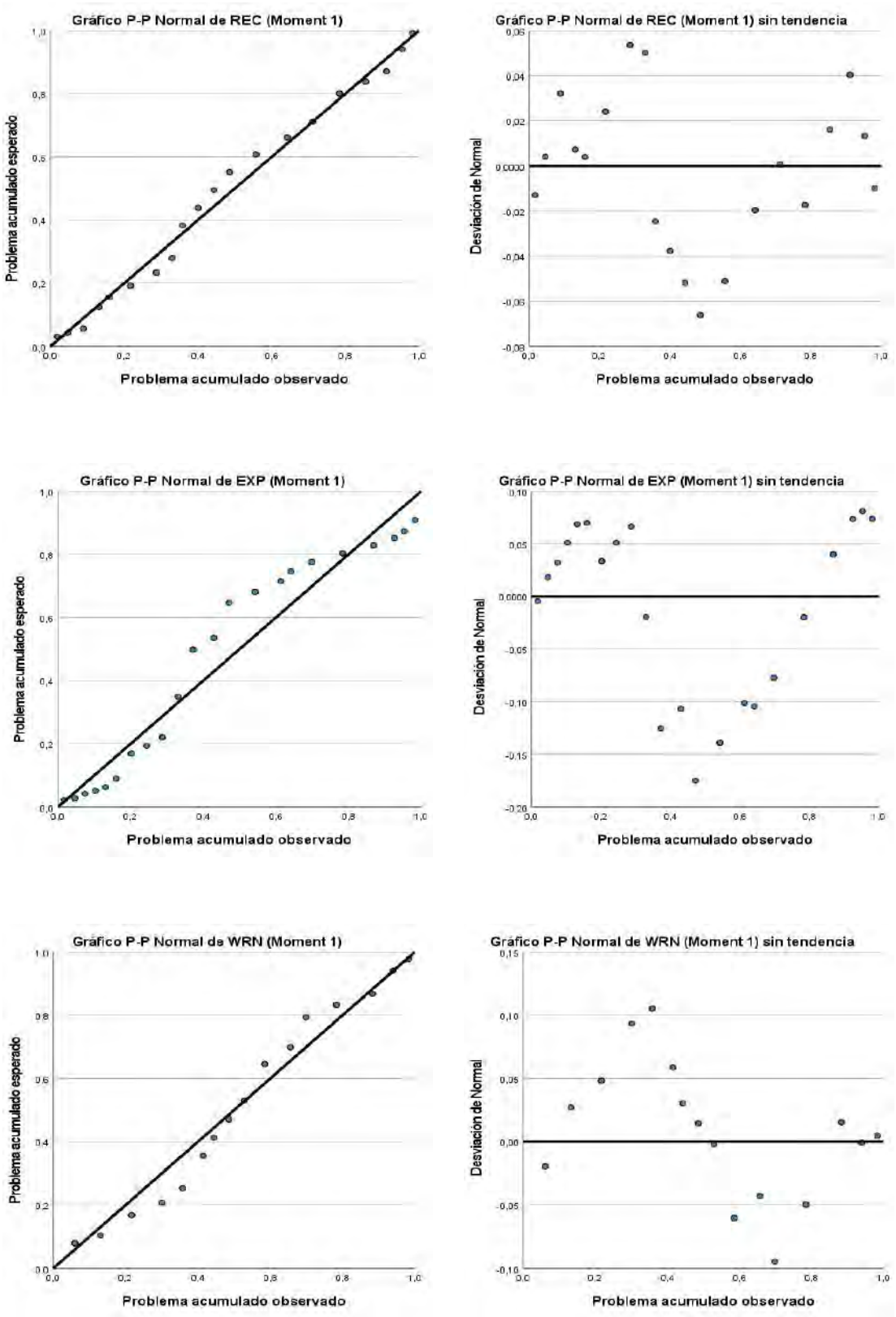
Table E.1

Communicative Range results (Moment 1)

	Participants	Receptive (rec)				Expressive (exp)				Written (wrn)				Communication (COM)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (EC+)	69 (9 years)	51	5	1:11	93	75	3	3:00	90	13	2	3:04	48	10
	71 (9 years)	52	5	2:00	94	78	4	3:02	92	14	2	3:06	50	11
	67 (10 years)	66	4	3:06	108	79	3	3:03	92	17	2	3:10	55	9
	5 (6 years)	36	4	1:04	80	49	2	1:10	76	2	2	<3:0	26	8
	19 (7 years)	44	5	1:08	87	60	2	2:02	82	1	1	<3:0	20	8
	29 (10 years)	55	6	2:03	96	79	3	3:03	92	17	2	3:10	54	11
	12 (6 years)	38	4	1:05	82	50	2	1:10	77	1	1	<3:0	20	7
	27 (9 years)	53	5	2:01	94	77	3	3:02	91	14	2	3:06	50	10
	17 (6 years)	37	4	1:04	81	52	2	1:11	78	1	1	<3:0	20	7
	25 (7 years)	43	5	1:07	86	61	2	2:03	82	1	1	<3:0	20	8
	1 (11 years)	57	6	2:05	98	81	3	3:05	94	21	2	4:02	58	11
	4 (12 years)	60	7	2:08	101	84	5	3:08	96	24	2	4:05	61	14
	14 (11 years)	57	6	2:05	98	82	4	3:06	94	21	2	4:02	58	12
	7 (10 years)	56	6	2:04	97	79	3	3:03	92	17	2	3:10	54	11
	26 (8 years)	49	5	1:10	91	70	2	2:08	87	6	1	<3:0	37	8
	21 (9 years)	51	5	1:11	93	74	2	2:11	89	10	1	3:01	44	8
	11 (6 years)	38	4	1:05	82	53	2	1:11	78	9	6	3:00	42	12
	24 (7 years)	45	5	1:08	88	62	2	2:04	83	6	3	<3:0	37	10
Group B (SymboTalk)	73 (8 years)	47	5	1:09	89	71	4	2:09	87	8	2	<3:0	41	11
	56 (8 years)	50	6	1:11	92	75	5	3:00	90	11	4	3:02	46	15
	58 (10 years)	55	6	2:03	96	80	4	3:04	93	18	3	3:11	55	13
	60 (7 years)	43	5	1:07	86	60	2	2:02	82	4	2	<3:0	32	9
	63 (6 years)	42	6	1:07	85	56	4	2:00	80	4	3	<3:0	32	13
	75 (7 years)	44	5	1:08	87	66	4	2:06	85	5	2	<3:0	35	10
	74 (11 years)	55	5	2:03	96	80	2	3:04	93	16	1	3:08	52	8
	66 (10 years)	52	4	2:00	94	78	2	3:02	92	18	2	3:11	55	8
	72 (8 years)	48	5	1:10	90	71	4	2:09	87	4	1	<3:0	32	10
	61 (10 years)	53	5	2:01	94	78	2	3:02	92	17	2	3:10	54	9
	57 (9 years)	52	5	2:00	94	75	3	3:00	90	6	1	<3:0	37	9
	70 (8 years)	48	5	1:10	90	70	2	2:08	87	10	3	3:01	44	10
	62 (9 years)	50	4	1:11	92	75	3	3:00	90	13	2	3:04	48	9
	64 (6 years)	43	6	1:07	87	54	4	1:11	79	4	3	<3:0	32	13
	59 (9 years)	51	5	1:11	93	76	4	3:01	90	13	2	3:04	48	11
	65 (10 years)	56	6	2:04	95	80	4	3:04	93	17	2	3:10	54	12
	68 (7 years)	41	4	1:06	84	62	3	2:04	83	4	2	<3:0	32	9

Note. *RS*: *Raw Score; V-S: v-Scale Score; AE*: *Age Equivalent*; GSV*:* Growth Scale Value.

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Note. REC: Receptive; EXP: Expressive; WRN: Written.

Figure E.1: Normal probability plot of the Communicative Range (Moment 1)

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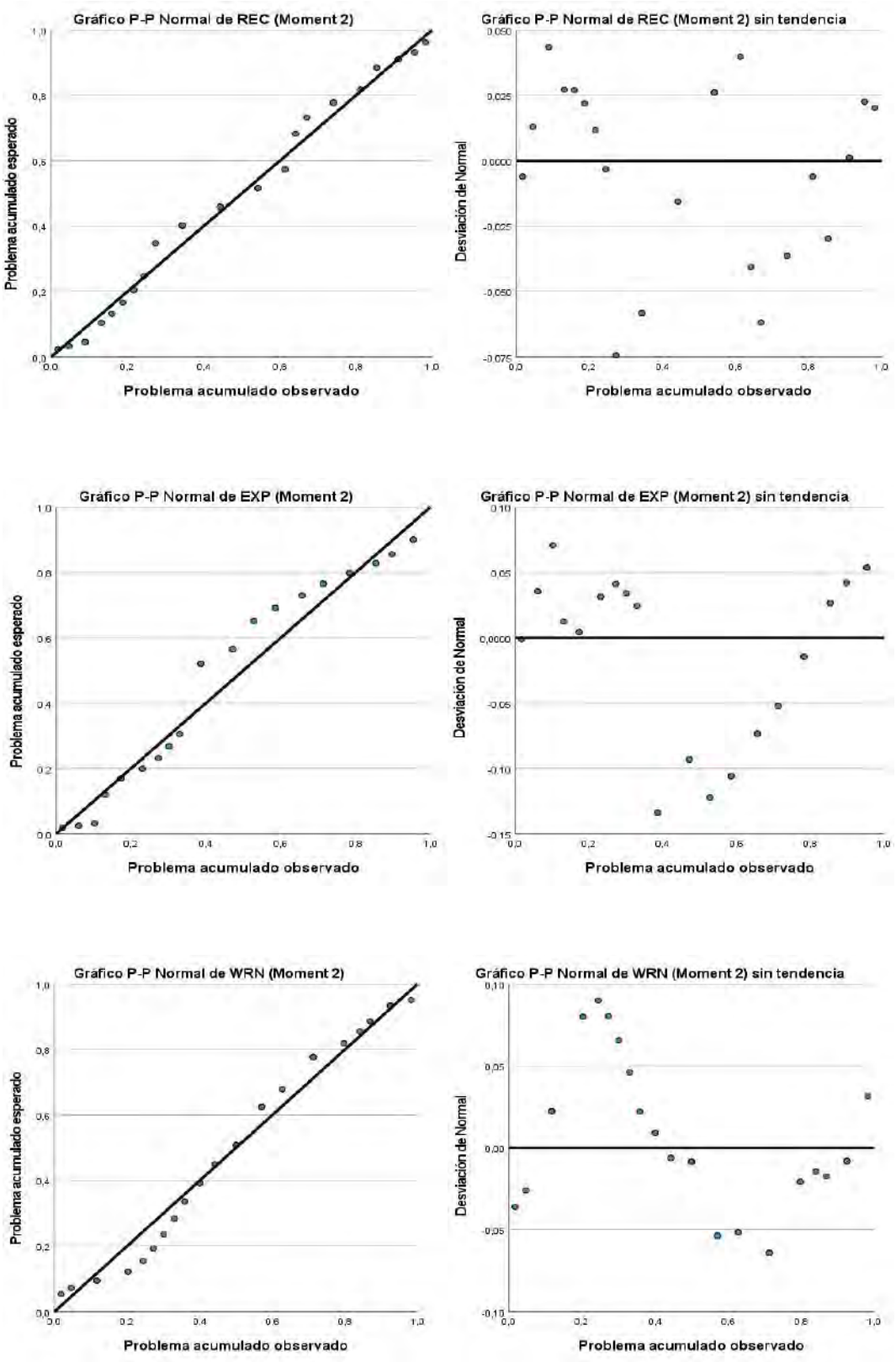
Table E.2

Communicative Range results (Moment 2)

	Participants	Receptive (rec)				Expressive (exp)				Written (wrn)				Communication (COM)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (EC+)	69 (9 years)	55	7	2:03	96	76	4	3:01	90	13	2	3:04	48	13
	71 (9 years)	58	8	2:06	99	78	4	3:02	92	16	2	3:08	52	14
	67 (10 years)	56	6	2:04	97	80	4	3:04	93	18	3	3:11	55	13
	5 (6 years)	44	7	1:08	87	57	5	2:01	80	2	2	<3:0	26	14
	19 (7 years)	51	8	1:11	93	66	5	2:06	85	4	2	<3:0	32	15
	29 (10 years)	62	9	2:10	103	82	6	3:06	94	18	3	3:11	55	18
	12 (6 years)	46	7	1:09	88	58	5	2:22	81	4	4	<3:0	32	16
	27 (9 years)	58	8	2:06	99	80	6	3:04	93	15	3	3:07	51	17
	17 (6 years)	45	7	1:08	88	56	4	2:00	80	3	2	<3:0	30	13
	25 (7 years)	52	8	2:00	94	67	5	2:06	85	4	2	<3:0	32	15
	1 (11 years)	68	10	3:10	111	86	7	3:11	98	21	2	4:02	58	19
	4 (12 years)	70	11	4:04	114	86	7	3:11	98	24	2	4:05	61	20
	14 (11 years)	67	10	3:08	109	86	7	3:11	98	23	4	4:04	60	21
	7 (10 years)	63	9	3:00	104	83	6	3:07	95	18	3	3:11	55	18
	26 (8 years)	56	8	2:04	97	75	5	3:00	90	9	2	3:00	42	15
	21 (9 years)	57	8	2:05	98	79	6	3:03	92	13	2	3:04	48	16
	11 (6 years)	46	7	1:09	88	57	4	2:01	80	8	6	<3:0	41	17
	24 (7 years)	49	7	1:10	91	68	5	2:07	86	5	2	<3:0	35	14
Group B (SymboTalk)	73 (8 years)	58	9	2:06	99	75	6	3:00	90	10	4	3:01	44	19
	56 (8 years)	56	8	2:04	97	76	6	3:01	90	11	4	3:02	46	18
	58 (10 years)	66	10	3:06	108	84	7	3:08	96	23	5	4:04	60	22
	60 (7 years)	56	9	2:04	97	66	5	2:06	85	6	4	<3:0	37	18
	63 (6 years)	53	9	2:01	94	67	7	2:06	85	4	3	<3:0	32	19
	75 (7 years)	50	7	1:11	92	70	5	2:08	87	7	3	<3:0	39	15
	74 (11 years)	67	10	3:08	109	83	5	3:07	95	23	4	4:04	60	19
	66 (10 years)	63	9	3:00	104	81	5	3:05	94	19	3	4:00	56	17
	72 (8 years)	63	10	3:00	104	75	6	3:00	90	11	4	3:02	46	20
	61 (10 years)	64	9	3:02	105	82	6	3:06	95	20	4	4:01	57	19
	57 (9 years)	58	8	2:06	99	79	6	3:03	92	16	4	3:08	52	18
	70 (8 years)	63	10	3:00	104	76	5	3:01	90	13	4	3:04	48	19
	62 (9 years)	61	9	2:09	102	79	6	3:03	92	15	4	3:07	51	19
	64 (6 years)	59	10	2:07	100	64	6	2:04	84	5	4	<3:0	35	20
	59 (9 years)	66	10	3:06	108	82	7	3:06	95	19	5	4:00	56	22
	65 (10 years)	57	7	2:05	98	81	5	3:05	94	18	3	3:01	55	15
	68 (7 years)	57	9	2:05	98	69	6	2:08	86	12	6	3:03	47	21

Note. *RS*: *Raw Score; V-S: v-Scale Score; AE*: *Age Equivalent*; GSV*:* Growth Scale Value.

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Note. REC: Receptive; EXP: Expressive; WRN: Written.

Figure E.2: Normal probability plot of the Communicative Range (Moment 2)

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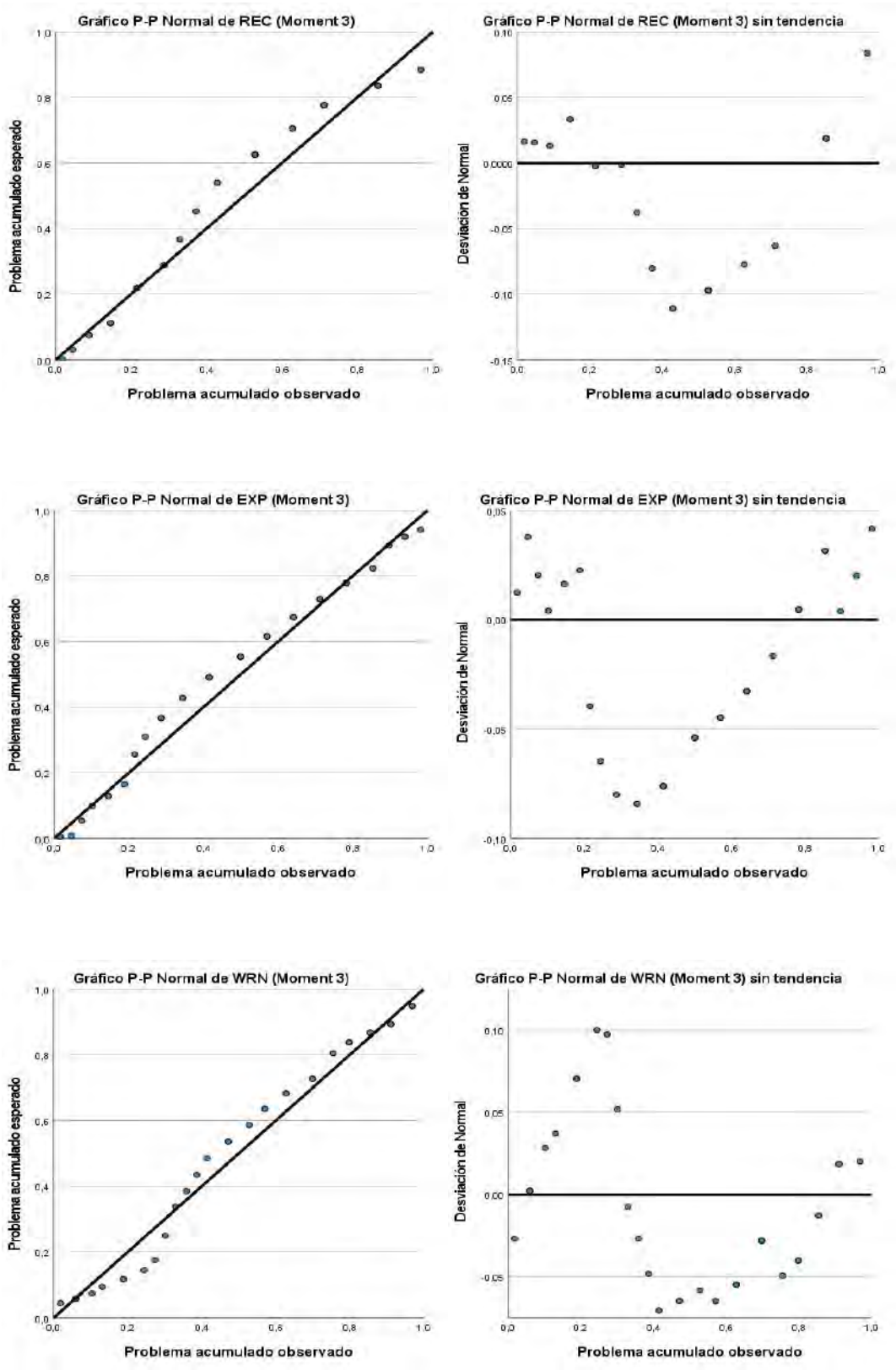
Table E.3

Communicative Range results (Moment 3)

	Participants	Receptive (rec)				Expressive (exp)				Written (wrn)				Communication (COM)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (EC+)	69 (9 years)	67	10	3:08	109	85	8	3:10	97	22	6	4:03	59	24
	71 (9 years)	72	12	5:03	117	83	7	3:07	95	18	4	3:11	55	22
	67 (10 years)	74	13	7:03	122	84	7	3:08	96	19	3	4:00	56	23
	5 (6 years)	65	12	3:04	107	77	10	3:02	91	7	5	<3:0	39	27
	19 (7 years)	64	11	3:02	105	79	9	3:03	92	9	5	3:00	42	25
	29 (10 years)	72	12	5:03	117	90	10	4:06	103	23	5	4:04	60	27
	12 (6 years)	57	10	2:05	98	69	8	2:08	86	6	5	<3:0	37	23
	27 (9 years)	70	11	4:04	114	87	9	4:00	99	17	3	3:10	54	23
	17 (6 years)	65	12	3:04	107	78	10	3:02	92	5	4	<3:0	35	26
	25 (7 years)	70	13	4:04	114	85	11	3:10	97	11	6	3:02	46	30
	1 (11 years)	76	15	11:00	129	95	12	8:03	113	31	6	5:01	67	33
	4 (12 years)	67	11	3:08	109	89	9	4:04	101	28	5	4:10	65	25
	14 (11 years)	73	12	6:03	119	93	10	5:06	108	23	5	4:04	60	27
	7 (10 years)	75	14	8:06	125	94	12	6:09	110	26	6	4:07	63	32
	26 (8 years)	64	10	3:02	105	81	8	3:05	94	15	5	3:07	51	23
	21 (9 years)	68	11	3:10	111	86	9	3:11	98	16	4	3:08	52	24
	11 (6 years)	62	11	2:10	103	70	8	2:09	87	6	5	<3:0	37	24
	24 (7 years)	67	12	3:08	109	83	10	3:07	95	10	5	3:01	44	27
Group B (SymboTalk)	73 (8 years)	74	14	7:03	122	89	11	4:04	101	19	7	4:00	56	32
	56 (8 years)	71	13	4:08	115	87	10	4:00	99	19	6	4:00	56	29
	58 (10 years)	75	14	8:06	125	90	10	4:06	103	27	6	4:08	64	30
	60 (7 years)	72	14	5:03	117	82	10	3:07	95	9	5	3:00	42	29
	63 (6 years)	68	13	3:10	111	75	9	3:00	90	8	6	<3:0	41	28
	75 (7 years)	73	14	6:03	119	84	10	3:08	96	13	6	3:04	48	30
	74 (11 years)	76	15	11:00	126	91	10	4:08	104	27	5	4:08	27	30
	66 (10 years)	72	12	5:03	117	88	9	4:02	100	28	6	4:10	65	27
	72 (8 years)	69	12	4:00	112	86	10	3:11	98	20	7	4:01	57	29
	61 (10 years)	75	14	8:06	125	88	9	4:02	100	25	6	4:06	62	29
	57 (9 years)	74	14	7:03	122	90	10	4:06	103	22	5	4:03	59	29
	70 (8 years)	75	15	8:06	125	85	9	3:10	97	21	6	4:02	58	30
	62 (9 years)	75	15	8:06	125	91	11	4:08	104	23	6	4:04	60	32
	64 (6 years)	72	14	5:03	117	78	9	3:02	92	9	6	3:00	42	29
	59 (9 years)	75	15	8:06	125	94	12	6:09	110	31	8	5:01	67	35
	65 (10 years)	74	13	7:03	122	88	9	4:02	100	26	6	4:07	63	28
	68 (7 years)	71	13	4:08	115	86	10	3:11	98	21	9	4:02	58	32

Note. *RS*: *Raw Score; V-S: v-Scale Score; AE*: *Age Equivalent*; GSV*:* Growth Scale Value.

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Note. REC: Receptive; EXP: Expressive; WRN: Written.

Figure E.3: Normal probability plot of the Communicative Range (Moment 3)

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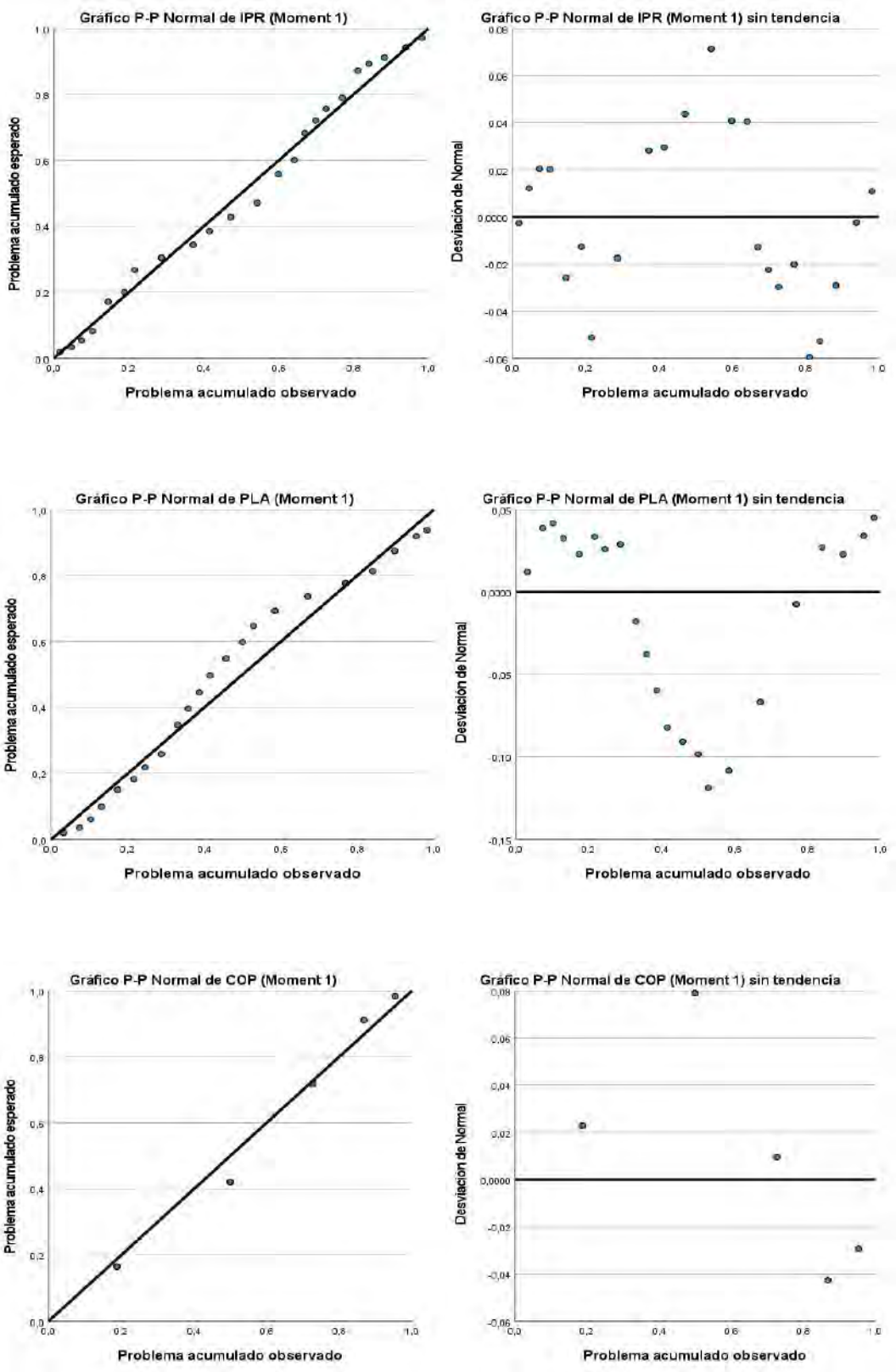
Table E.4

Social Range results (Moment 1)

	Participants	Interpersonal Relationships (ipr)				Play and Leisure (pla)				Coping Skills (cop)				Socialization (SOC)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (EC+)	69 (9 years)	37	5	1:05	72	31	6	2:02	66	3	4	<2:0	32	15
	71 (9 years)	35	4	1:04	70	30	5	2:01	66	4	4	<2:0	35	13
	67 (10 years)	36	4	1:05	71	32	5	2:03	67	2	3	<2:0	28	12
	5 (6 years)	26	5	0:10	64	21	7	1:06	59	1	4	<2:0	21	16
	19 (7 years)	22	3	0:07	60	18	5	1:04	56	1	3	<2:0	21	11
	29 (10 years)	30	2	1:00	67	30	4	2:01	66	1	2	<2:0	21	8
	12 (6 years)	35	7	1:04	70	26	8	1:09	63	1	4	<2:0	21	19
	27 (9 years)	44	6	1:10	76	28	4	1:11	64	1	2	<2:0	21	12
	17 (6 years)	31	6	1:01	68	12	4	0:09	50	1	4	<2:0	21	14
	25 (7 years)	37	7	1:05	72	19	5	1:04	57	1	3	<2:0	21	15
	1 (11 years)	38	4	1:06	72	35	5	2:06	69	2	2	<2:0	28	11
	4 (12 years)	43	5	1:09	76	37	5	2:08	70	5	2	<2:0	38	12
	14 (11 years)	34	3	1:04	70	33	4	2:04	68	2	2	<2:0	28	9
	7 (10 years)	51	7	2:05	81	32	5	2:03	67	2	3	<2:0	28	15
	26 (8 years)	53	9	2:08	82	31	7	2:02	66	5	5	<2:0	38	21
	21 (9 years)	30	3	1:00	67	27	4	1:10	64	2	3	<2:0	28	10
	11 (6 years)	24	4	0:09	62	10	3	0:07	48	1	4	<2:0	21	11
	24 (7 years)	34	6	1:04	70	20	5	1:05	58	3	4	<2:0	32	15
Group B (SymboTalk)	73 (8 years)	41	7	1:08	75	25	5	1:09	62	1	3	<2:0	21	15
	56 (8 years)	34	5	1:04	70	23	3	1:08	61	2	4	<2:0	28	12
	58 (10 years)	45	6	1:11	77	32	5	2:03	67	3	3	<2:0	32	14
	60 (7 years)	37	7	1:05	72	16	4	1:02	55	2	4	<2:0	28	15
	63 (6 years)	40	8	1:07	74	14	5	0:11	53	1	4	<2:0	21	17
	75 (7 years)	46	6	1:11	78	18	4	1:04	56	1	3	<2:0	21	13
	74 (11 years)	34	6	1:04	70	35	5	2:06	69	3	3	<2:0	32	14
	66 (10 years)	50	7	2:04	80	31	4	2:03	67	2	3	<2:0	28	14
	72 (8 years)	46	8	1:11	76	27	6	1:10	64	3	4	<2:0	32	18
	61 (10 years)	40	5	1:07	74	35	6	2:06	69	5	4	<2:0	38	15
	57 (9 years)	51	8	2:05	81	38	5	3:00	71	2	3	<2:0	28	16
	70 (8 years)	38	6	1:06	72	24	4	1:08	61	4	5	<2:0	35	15
	62 (9 years)	53	8	2:08	82	32	6	2:03	67	4	4	<2:0	35	18
	64 (6 years)	20	3	0:05	59	10	3	0:07	48	1	4	<2:0	21	10
	59 (9 years)	56	9	2:11	84	29	5	2:00	65	3	4	<2:0	32	18
	65 (10 years)	49	7	2:02	80	30	4	2:01	66	3	3	<2:0	32	14
	68 (7 years)	33	6	1:04	70	21	6	1:06	59	1	3	<2:0	21	15

Note. *RS*: *Raw Score; V-S: v-Scale Score; AE*: *Age Equivalent*; GSV*:* Growth Scale Value.

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Note. IPR: Interpersonal Relationships; PLA: Play and Leisure; COP: Coping Skills.

Figure E.4: Normal probability plot of the Social Range (Moment 1)

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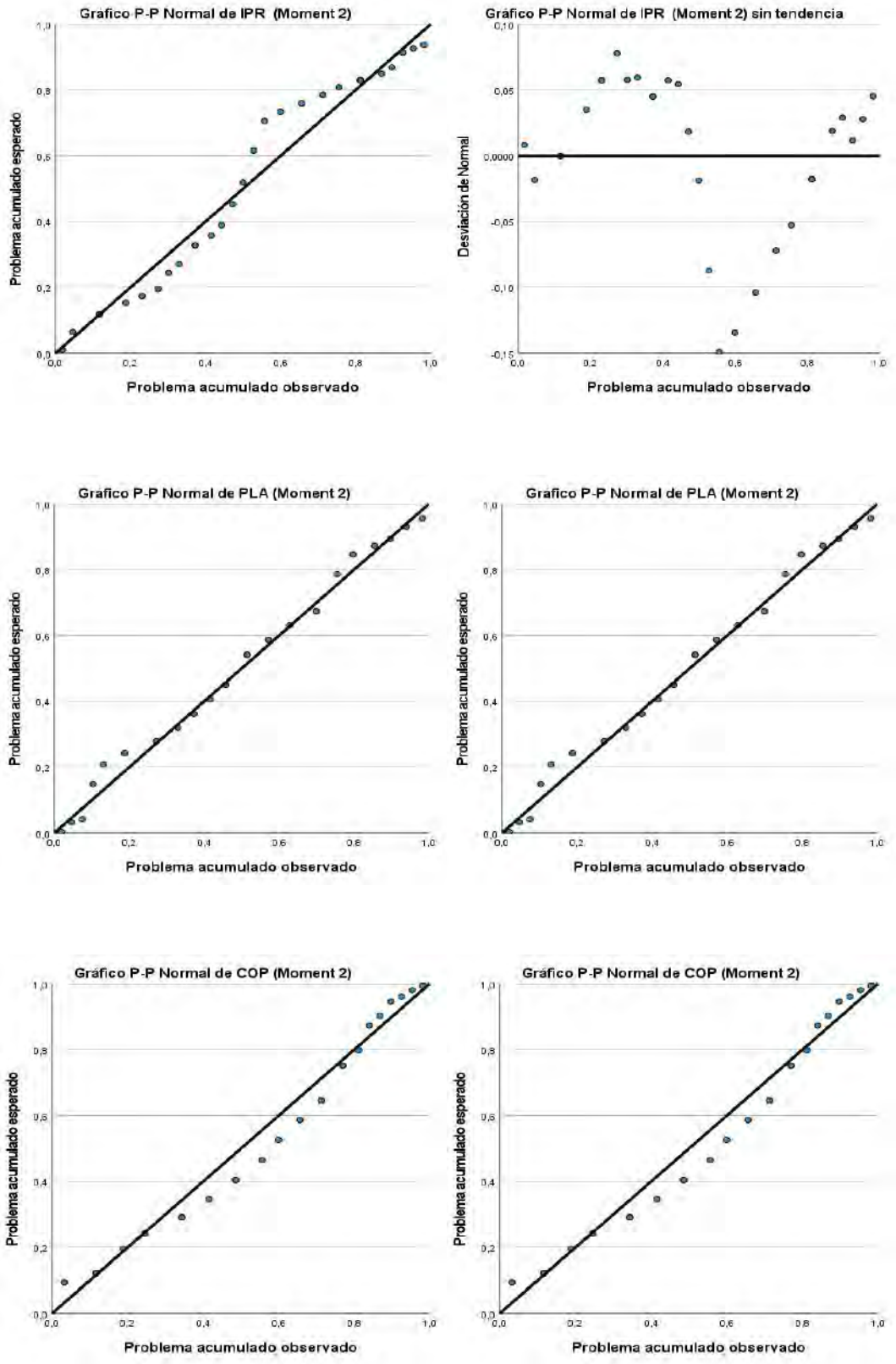
Table E.5

Social Range results (Moment 2)

	Participants	Interpersonal Relationships (ipr)				Play and Leisure (pla)				Coping Skills (cop)				Socialization (SOC)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (EC+)	69 (9 years)	47	7	2:00	78	31	6	2:03	67	10	6	<2:0	46	19
	71 (9 years)	44	6	1:10	76	40	8	3:02	72	5	4	<2:0	38	18
	67 (10 years)	41	5	1:08	75	38	7	3:00	71	14	7	<2:0	51	19
	5 (6 years)	34	7	1:04	70	31	9	2:02	66	5	6	<2:0	38	22
	19 (7 years)	37	7	1:05	75	35	9	2:06	69	5	6	<2:0	38	22
	29 (10 years)	34	3	1:04	70	30	4	2:01	66	2	3	<2:0	28	10
	12 (6 years)	45	9	1:11	77	45	12	3:09	76	6	6	<2:0	40	27
	27 (9 years)	43	6	1:09	76	37	7	2:10	70	9	6	<2:0	45	19
	17 (6 years)	36	7	1:05	71	27	8	1:10	64	4	6	<2:0	35	21
	25 (7 years)	30	5	1:00	67	21	6	1:06	59	6	6	<2:0	40	17
	1 (11 years)	56	8	2:11	84	51	10	4:08	81	8	5	<2:0	43	23
	4 (12 years)	57	8	3:00	85	49	9	4:04	79	26	8	<2:0	62	25
	14 (11 years)	34	3	1:04	70	33	4	2:04	68	6	4	<2:0	40	11
	7 (10 years)	55	8	2:10	84	46	9	3:10	77	11	6	<2:0	47	23
	26 (8 years)	49	8	2:02	80	49	11	4:04	79	8	6	<2:0	43	25
	21 (9 years)	38	5	1:06	72	32	6	2:03	67	8	6	<2:0	43	17
	11 (6 years)	20	3	0:05	59	12	4	0:09	50	1	4	<2:0	21	11
	24 (7 years)	34	6	1:04	70	20	5	1:05	58	12	8	<2:0	49	19
Group B (SymboTalk)	73 (8 years)	62	11	3:07	89	40	9	3:02	72	7	6	<2:0	42	26
	56 (8 years)	58	10	3:02	86	35	8	2:06	69	21	9	<2:0	58	27
	58 (10 years)	52	7	2:06	82	46	9	3:10	77	2	3	<2:0	28	19
	60 (7 years)	56	10	2:11	84	31	8	2:02	66	18	9	<2:0	55	27
	63 (6 years)	58	11	3:02	6	33	9	2:04	68	6	6	<2:0	40	26
	75 (7 years)	40	7	1:07	74	29	7	2:00	65	2	4	<2:0	28	18
	74 (11 years)	57	8	3:00	85	45	8	3:09	76	20	7	<2:0	57	23
	66 (10 years)	60	9	3:04	87	37	6	2:10	70	11	6	<2:0	47	21
	72 (8 years)	59	10	3:03	87	34	8	2:05	68	1	3	<2:0	21	21
	61 (10 years)	65	10	3:11	91	39	7	3:01	72	12	6	<2:0	49	23
	57 (9 years)	67	11	4:02	92	39	8	3:01	72	23	9	<2:0	60	28
	70 (8 years)	43	7	1:09	76	38	8	3:00	71	8	6	<2:0	43	21
	62 (9 years)	61	10	3:06	88	43	9	3:06	74	10	6	<2:0	46	25
	64 (6 years)	37	7	1:05	72	30	8	2:01	66	2	4	<2:0	28	19
	59 (9 years)	66	11	4:00	92	47	10	4:00	77	15	7	<2:0	52	28
	65 (10 years)	60	9	3:04	87	40	7	3:02	72	14	7	<2:0	51	23
	68 (7 years)	60	11	3:04	87	30	7	2:01	66	17	9	<2:0	54	27

Note. *RS*: *Raw Score; V-S: v-Scale Score; AE*: *Age Equivalent*; GSV*:* Growth Scale Value.

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Note. IPR: Interpersonal Relationships; PLA: Play and Leisure; COP: Coping Skills.

Figure E.5: Normal probability plot of the Social Range (Moment 2)

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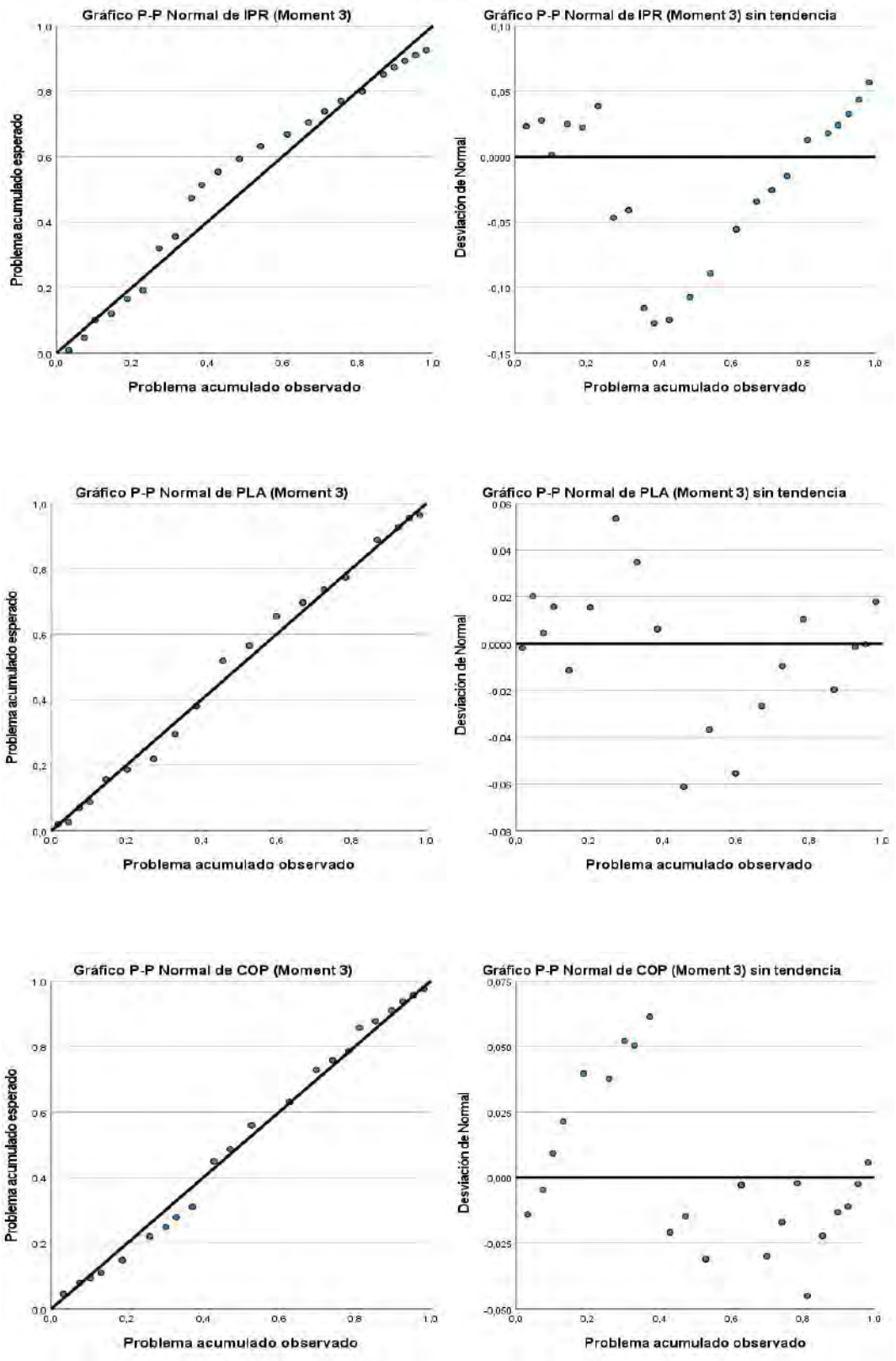
Table E.6

Social Range results (Moment 3)

	Participants	Interpersonal Relationships (ipr)				Play and Leisure (pla)				Coping Skills (cop)				Socialization (SOC)
		RS	V-S	AE	GSV	RS	V-S	AE	GSV	RS	V-S	AE	GSV	Sum of V-S
Group A (EC+)	69 (9 years)	68	11	4:04	93	44	9	3:08	75	12	7	<2:0	49	27
	71 (9 years)	60	9	3:04	87	52	11	4:10	81	8	5	<2:0	43	25
	67 (10 years)	64	10	3:10	90	42	8	3:05	74	36	10	3:02	70	28
	5 (6 years)	47	9	2:00	78	40	11	3:02	72	22	10	<2:0	59	30
	19 (7 years)	60	11	3:04	87	41	10	3:04	73	17	9	<2:0	54	30
	29 (10 years)	72	12	5:06	97	53	11	5:00	82	45	12	5:00	78	35
	12 (6 years)	40	8	1:07	74	31	9	2:02	66	16	9	<2:0	53	26
	27 (9 years)	59	9	3:03	87	49	10	4:04	79	25	9	<2:0	61	28
	17 (6 years)	52	10	2:06	82	42	11	3:05	74	22	10	<2:0	59	31
	25 (7 years)	55	10	2:10	84	41	10	3:04	73	23	10	<2:0	60	30
	1 (11 years)	63	9	3:08	89	61	13	8:06	91	25	8	<2:0	61	30
	4 (12 years)	67	10	4:02	92	63	14	9:08	94	15	6	<2:0	52	30
	14 (11 years)	66	10	4:00	92	53	10	5:00	82	38	10	3:06	72	30
	7 (10 years)	66	10	4:00	92	50	10	4:06	80	27	9	<2:0	63	29
	26 (8 years)	55	9	2:10	84	46	10	3:10	77	27	10	<2:0	63	29
	21 (9 years)	52	8	2:06	82	36	9	2:08	70	18	8	<2:0	55	25
	11 (6 years)	40	8	1:07	74	32	9	2:03	67	12	8	<2:0	49	27
	24 (7 years)	51	9	2:05	81	37	9	2:10	70	10	7	<2:0	46	25
Group B (SymboTalk)	73 (8 years)	68	12	4:04	93	52	12	4:10	81	15	8	<2:0	52	32
	56 (8 years)	69	12	4:06	94	50	11	4:06	80	30	10	2:02	66	33
	58 (10 years)	65	10	3:11	91	59	13	7:03	89	27	9	<2:0	63	32
	60 (7 years)	70	13	4:08	95	46	11	3:10	77	35	12	3:00	70	36
	63 (6 years)	54	10	2:09	83	46	12	3:10	77	12	8	<2:0	49	30
	75 (7 years)	70	13	4:08	95	49	12	4:04	79	5	5	<2:0	38	30
	74 (11 years)	72	11	5:06	97	55	11	5:06	84	25	8	<2:0	61	30
	66 (10 years)	75	13	7:00	100	64	15	11:00	96	31	9	2:04	66	37
	72 (8 years)	76	14	7:03	101	54	13	5:03	83	27	10	<2:0	63	37
	61 (10 years)	78	14	8:06	104	53	11	5:00	82	31	9	2:04	66	34
	57 (9 years)	71	12	5:00	96	55	12	5:06	84	40	12	3:10	74	36
	70 (8 years)	72	13	5:06	97	50	11	4:06	80	5	5	<2:0	38	29
	62 (9 years)	74	13	6:06	99	59	14	7:03	89	18	8	<2:0	55	35
	64 (6 years)	65	12	3:11	91	40	10	3:02	72	9	7	<2:0	45	29
	59 (9 years)	67	11	4:02	92	55	12	5:06	84	42	12	4:04	75	35
	65 (10 years)	77	14	7:09	103	59	13	7:03	89	36	10	3:02	70	37
	68 (7 years)	68	13	4:04	93	42	10	3:05	74	32	11	2:06	67	34

Note. *RS*: *Raw Score; V-S: v-Scale Score; AE*: *Age Equivalent*; GSV*:* Growth Scale Value.

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Note. IPR: Interpersonal Relationships; PLA: Play and Leisure; COP: Coping Skills.

Figure E.6: Normal probability plot of the Social Range (Moment 3)

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Table E.7

Behavioral Range results (Moment 1)

	Participants	Section A	Section B	Section C	Problematic behaviors
Group A (EC+)	69 (9 years)	9	9	13	31
	71 (9 years)	8	6	12	26
	67 (10 years)	10	7	14	31
	5 (6 years)	7	8	10	25
	19 (7 years)	11	9	15	35
	29 (10 years)	9	9	16	34
	12 (6 years)	7	3	11	21
	27 (9 years)	8	9	14	31
	17 (6 years)	11	10	9	30
	25 (7 years)	10	9	14	33
	1 (11 years)	6	9	13	28
	4 (12 years)	3	7	10	20
	14 (11 years)	9	8	15	32
	7 (10 years)	4	8	14	26
	26 (8 years)	11	7	13	31
	21 (9 years)	9	5	11	25
	11 (6 years)	5	3	11	19
	24 (7 years)	6	6	9	21
Group B (SymboTalk)	73 (8 years)	12	9	11	32
	56 (8 years)	10	8	11	29
	58 (10 years)	9	7	10	26
	60 (7 years)	10	9	14	33
	63 (6 years)	5	8	11	24
	75 (7 years)	11	7	11	29
	74 (11 years)	10	9	11	30
	66 (10 years)	12	7	13	32
	72 (8 years)	9	6	7	22
	61 (10 years)	11	8	11	30
	57 (9 years)	6	7	12	25
	70 (8 years)	8	6	12	26
	62 (9 years)	13	8	11	32
	64 (6 years)	12	9	9	30
	59 (9 years)	11	7	12	30
	65 (10 years)	10	8	9	27
	68 (7 years)	9	7	9	25

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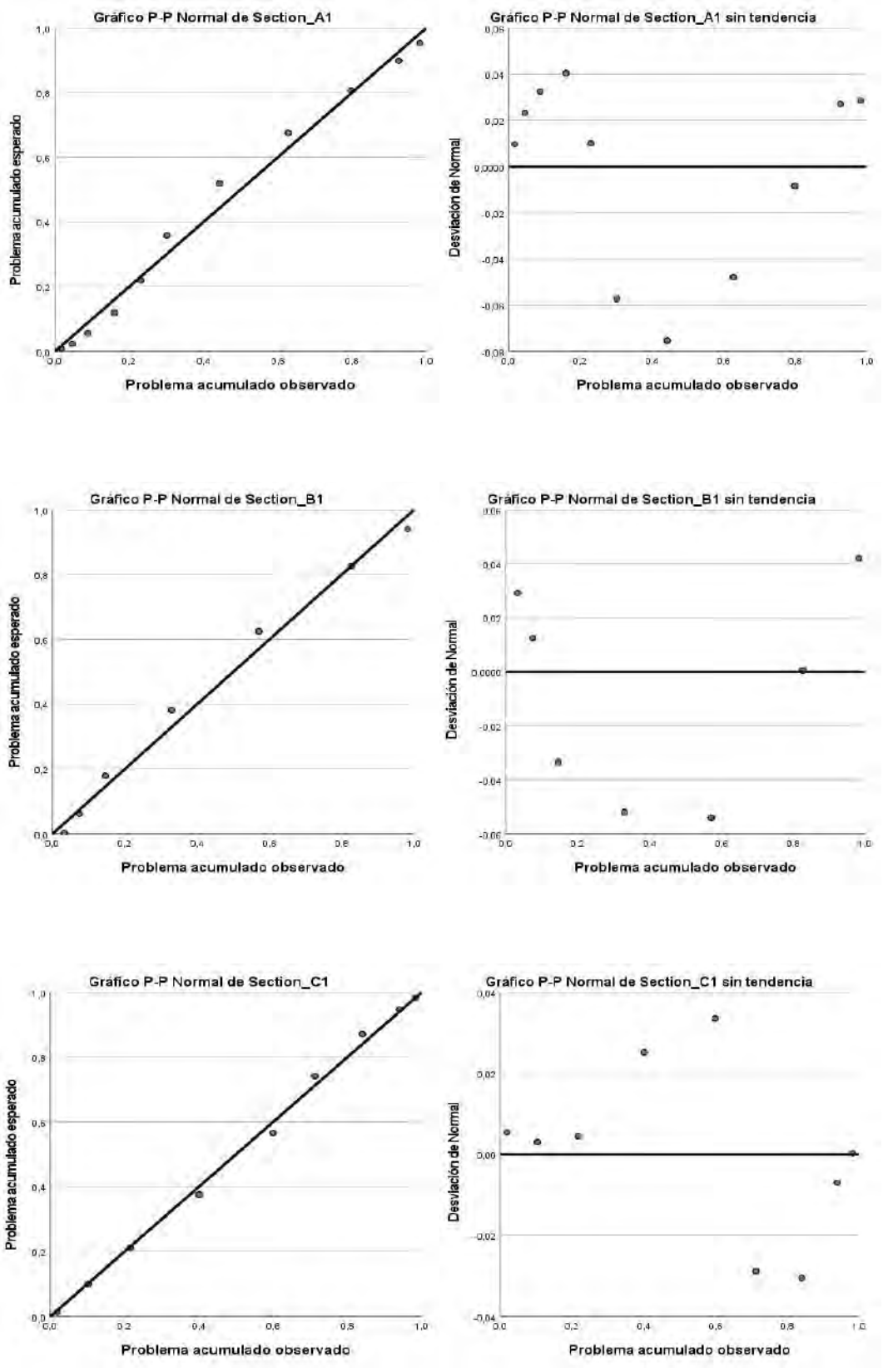


Figure E.7: Normal probability plot of the Behavioral Range (Moment 1)

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Table E.8

Behavioral Range results (Moment 2)

	Participants	Section A	Section B	Section C	Problematic behaviors
Group A (EC+)	69 (9 years)	9	9	10	28
	71 (9 years)	7	7	9	21
	67 (10 years)	9	6	9	24
	5 (6 years)	5	4	6	15
	19 (7 years)	10	9	7	26
	29 (10 years)	9	9	10	28
	12 (6 years)	5	3	5	13
	27 (9 years)	10	9	14	33
	17 (6 years)	9	10	9	28
	25 (7 years)	10	9	8	27
	1 (11 years)	4	6	7	17
	4 (12 years)	3	5	8	16
	14 (11 years)	4	5	10	19
	7 (10 years)	4	6	7	17
	26 (8 years)	11	7	10	28
	21 (9 years)	5	2	5	12
	11 (6 years)	5	4	8	17
	24 (7 years)	6	5	7	18
Group B (SymboTalk)	73 (8 years)	7	4	4	15
	56 (8 years)	6	3	4	13
	58 (10 years)	9	4	4	17
	60 (7 years)	10	6	5	21
	63 (6 years)	8	5	5	18
	75 (7 years)	9	6	3	18
	74 (11 years)	7	5	3	15
	66 (10 years)	8	3	4	15
	72 (8 years)	9	4	2	15
	61 (10 years)	4	5	11	20
	57 (9 years)	7	4	5	16
	70 (8 years)	5	3	4	12
	62 (9 years)	9	4	7	20
	64 (6 years)	6	4	10	20
	59 (9 years)	6	2	4	12
	65 (10 years)	10	7	13	30
	68 (7 years)	9	4	3	16

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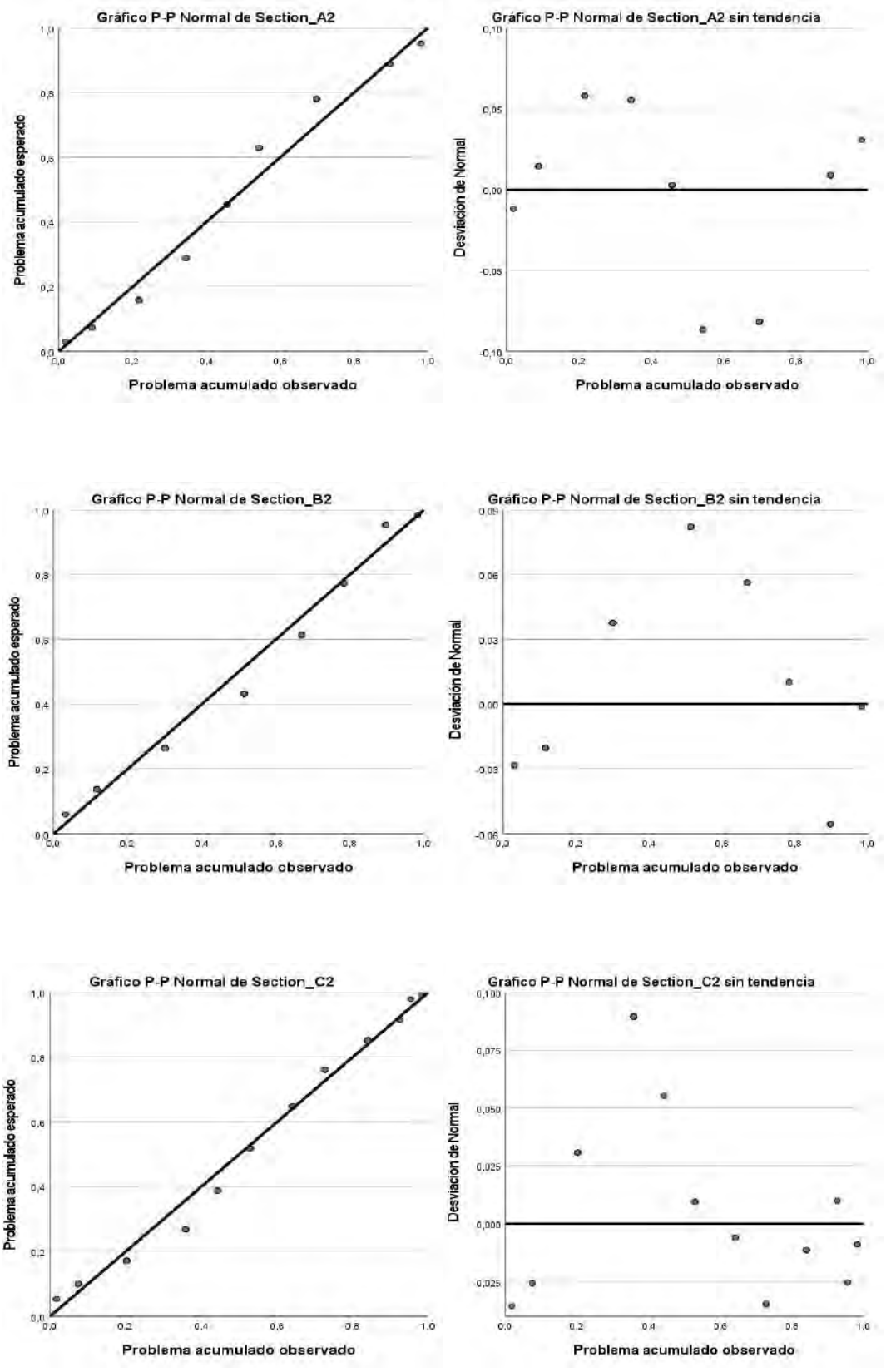


Figure E.8: Normal probability plot of the Behavioral Range (Moment 2)

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Table E.9

Behavioral Range results (Moment 3)

	Participants	Section A	Section B	Section C	Problematic behaviors
Group A (EC+)	69 (9 years)	5	3	4	12
	71 (9 years)	4	5	7	16
	67 (10 years)	6	4	5	15
	5 (6 years)	3	1	3	6
	19 (7 years)	2	3	1	6
	29 (10 years)	2	5	4	11
	12 (6 years)	2	1	2	5
	27 (9 years)	5	1	4	10
	17 (6 years)	1	7	2	10
	25 (7 years)	5	2	8	15
	1 (11 years)	1	3	2	6
	4 (12 years)	2	5	3	10
	14 (11 years)	3	4	1	8
	7 (10 years)	3	3	6	12
	26 (8 years)	2	6	4	12
	21 (9 years)	3	2	1	6
	11 (6 years)	5	2	3	10
	24 (7 years)	2	3	2	7
Group B (SymboTalk)	73 (8 years)	3	2	3	8
	56 (8 years)	5	3	4	12
	58 (10 years)	4	3	3	10
	60 (7 years)	2	2	3	7
	63 (6 years)	4	1	3	8
	75 (7 years)	3	2	2	7
	74 (11 years)	5	2	3	10
	66 (10 years)	3	3	2	8
	72 (8 years)	7	5	3	15
	61 (10 years)	4	2	2	8
	57 (9 years)	6	4	4	14
	70 (8 years)	2	1	2	5
	62 (9 years)	4	3	2	9
	64 (6 years)	6	3	3	12
	59 (9 years)	5	4	1	10
	65 (10 years)	7	4	4	15
	68 (7 years)	2	2	2	6

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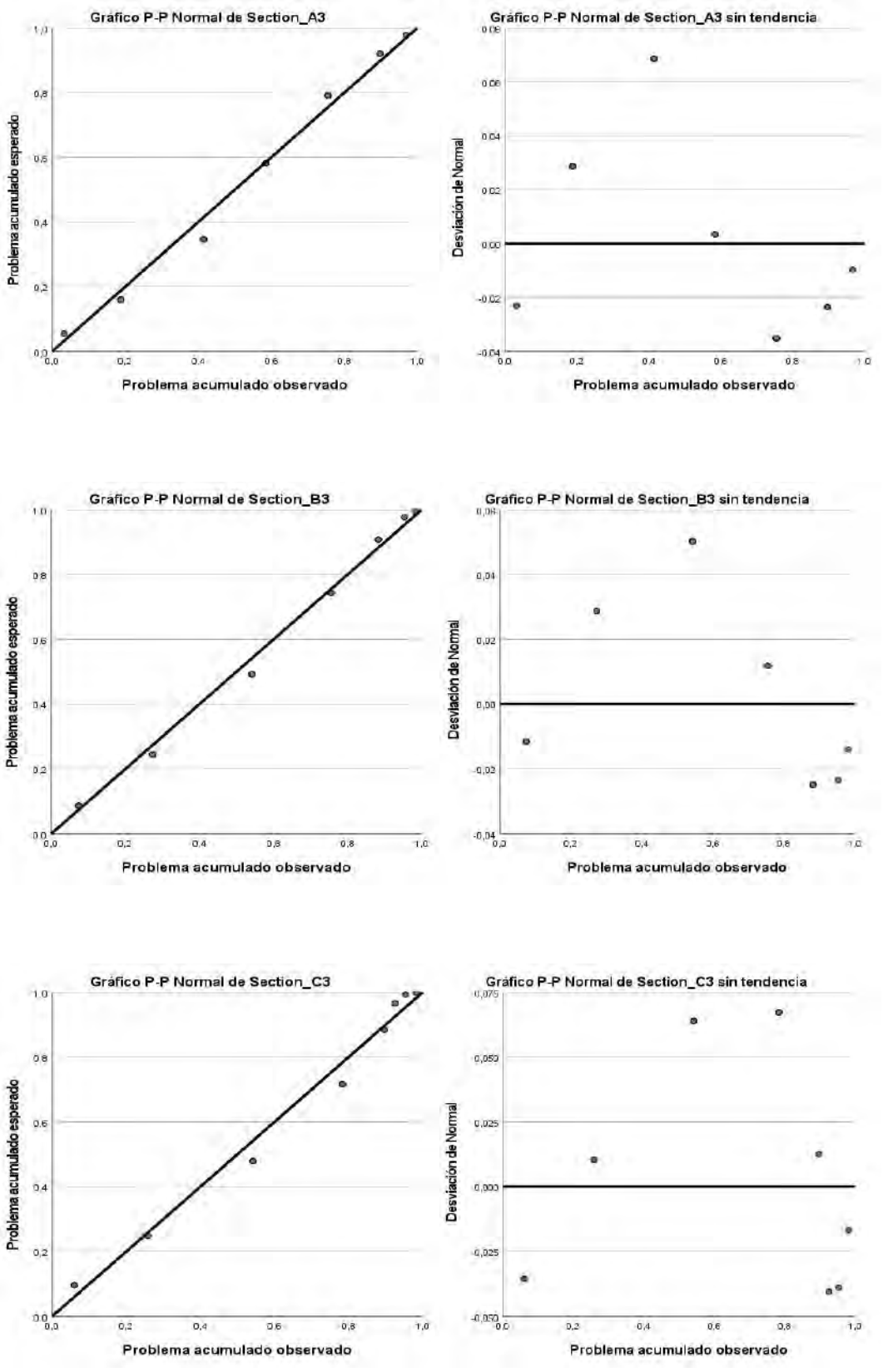


Figure E.9: Normal probability plot of the Behavioral Range (Moment 3)

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APPENDIX F

Visual documentation

The following section presents a series of photographs, all taken by the author of this thesis, to provide a detailed visual representation of the various AAC+a and AAC-a resources and supports utilized throughout the research. These images serve to illustrate key examples, enhancing the understanding of the materials employed in the study.

F.1 Paper-based pictograms from ARASAAC

The ARASAAC pictograms used in the studies from Chapters 5 and 6 were printed on paper and presented individually by the interlocutor alongside aided augmented input. Each pictogram measured 7 x 7 cm and was laminated to ensure durability and protection. The following images, taken inside the speech therapy office, show examples of paper-based pictograms from ARASAAC prepared for use, as seen in Figure F.1.1, F.1.2 and F.1.3.

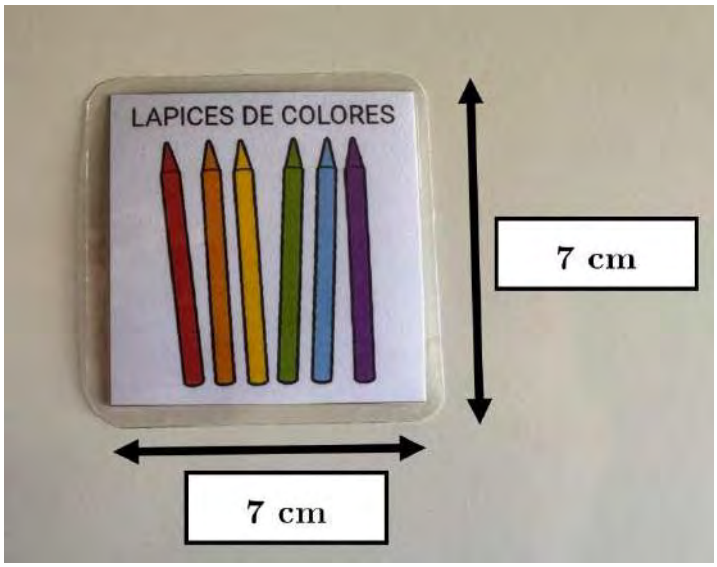


Figure F.1.1: ARASAAC visual example

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Figure F.1.2: ARASAAC pictograms from different semantic categories



Figure F.1.3: Examples of behavior-related pictograms

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F.2 Pictograms from Mi Estuche de Pictos ®

The pictograms from *Mi Estuche de Pictos* ®, used in the study presented in Chapter 6, have predefined characteristics that distinguish them from ARASAAC pictograms, although their symbolic level remains high. In this case, all pictograms have a standard size of 7 x 7 cm and are organized within the box using dividers that separate them by semantic fields, making selection easier. The laminated material used for all the pictograms enhances their durability and ensures resistance to wear and tear. Photographs of these elements are shown in Figure F.2.1, F.2.2 and F.2.3.



Figure F.2.1: Box of Mi Estuche de Pictos ®

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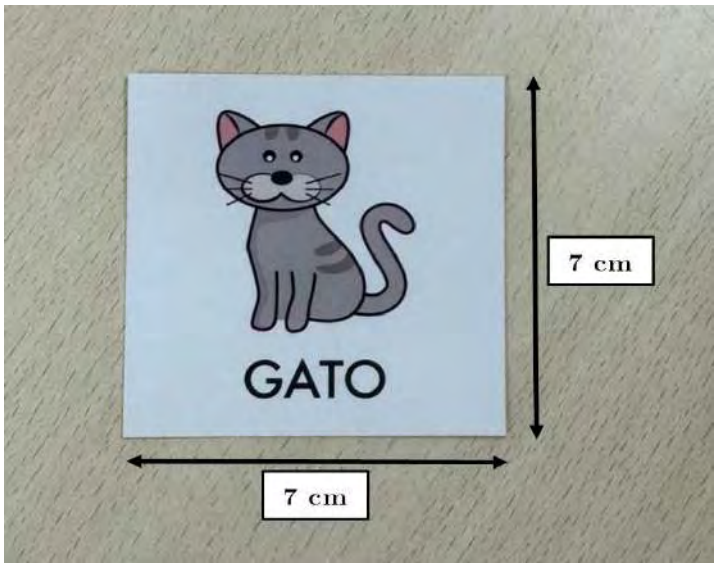


Figure F.2.2: Mi Estuche de Pictos ® visual example



Figure F.2.3: Pictograms of different semantic fields

F.3 EC+ technological support

The multimodal AAC+a support EC+ was used in Chapters 5 and 7. The EC+ pictograms, specifically designed for this app, were the primary tool during aided augmented input, with the option to complement them with videos or real images also available within the platform. The list of items visible on the tablet

screen, both in landscape and portrait modes, along with the multimodal functions, is presented in Figure F.3.1, F.3.2, F.3.3, F.3.4 and F.3.5.



Figure F.3.1: Use of the Tablet with EC+ running

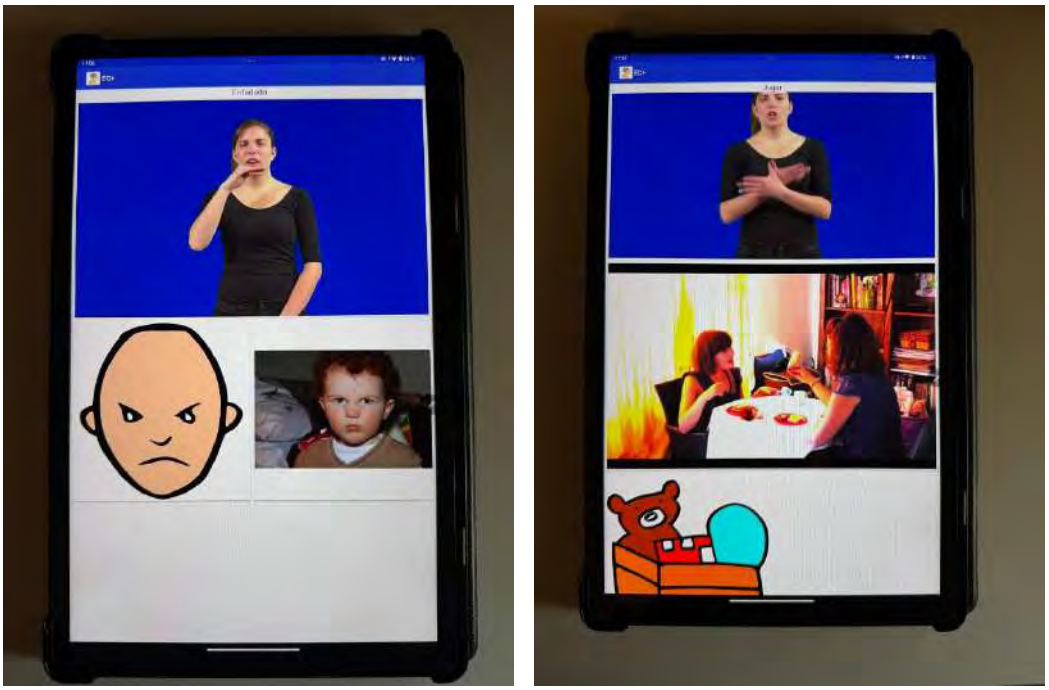


Figure F.3.2: EC+ visual example

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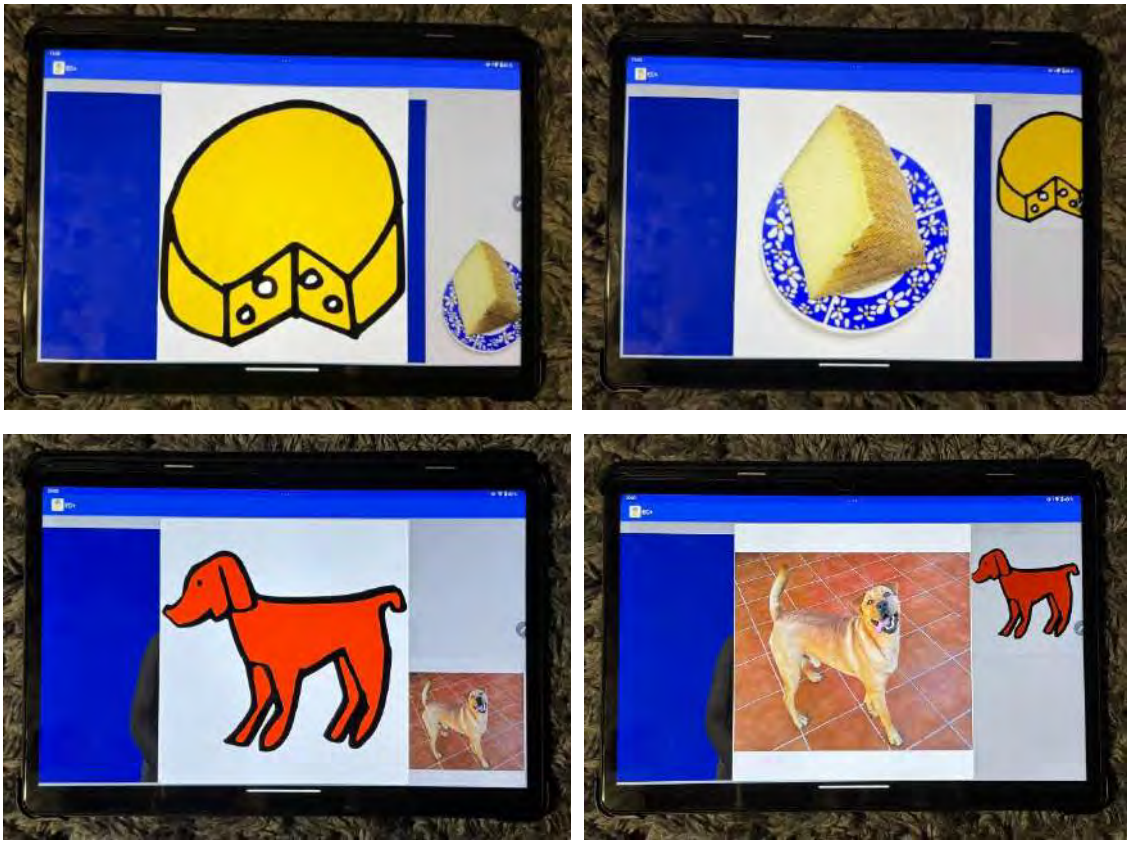


Figure F.3.3: Example of selecting a pictogram or image after clicking

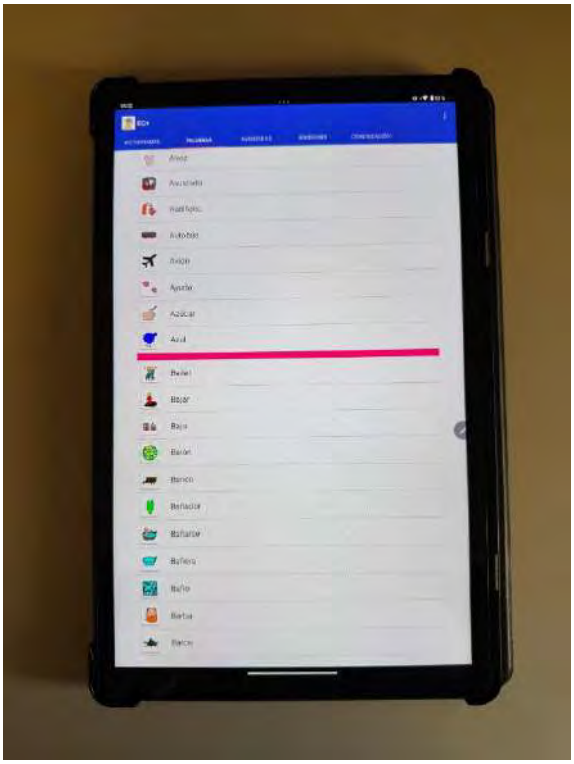


Figure F.3.4: List format with all elements

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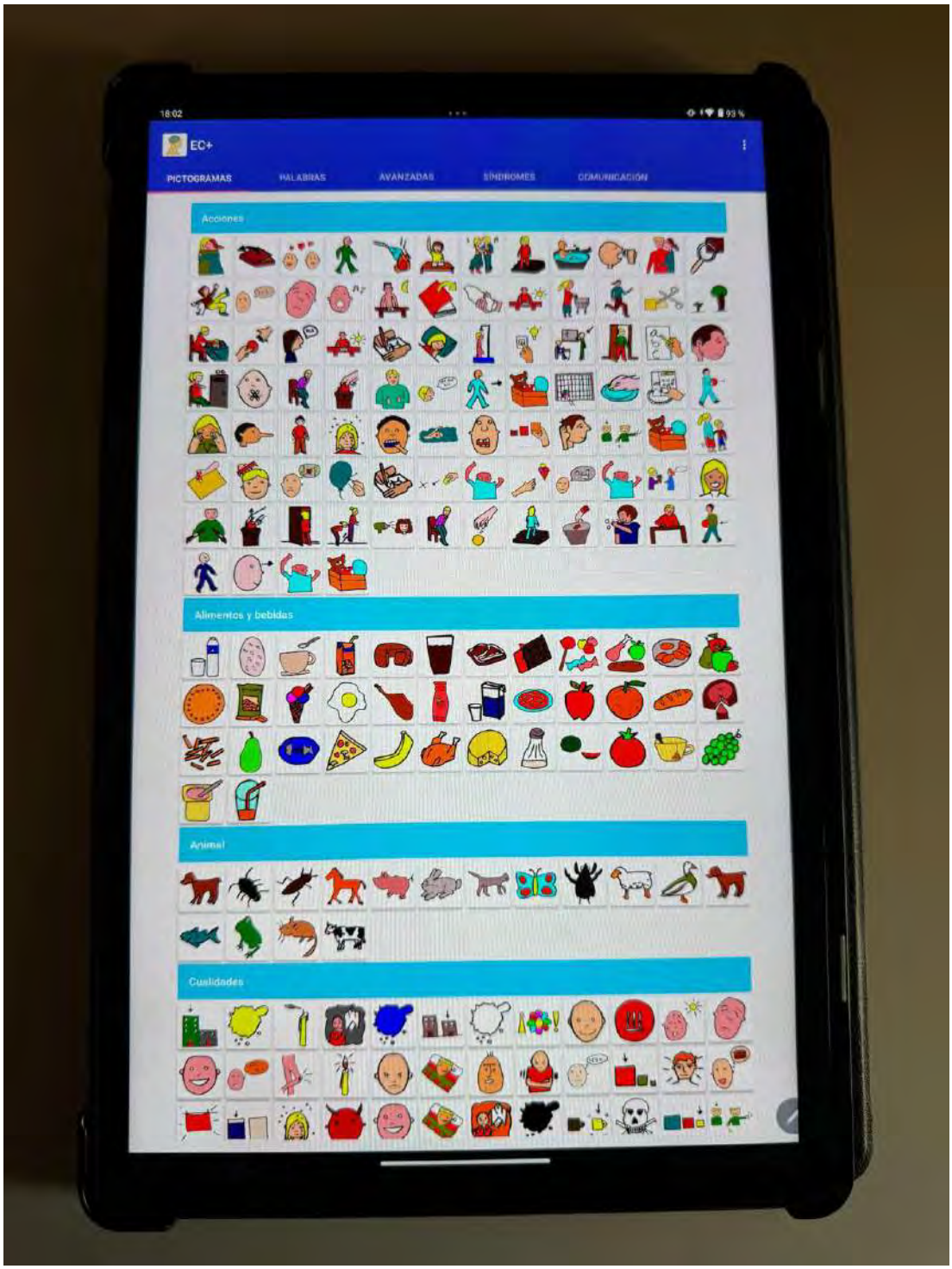


Figure F.3.5: EC+ interface (Portrait orientation)

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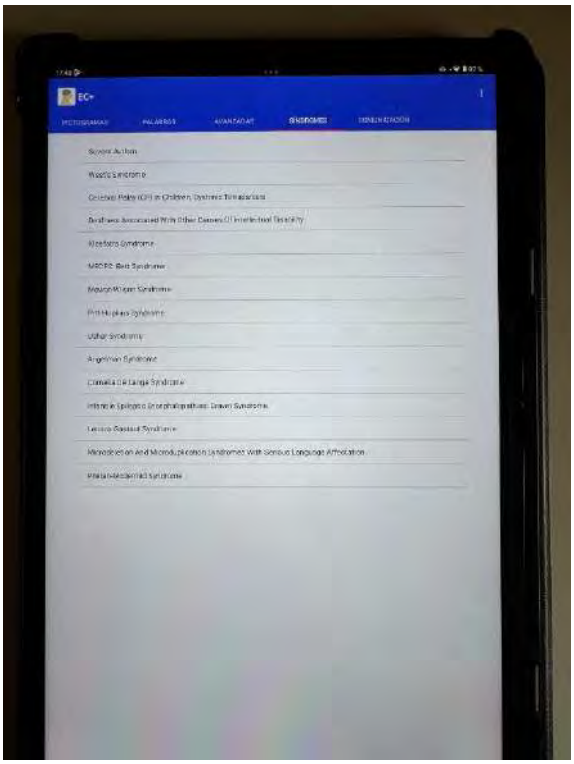


Figure F.3.6: Theoretical information included in the "SÍNDROMES" section (English mode)

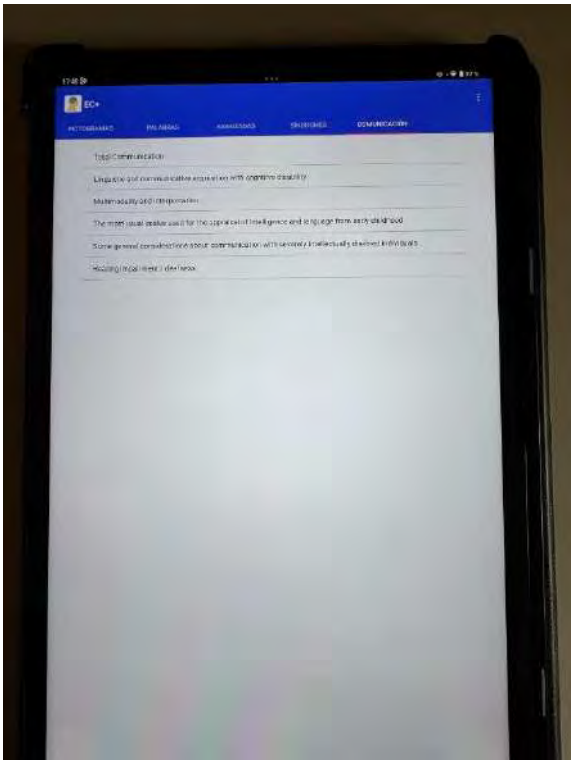


Figure F.3.7: Theoretical information included in the "COMUNICACIÓN" section (English mode)

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F.4 SymboTalk – AAC Talker ® communication board

The SymboTalk – AAC Talker ® app, used in Chapter 7 of this thesis, was presented on a tablet as part of the intervention strategy. The default pictograms come from ARASAAC, with the option to access the full range of content available on the website to add or edit new elements as needed. The communication board on the tablet screen, compatible only in landscape mode, along with the editing functions to add new pictograms, is presented in Figure F.4.1, F.4.2, F.4.3, F.4.4 and F.4.5.

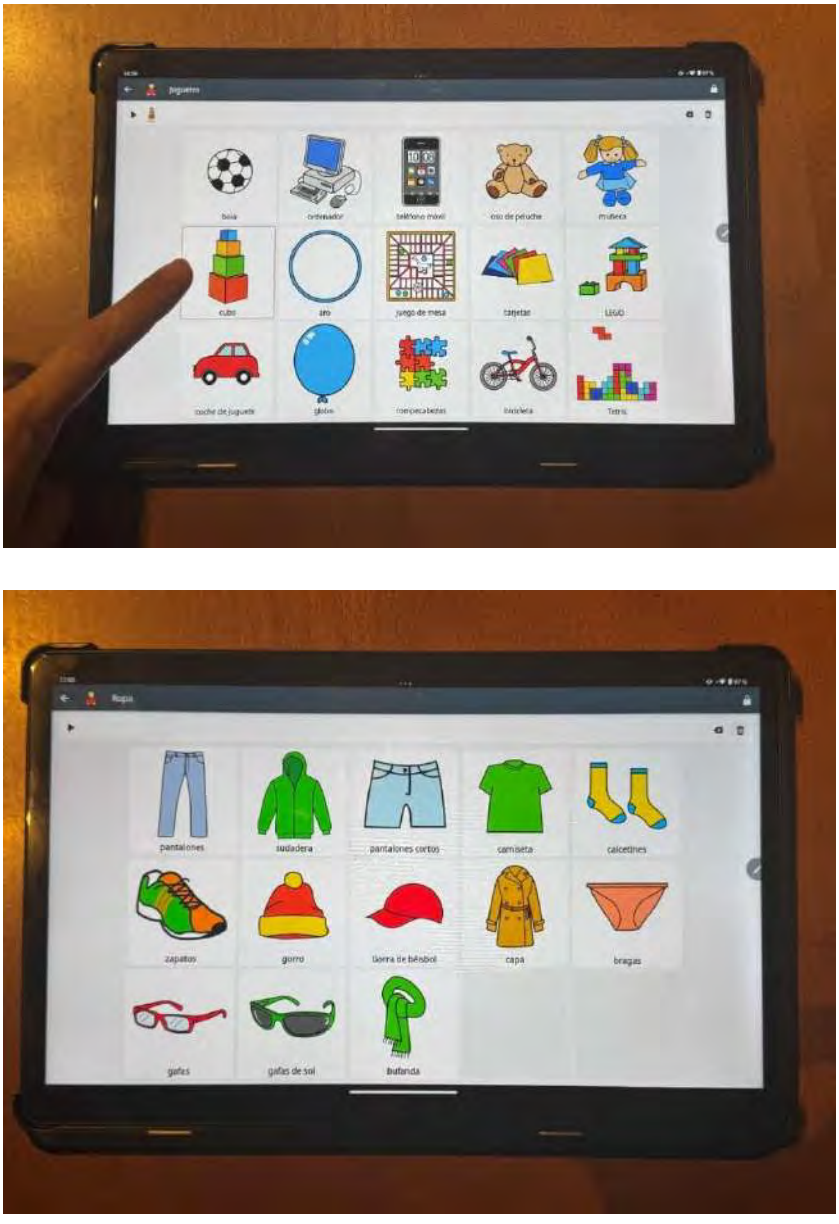


Figure F.4.1: Semantic field of "Toys" and "Clothing"

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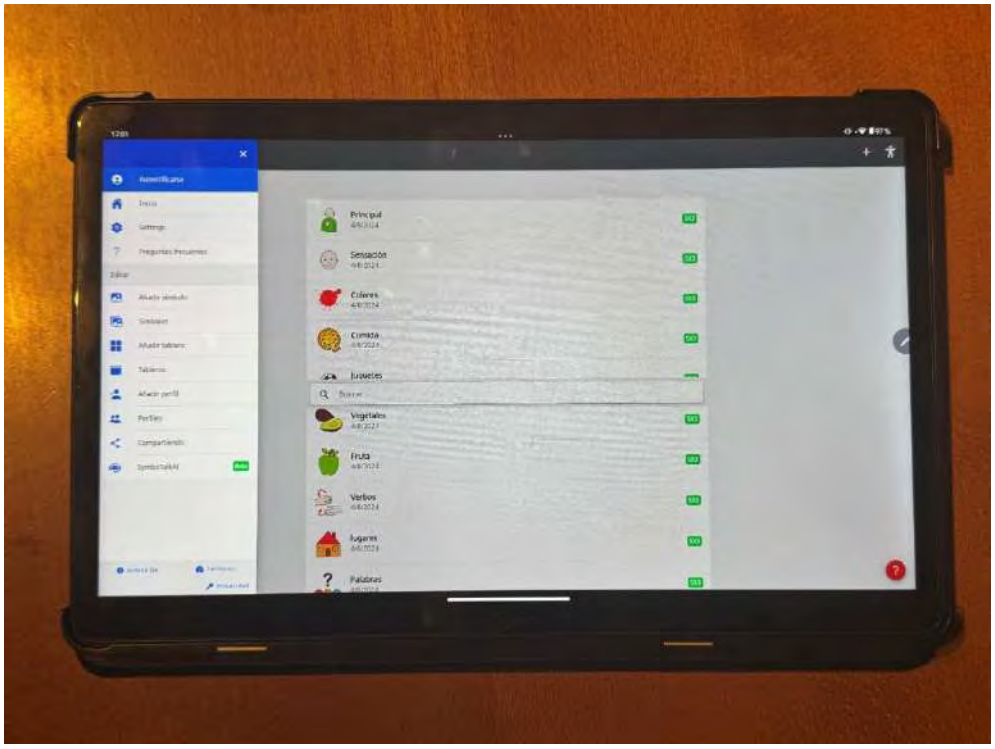
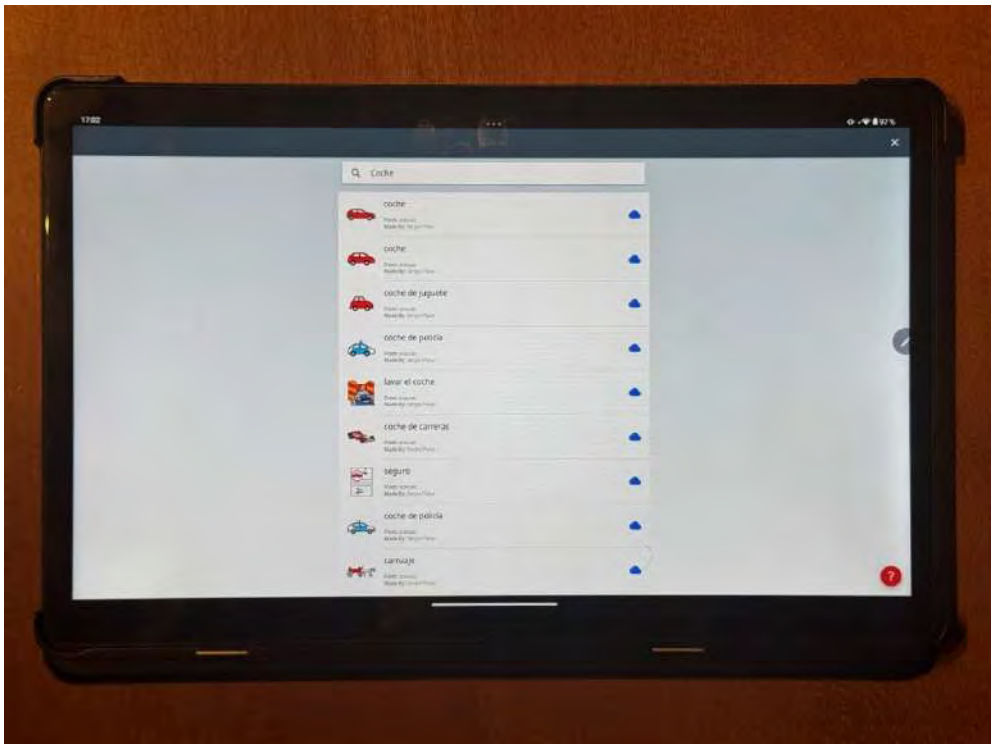


Figure F.4.2: App functionalities

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Figure F.4.3: Included pictogram search tool

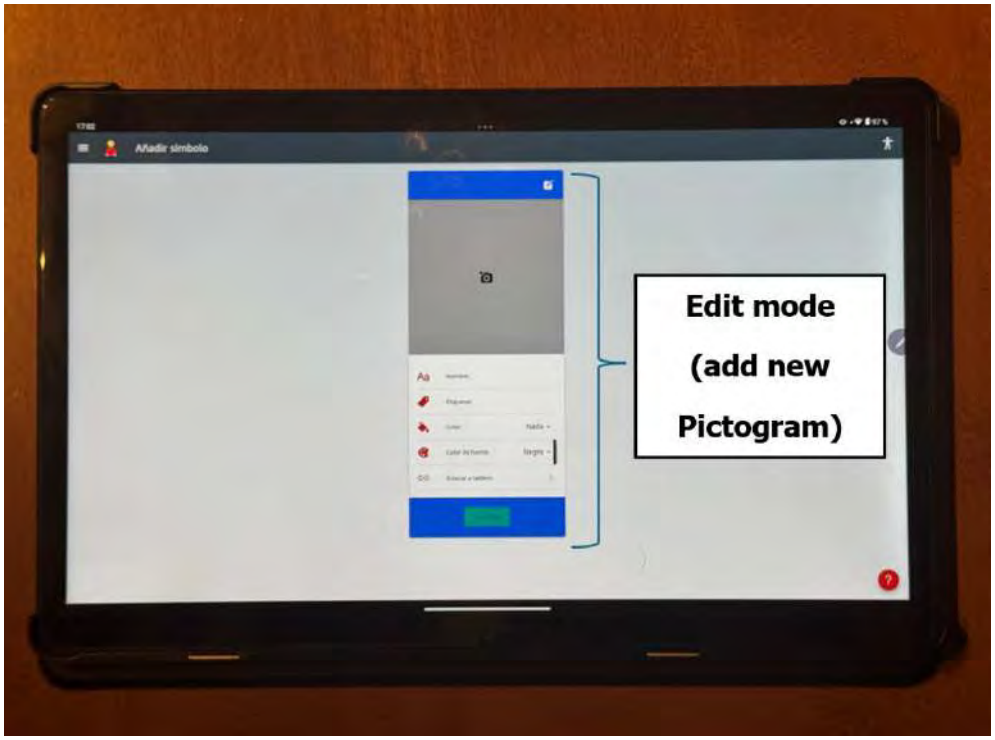


Figure F.4.4: Edit Mode function

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APPENDIX G

Dissemination of the thesis results

The main contributions resulting from this thesis are set out in this appendix.

G.1 Publication in Q1: Estimulación asistida del lenguaje y la app EC+ en el trastorno del espectro autista

This article is published in the *Revista Comunicar: Revista Científica de Comunicación y Educación*, year 2024, volume 32, no 79. The journal is indexed in the JCR at 9th/96 (Q1) in Communication and 17th/296 in Education in the year of publication, with an impact factor of 5.6.

It contains relevant results of the work presented in Chapter 5 of the thesis, which analyzes the influence of an AAC+a support, such as EC+, compared to AAC-a resources like paper-based ARASAAC pictograms, by conducting an intervention based on aided augmented input. In addition, the publication includes a fully written version in English, titled "Aided Augmented Input and the EC+ App in Autism Spectrum Disorder".

The first page of the publication, in both Spanish and English, is included on the following pages.

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www.comunicarjournal.com



Estimulación asistida del lenguaje y la app EC+ en el trastorno del espectro autista

Aided Augmented Input and the EC+ App in Autism Spectrum Disorder

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Dra. Marina Calleja-Reina, Universidad de Málaga (España) (marinac@uma.es)
(https://orcid.org/0000-0002-0089-7300)

RESUMEN
El trastorno del espectro autista (TEA) afecta significativamente las habilidades comunicativas, sociales y conductuales, especialmente en niños con TEA de Grado 3. Los sistemas de comunicación aumentativa y alternativa (CAA) pueden ayudar a enfrentar estos desafíos. La estimulación asistida del lenguaje surge como una estrategia de CAA que mejora la expresión y la comprensión a través de inputs visuales y orales del interlocutor. Por otra parte, el desarrollo de las tecnologías de la información y la comunicación (TIC) ha permitido su uso educativo y terapéutico para apoyar a personas con TEA, ya que proporciona herramientas versátiles y accesibles que facilitan el aprendizaje, la interacción y el desarrollo de sus habilidades. El objetivo del estudio es analizar los efectos de combinar la estimulación asistida del lenguaje con un soporte TIC multimodal llamado EC+, en comparación con recursos en papel de ARASAAC, sobre las habilidades comunicativas, sociales y conductuales. Se empleó un diseño cuasiexperimental para comparar los efectos de ambos recursos, incluyendo dos grupos de 6 niños cada uno, todos con TEA de Grado 3. Los resultados mostraron mejoras significativas con ambos recursos, pero el soporte TIC resultó más efectivo en el área de la comunicación y del comportamiento. Se concluye que EC+ ofrece un enfoque más interactivo y eficaz para mejorar el desarrollo global de los niños con TEA, y complementa los recursos en papel de manera valiosa e innovadora.

ABSTRACT
Autism spectrum disorder (ASD) significantly impacts communicative, social, and behavioral skills, especially in children with Level 3 ASD. Augmentative and alternative communication (AAC) systems can help address these challenges. Aided augmented input emerges as an AAC strategy that enhances expression and comprehension through visual and verbal inputs from the communicator. Additionally, the development of information and communication technologies (ICT) has enabled their educational and therapeutic use to support individuals with ASD, providing versatile and accessible tools that facilitate learning, interaction, and skill development. This study aims to analyze the effects of combining aided augmented input with a multimodal ICT support called EC+, compared to ARASAAC paper-based resources, on communicative, social, and behavioral skills. A quasi-experimental design was employed to compare the effects of both resources, including two groups of 6 children each, all with Level 3 ASD. The results showed significant improvements with both resources, but the ICT support proved more effective in the areas of communication and behavior. It is concluded that EC+ offers a more interactive and effective approach to enhancing the overall development of children with ASD, complementing paper-based resources in a valuable and innovative way.

PALABRAS CLAVE | KEYWORDS
Apps, Competencias Comunicativas, Métodos, Tecnología Educativa, TIC, Trastorno del Espectro Autista.
Apps, Communication Skills, Methods, Educational Technology, ICT, Autism Spectrum Disorder.

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DOI: https://doi.org/10.58262/V33279 | Páginas: 95-106

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Aided Augmented Input and the EC+ App in Autism Spectrum Disorder

Estimulación asistida del lenguaje y la app EC+ en el trastorno del espectro autista

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Dr. Marina Calleja-Reina, Universidad de Málaga (Spain) (marinac@uma.es) (https://orcid.org/0000-0002-0089-7300)

ABSTRACT

Autism spectrum disorder (ASD) significantly impacts communicative, social, and behavioral skills, especially in children with Level 3 ASD. Augmentative and alternative communication (AAC) systems can help address these challenges. Aided augmented input emerges as an AAC strategy that enhances expression and comprehension through visual and verbal inputs from the communicator. Additionally, the development of information and communication technologies (ICT) has enabled their educational and therapeutic use to support individuals with ASD, providing versatile and accessible tools that facilitate learning, interaction, and skill development. This study aims to analyze the effects of combining aided augmented input with a multimodal ICT support called EC+, compared to ARASAAC paper-based resources, on communicative, social, and behavioral skills. A quasi-experimental design was employed to compare the effects of both resources, including two groups of 6 children each, all with Level 3 ASD. The results showed significant improvements with both resources, but the ICT support proved more effective in the areas of communication and behavior. It is concluded that EC+ offers a more interactive and effective approach to enhancing the overall development of children with ASD, complementing paper-based resources in a valuable and innovative way.

RESUMEN

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KEYWORDS | PALABRAS CLAVE

Apps, Communication Skills, Methods, Educational Technology, ICT, Autism Spectrum Disorder.
Apps, Competencias Comunicativas, Métodos, Tecnología Educativa, TIC, Trastorno del Espectro Autista.

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DOI: https://doi.org/10.58262/V33279.9 | Pages: 95-106

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G.2 Publication in Q3/Q4: Enhancing communication and behavioral skills in Spanish-speaking children with autism spectrum disorder using SymboTalk and EC+: A pilot study

This article is published in the *Revista de Logopedia, Foniatría y Audiología*, year 2025, volume 45(3), no 100526. The journal is indexed in Scopus with a CiteScore of 1.1, ranking 44th out of 66 in Speech and Hearing (Q3) and 11th out of 16 in LPN and LVN (Q3). Additionally, it has an SJR of 0.156, placing it 58th out of 66 in Speech and Hearing (Q4) and 14th out of 17 in LPN and LVN (Q4). The journal also has an h-index of 14.

It includes relevant results from Chapter 7 of the thesis, which examines the influence of two different AAC+a supports: the multimodal EC+ app, where items are presented as pictograms in a list format, compared to SymboTalk ®, where they are displayed in a communication board format. The study focuses on aided augmented input as the central approach during intervention with participants with ASD.

The first page of the publication is included on the following page.

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Revista de Logopedia, Foniatría y Audiología 45 (2025) 100526

Revista de
LOGOPEDIA, FONIATRÍA y AUDIOLOGÍA

www.elsevier.es/logopedia



ORIGINAL ARTICLE

Enhancing communication and behavioral skills in Spanish-speaking children with autism spectrum disorder using SymboTalk and EC+: A pilot study

Antonio Javier Zurita Díaz*, **Marina Calleja Reina**

Faculty of Psychology and Speech Therapy, University of Málaga (UMA), C. Dr. Ortiz Ramos, 12, 29010 Málaga, Spain

Received 24 December 2024; accepted 28 February 2025

KEYWORDS
Autism spectrum disorder;
Aided augmented input;
Augmentative and alternative communication;
Information and communication technologies;
Technology

Abstract
Introduction: Autism spectrum disorder (ASD) is a neurological condition that impacts receptive and expressive communication as well as behavior. In this context, augmentative and alternative communication (AAC) strategies are increasingly integrated with information and communication technologies (ICT). ICT supports have significantly advanced AAC interventions, incorporating tools, software, and digital apps to facilitate information processing in educational and therapeutic settings. Despite the benefits, the wide range of these supports raises concerns about proper usage and optimal alignment with specific needs.
Method: This pilot study evaluated the impact of an intervention with two different AAC with assistance (AAC+a) on 40 participants with ASD Level 3 within a Spanish-speaking context: communication board from the SymboTalk platform and list-form from the multimodal EC+ app. These supports were implemented using the aided augmented input strategy, an intervention methodology that utilizes these supports to facilitate functional communication by combining visual and oral input.
Results: After 16 weeks, significant improvements in expressive and receptive communication were observed using the communication board support, although the other resource also proved to be a favorable support for the intervention. No differences were found between groups in behavioral outcomes and modes of communication.
Conclusions: The results highlight the effectiveness of these supports, emphasizing the importance of teaching communication skills and implementing this strategy in a Spanish-speaking context. This consideration is crucial given the unique characteristics of this context and its potential impact on children with ASD and complex communication needs.
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0214-4603/© 2025 Elsevier España, S.L.U. y Asociación Española de Logopedia, Foniatría y Audiología e Iberoamericana de Fonoaudiología. All rights are reserved, including those for text and data mining, AI training, and similar technologies.

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G.3 Book Chapter Publication: Lenguaje asistido aplicado a Trastorno del Espectro Autista mínimamente verbal con la herramienta EC+: Propuesta de un proyecto de intervención

This book chapter has been published in *Avances y desafíos en salud: Progresando desde la investigación*, edited by ASUNIVEP Publishing, a reputable publisher indexed in the Spi-Scholarly Publishers Indicators. The publication details are as follows:

- ISBN: 978-84-09-48790-5
- Legal deposit: AL 430-2023
- Publication date: March 7, 2023

The book is indexed in various scientific databases, including Dialnet. It has undergone a thorough peer-review process conducted by an editorial committee composed of doctoral-level specialists from diverse fields such as Nursing, Physiotherapy, Medicine, and Psychology, ensuring the scientific and professional value of each published work. It is available in print format, with a significant number of copies distributed both nationally and internationally, including to various Spanish universities.

The first page of the publication is included on the following page.

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Lenguaje asistido aplicado a Trastorno del Espectro Autista minimamente verbal con la herramienta EC+: propuesta de un proyecto de intervención

Antonio Javier Zurita Díaz y Marina Calleja Reina
Universidad de Málaga

Introducción

El Trastorno del Espectro Autista (en adelante TEA) se trata de una afección del desarrollo caracterizado por la carencia de relaciones sociales y habilidades comunicativas, la insistencia en rutinas, la inflexibilidad al cambio, la falta de afectividad, el aislamiento generalizado y por la aparición de alteraciones en el pensamiento, los sentimientos y el lenguaje (Sauer et al., 2021). Su etiología se considera multifactorial, destacando las alteraciones neurológicas funcionales y estructurales de origen epigenético y genético (Reynoso et al., 2017), y las causas ambientales como una edad avanzada en los padres, dificultades en el parto, enfermedades inmunológicas durante el embarazo o a la exposición de altos niveles de contaminación en el aire entre otros aspectos (Bhandari et al., 2020). En cuanto a su prevalencia, se estima que existen más de 70 millones de personas afectadas con el trastorno a nivel mundial, con una dominancia de aproximadamente un caso de TEA por cada 100 nacimientos, siendo habitual una aparición más frecuente en niños que en niñas, en una proporción de 4:1 aproximadamente. Según los estudios más recientes, en España se pueden encontrar 15,5/1000 niños con TEA en etapa preescolar y 10/1000 en etapa escolar (Narzisi et al., 2020).

El área comunicativa y del lenguaje puede estar realmente afectado en los niños con TEA, llegando a encontrar un 25% de casos en los que no se desarrolla un habla funcional como tal. Las primeras alteraciones comienzan a manifestarse a partir de los 9 meses de edad, cuando se produce una falta de iniciativa en las relaciones y en la respuesta con otras personas, siendo más notorias a partir de los 18 meses, cuando puede haber ausencia o limitaciones del lenguaje y de la comunicación. La detección y su posterior intervención puede sufrir un retraso por la falta de señales, siendo habitual que su diagnóstico se haga a partir del segundo año de vida, en el momento en que aparecen otros síntomas que afectan al sujeto en todos los contextos a los que está expuesto (Shen y Piven, 2022). Entre los 18 meses y los 5 años se desarrollan una serie de limitaciones, caracterizadas por la aparición de las primeras estereotipias, el aislamiento generalizado, la falta de interacciones en el juego y déficit a nivel comunicativo. Desde los 5 años hasta la adolescencia y la posterior vida adulta, hay una evolución desigual marcada por la intervención y por la aparición de otras posibles alteraciones como la epilepsia, la depresión o la hiperactividad (Lai, 2022).

Las alteraciones de la comunicación en el TEA han llevado a numerosos investigadores a idear una serie de posibles estrategias de intervención que se adecuen a las características de esta patología. Haciendo uso de las habilidades visoespaciales de los niños con TEA, se han generado formas de actuar mediante el uso de diferentes sistemas de Comunicación Aumentativa y Alternativa (CAA). Dentro de la intervención en CAA, se encuentra lo que se conoce como la Estimulación Asistida del Lenguaje, un método en el que se impulsa la comunicación expresiva y la comprensión mediante el uso de estímulos visuales por parte de un interlocutor (O'Neill et al., 2018). Se trata de una estrategia de modelado del lenguaje que proporciona una vía para utilizar símbolos gráficos como un modo de comunicación viable, trabajando directamente el input lingüístico en cualquier situación comunicativa, como por ejemplo durante las interacciones cotidianas, la creación de rutinas e incluso durante las instrucciones del propio CAA o de nuevos aprendizajes en la terapia. Para que se produzca esta generalización en distintos contextos, se recomienda habilitar el entorno social del individuo, recibiendo un input oral por parte de los interlocutores para que las experiencias del lenguaje de los niños sean similares a aquellos que tienen un desarrollo normo-típico.

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G.4 Book Chapter Publication: La influencia de la estimulación asistida del lenguaje en el componente comunicativo y lingüístico evaluado con el protocolo PCL-DIS-NCC

This book chapter has been published in *Investigación y desarrollo de recursos de intervención en contextos clínicos y de la salud*, edited by DYKINSON Publishing, which is ranked in the first quartile (Q1) of the Scholarly Publishers Indicators (SPI) ranking—the only ranking that evaluates the prestige of national and international publishers, developed by the Spanish National Research Council (CSIC).

The publication details are as follows:

- ISBN: 978-84-1170-860-9
- Publication date: December 18, 2023

The book has undergone a rigorous peer-review process conducted by an editorial committee composed of specialists from various fields, ensuring the scientific and professional value of each published work. Its dissemination has been both national and international.

The first page of the publication is included on the following page.

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LA INFLUENCIA DE LA ESTIMULACIÓN ASISTIDA DEL LENGUAJE EN EL COMPONENTE COMUNICATIVO Y LINGÜÍSTICO EVALUADO CON EL PROTOCOLO PCL-DIS-NCC

ANTONIO JAVIER ZURITA DÍAZ Y MARINA CALLEJA REINA
Universidad de Málaga

INTRODUCCIÓN

La comunicación se puede definir como la transmisión de señales mediante un código compartido entre el emisor y el receptor. Este concepto no ha de ser confundido con el lenguaje, el cual se forma a partir de un código arbitrario que se emplea para comunicarse y así interactuar con el medio. Ambos procesos están conectados y desempeñan un papel esencial en el desarrollo humano, puesto a que facilitan el aprendizaje y la expresión de emociones, necesidades, deseos, gustos y pensamientos (Romski, Sevcik, Barton-Hulsey, y Whitmore, 2015). Aunque la capacidad comunicativa es innata, se desarrolla principalmente durante la infancia a través del contacto e interacción con otros individuos en los contextos naturales donde se desenvuelva el niño (Gómez y Strasser, 2021). No obstante, este proceso puede verse afectado, desarrollando dificultades y generando numerosas limitaciones que van a repercutir en su día a día. Todo ello se puede ver reflejado en las personas con trastorno del espectro autista (TEA), encontrando un 25% de casos donde no se llega a desarrollar un habla considera como funcional (Eigsti et al., 2016). Según la quinta edición del Diagnostic and Statistical Manual of Mental Disorders o DMS-5 (American Psychiatric Association [APA], 2013) el TEA es un trastorno del neurodesarrollo caracterizado por carencias en las habilidades de la comunicación y de las relaciones sociales, acompañado de insistencia en rutinas y resistencia al cambio, afectividad limitada, aislamiento y alteraciones en el pensamiento, en los sentimientos y en el lenguaje (Sauer, Stanton, Hans, y Grabrucker, 2021).

El TEA representa un diagnóstico complejo cuya evaluación es de carácter prescriptivo y multiaxial, delimitado en gran parte por la observación de las carencias conductuales en las habilidades comunicativas, en las interacciones sociales y en el rango comportamental, considerados los signos afectados más destacables de esta población (Lai, 2022). El proceso de evaluación se lleva a cabo a partir de escalas de cribado, entrevistas y pruebas sobre el desarrollo general, pudiendo dividirlo en dos etapas: la primera se produce a través de una evaluación del desarrollo procesada por profesionales que detecten alguna irregularidad, como en el caso del pediatra, psicólogos especializados, el logopeda o un experto en salud. La segunda etapa se lleva a cabo a partir de una evaluación mucho más minuciosa por parte de un equipo de

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G.5 Book Chapter Publication: El uso combinado de la Estimulación Asistida del Lenguaje con la herramienta digital EC+ en la intervención logopédica

This book chapter has been published in *Innovación docente e investigación en salud: Nuevas tendencias para el cambio en la enseñanza superior*, edited by DYKINSON Publishing, which is ranked in the first quartile (Q1) of the Scholarly Publishers Indicators (SPI) ranking—the only ranking that evaluates the prestige of national and international publishers, developed by the Spanish National Research Council (CSIC).

The publication details are as follows:

- ISBN: 978-84-1170-863-0
- Publication date: December 28, 2023

The book has undergone a rigorous peer-review process conducted by an editorial committee composed of specialists from various fields, ensuring the scientific and professional value of each published work. Its dissemination has been both national and international.

The first page of the publication is included on the following page.

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EL USO COMBINADO DE LA ESTIMULACIÓN ASISTIDA DEL LENGUAJE CON LA HERRAMIENTA DIGITAL EC+ EN LA INTERVENCIÓN LOGOPÉDICA

ANTONIO JAVIER ZURITA DÍAZ Y MARINA CALLEJA REINA
Universidad de Málaga

INTRODUCCIÓN

El uso de sistemas de Comunicación Aumentativos y Alternativos (CAA) en combinación con las Tecnologías de la Información y de la Comunicación (TIC) ha generado una nueva dimensión de estudio y ha revolucionado la forma en que se aborda la intervención en personas con dificultades comunicativas, sobre todo, en el ámbito docente y logopédico.

La CAA se presenta como un enfoque terapéutico que complementa o reemplaza el habla oral, permitiendo a los individuos comunicarse de manera efectiva utilizando diferentes formas de expresión, como pictogramas, gestos o símbolos visuales (Calleja, 2018). Estos sistemas ofrecen una herramienta valiosa para superar las barreras comunicativas y brindar a las personas la capacidad de expresar sus necesidades, pensamientos y emociones de manera autónoma, adaptándose a sus necesidades y a diferentes contextos naturales (Landa, 2018). Dentro de los métodos de intervención con el uso CAA se encuentra la metodología de la Estimulación Asistida del Lenguaje, una estrategia del modelado del lenguaje en el que se impulsa la comunicación expresiva y la comprensión mediante el uso de estímulos visuales por parte del propio interlocutor (O´Neill et al., 2018). Se trabaja directamente el input lingüístico en cualquier situación comunicativa, como por ejemplo durante las interacciones cotidianas, la creación de rutinas e incluso durante las instrucciones de nuevos aprendizajes en la terapia. Todo ello proporciona más oportunidades, tanto sociales como educativas, aprovechando las habilidades de estas personas y desarrollando aquellas que puedan estar afectadas (Gómez-Taibo y Eligio de la Puente, 2016).

Por otra parte, las TIC, que incluyen aplicaciones, programas informáticos y dispositivos digitales, ofrecen un amplio abanico de posibilidades para el apoyo y la mejora de las habilidades comunicativas. Estas tecnologías permiten una personalización y adaptación flexibles a las necesidades individuales, así como la creación de entornos interactivos y motivadores que facilitan la adquisición y la práctica de nuevas habilidades lingüísticas (Quiroga et al., 2019). Un ejemplo de herramienta que combina CAA y recurso TIC es EC+, una aplicación gratuita compatible con Android e IOS desarrollada en la Universidad de Málaga por los investigadores y expertos en software Luque et al. (2018). Su propósito principal es

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G.6 Contribution to an international congres: VI Congreso Internacional de Intervención e Investigación en Salud (CIIIS), 21 – 22 February 2023, Almeria, Spain.

A contribution was presented at the VI Congreso Internacional de Intervención e Investigación en Salud (VI CIIIS) titled: "Lenguaje asistido aplicado a Trastorno del Espectro Autista mínimamente verbal: Análisis descriptivo de tres casos". This study represents one of the first approaches to the aided augmented input strategy and the assessment of its effects on communication, social interaction, and behavior, all analyzed using the Vineland-3 scale.

The contribution is included on the following page.

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Lenguaje asistido aplicado a Trastorno del Espectro Autista mínimamente verbal. Análisis descriptivo de tres casos

VI CONGRESO INTERNACIONAL DE INTERVENCIÓN E INVESTIGACIÓN EN SALUD
Murcia 21 Y 22 DE FEBRERO DE 2023

Antonio Javier Zurita Díaz y Marina Calleja Reina

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Proyecto *Herramienta digital para evaluar comunicación y lenguaje en personas con necesidades complejas de comunicación: comunicación inclusiva*. II Plan Propio de Investigación y Transferencia, UMA (Referencia B2-2022_02)
Proyecto Red Temática de Investigación: *Prácticas eficientes de comunicación inclusiva en poblaciones con enfermedades infrecuentes* (COMIN-ENIN). II Plan Propio de Investigación y Transferencia, UMA (Referencia D5-2022_01)

1. INTRODUCCIÓN

La **Estimulación Asistida del Lenguaje** (Goossens & Crain, 1986) es una intervención en la que se impulsa la comunicación expresiva y la comprensión mediante el uso de estímulos visuales por parte de un interlocutor. La estrategia consiste en el uso conjunto de un input de naturaleza oral y otro de naturaleza visual, donde al aumentar el input, se pretende favorecer la comprensión y ayudar al niño a aclarar y comprender el mensaje (Drager et al. 2006). Esta estrategia puede resultar beneficiosa para niños con **Trastorno del Espectro Autista** (TEA) con severas alteraciones sociales, comunicativas y conductuales.

En la actualidad, existen pocas evidencias de los efectos del uso del lenguaje asistido en personas con TEA de habla española.



Figura 1: Ejemplos de Estimulación Asistida del lenguaje

2. OBJETIVO

Evaluar el impacto del lenguaje asistido en niños con TEA a **nivel comunicativo, receptivo y conductual**

3. MÉTODO

La intervención se ha llevado a cabo con tres niños de 5 años diagnosticados de TEA mínimamente verbales y cuya lengua materna es el español. En sesiones clínicas estructuradas, el logopeda debe señalar los símbolos pictográficos en un tablero de comunicación junto a la estimulación del lenguaje oral, proporcionando el input correspondiente, haciendo extensiones y reforzando las respuestas correctas. El niño generalizará las interacciones de una manera natural y constante. Se ha usado la **escala Vineland-3** para evaluar los dominios de la comunicación, la socialización y la conducta a partir de las puntuaciones obtenidas.

4. RESULTADOS

Durante 10 semanas con una intervención basada en el lenguaje asistido, los datos fueron analizados mediante el programa estadístico SPSS versión 24. Se observa un aumento significativo en las puntuaciones en aspectos comunicativos y en el componente social, mientras que las puntuaciones para el aspecto comportamental descienden, lo que implica una disminución de conductas disruptivas.



Figura 2: Comparación de Medias (Comunicación, Social y Comportamental)

	RANGO DE COMUNICACIÓN		RANGO SOCIAL		RANGO COMPORTAMENTAL	
	Sem. 1	Sem. 10	Sem. 1	Sem. 10	Sem. 1	Sem. 10
Media	15,00	31,33	18,33	36,67	31,00	16,67
Media de error estándar	0,577	0,882	2,603	3,383	5,568	2,848
N	3	3	3	3	3	3
Desviación estándar	1,000	1,528	4,509	5,859	9,644	4,933
Rango	2	3	9	11	18	9
Normalidad (Kolmogórov-Smirnov)	0,175	0,253	0,196	0,321	0,328	0,349

Tabla 1: Análisis Descriptivo de muestras emparejadas entre Semana 1 y Semana 10

	RANGO DE COMUNICACIÓN	RANGO SOCIAL	RANGO COMPORTAMENTAL
	Sem. 1 – Sem. 10	Sem. 1 – Sem. 10	Sem. 1 – Sem. 10
t	-13,590	-13,994	4,932
Valor de significación (p)	0,005	0,005	0,039
95% Intervalo de confianza inferior	-21,504	-26,585	1,830
95% Intervalo de confianza superior	-11,162	-14,082	26,837
Conclusión	Hay diferencia significativa (p< 0,05). Se concluye que el lenguaje asistido sí tiene efectos significativos sobre la capacidad comunicativa de los participantes	Hay diferencia significativa (p< 0,05). Se concluye que el lenguaje asistido sí tiene efectos significativos sobre las habilidades sociales de los participantes	Hay diferencia significativa (p< 0,05). Se concluye que el lenguaje asistido sí tiene efectos significativos sobre la capacidad comportamental de los participantes

Tabla 2: Prueba t de Student

5. CONCLUSIONES

Podemos sostener que la intervención mediante el lenguaje asistido **mejora la capacidad comunicativa expresiva** de los participantes de la muestra (t= -13,590, p=.005**), así como la **competencia social** (t= -13,994, p=.005**) y **reduce la presencia de conductas disruptivas** (t=4,932, p=.039**).

**= Intervalo de Confianza 95%"

6. REFERENCIAS

- Drager, K.D., Light, J., & McNaughton, D. (2010). Effects of AAC interventions on communication and language for young children with complex communication needs. *Journal of Pediatric Rehabilitation Medicine*, 3(4), 303–310.
- Goossens, C., & Crain, S. (1986). Establishing multiple communication displays. Augmentative communication: An introduction, 337-344.
- Lai, M. C. (2022). Clinical reflections on the intersections of autism and personality development. *Autism*, 26(4), 739-742.
- Pereira, E. T., Montenegro, A., Rosal, A., & Waller, C. (2020). Augmentative and Alternative Communication on Autism Spectrum Disorder: Impacts on Communication. *CoDAS*, 32(6).

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G.7 Contribution to an international congres: 7th International Conference on Research in Education, Teaching and Learning (ICETL), 10 – 12 August 2023, Berlin, Germany.

A contribution was presented at the 7th International Conference on Research in Education, Teaching and Learning (ICETL) titled: "The impact of aided augmented input with the EC+ app on the development of communicative skills in children with autism spectrum disorders". This study aimed to showcase the potential of EC+ as a multimodal AAC+a support, focusing exclusively on the results related to communication skills.

The contribution is included on the following page.

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The impact of aided augmented input with the EC+ app on the development of communicative skills in children with autism spectrum disorders

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Digital Tool Project for Assessing Communication and Language in Individuals with Complex Communication Needs: Inclusive Communication. II Plan Propio de Investigación y Transferencia, UMA (Reference B1-2022_02)
Research Thematic Network Project: Prácticas eficientes de comunicación inclusiva en poblaciones con enfermedades infrecuentes (COMIN-ENIN). II Plan Propio de Investigación y Transferencia, UMA (Reference: D5-2022_01)
Inclusive Communication (Comin) for Individuals with Rare Diseases and Complex Communication Needs (Reference B4-2023-18)

INTRODUCTION

Aided augmented input promotes expressive communication and comprehension through visual stimuli. This teaching method can be complemented with information and communication technologies (ICT), such as the EC+ digital tool and its multimodal resources. EC+ (Luque et al., 2018) is a free app compatible with Android and iOS, released in 2018, that adapts to the needs and abilities of users, proving beneficial for teaching children with complex communication needs associated with autism spectrum disorder (ASD).

AIM

Evaluating the impact of EC+ combined with augmented input in children with ASD on communicative range

METHOD

A quasi-experimental and longitudinal study design was conducted. Data collected from 3 children aged between 6 and 12 years with ASD, who broad communication disorder and whose main language is Spanish. They underwent a 16-week intervention using the EC+ tool, following the augmented input methodology and whose main language is Spanish. To assess participants' communication skills, the Spanish version of the Vineland-3 Scale (Sparrow, Cicchetti, & Saulnier, 2016) was employed, specifically the Communication Domain subscale, at three different time points: the initial assessment in week 1, the second assessment in week 7, and the final assessment in week 16.

RESULTS

The data were analyzed using SPSS version 27 statistical software. When comparing the results at the final assessment (week 16), it can be concluded that the intervention with EC+ enhances the communicative skills of the participants in the sample (t=24,001, p<,005 [IC 95% 34.74, 49.92]).

Statistical

N	Valid	3	3	3
	Lost	0	0	0
Mean		5,67	18,67	42,33
Standard Error of Mean		2,028	3,844	1,764
Median		7,00	22,00	43,00
Variance		12,333	44,333	9,333
Minimum		3	11	39
Maximum		12	28	45

Table 1: Statistics Communication Range

Test for a sample

	t	df	Sig. (bilateral)	Mean difference	Lower	Upper
Week 1	3,298	2	,081	6,667	-2,06	15,39
Week 7	4,690	2	,042	18,667	2,13	35,21
Week 16	24,001	2	,002	42,333	34,74	49,92

Table 2: T-Student's Test for Communication Range



Figure 1: Communication Range Graph

CONCLUSIONS

The combined intervention of aided augmented input and EC+ has been shown to be effective in the development of communication skills in children with ASD, promoting better adaptation in educational context.

REFERENCES

- Chicano, F., & Luque, G. (2017). A mobile application and academic portal to support professionals working with people having severe intellectual or developmental disabilities. *Procedia-Social and Behavioral Sciences*, 237, 568-575.
- Friedman, L., & Sterling, A. (2019). A review of language, executive function, and intervention in autism spectrum disorder. In Seminars in speech and language. *Thieme Medical Publishers*, 40(4), 291-304.
- Luque Polo, G., Postigo Pinazo, E., Calleja Reina, M., & Chicano, F. (2018). EC+ (1.0) [Mobile app]. Google Play. **https://bit.ly/3ravvgV**

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G.8 XXXIII Congreso Internacional de la Asociación Española de Logopedia, Foniatría y Audiología e Iberoamericana de Fonoaudiología (AELFA-IF), 28 – 30 September 2023, Santander, Spain.

A contribution was presented at the XXXIII Congreso Internacional de la Asociación Española de Logopedia, Foniatría y Audiología e Iberoamericana de Fonoaudiología (AELFA-IF) titled: "La evaluación del componente expresivo y receptivo en Trastorno del Espectro Autista con la herramienta PCL-DIS-NCC". This study provided deeper insight into the characteristics and functionality of the PCL-DIS-NCC assessment protocol, which was also used to present the participants in this thesis. Its effectiveness for people with ASD and complex communication needs was confirmed, facilitating their evaluation in these areas.

The contribution is included on the following page.

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La evaluación del componente expresivo y receptivo en Trastorno del Espectro Autista con la herramienta PCL-DIS-NCC

XXXIII CONGRESO INTERNACIONAL DE AELFA-IF Santander 2023

Antonio Javier Zurita Díaz, Marina Calleja Reina y María Luisa Luque Liñán

Universidad de Málaga

Proyecto *Herramienta digital para evaluar comunicación y lenguaje en personas con necesidades complejas de comunicación: comunicación inclusiva*. II Plan Propio de Investigación y Transferencia, UMA (Referencia B2-2022_02)

Proyecto Red Temática de Investigación: *Prácticas eficientes de comunicación inclusiva en poblaciones con enfermedades infrecuentes* (COMIN-ENIN). II Plan Propio de Investigación y Transferencia, UMA (Referencia D5-2022_01)

INTRODUCCIÓN

Las personas con **Trastorno del Espectro Autista (TEA)** con severas alteraciones sociales, comunicativas y conductuales tienen la necesidad de ser evaluados tanto en el componente expresivo y receptivo, pero esto supone un reto dada sus características El **Protocolo de Valoración del Perfil Comunicativo Lingüístico de personas con Discapacidad Intelectual y Necesidades Complejas de Comunicación** o **PCL-DIS-NCC** (Calleja, Luque & Rodríguez Santos, 2021) es una prueba de evaluación que intenta facilitar este proceso. Está compuesta por 5 escalas de conducta que miden la comprensión (PCL-EC), la variedad de interlocutores (PCL-EE-VI), las funciones de la comunicación (PCL-EE-FC), los modos de comunicación (PCL-EE-MC) y los temas y preferencias conversacionales (PC-EE-T).

MÉTODO

La evaluación se ha llevado a cabo con 12 participantes diagnosticados de TEA mínimamente verbales. Para contrastar los resultados, se compararon los resultados del Momento 1 (pre intervención) con los resultados del Momento 2 (post intervención) con una diferencia de 3 semanas entre cada evaluación

RESULTADOS

Los datos fueron analizados mediante el programa estadístico JASP. En los resultados se observan diferencias significativas entre el Momento 1 y el Momento 2 ($p < 0.05$), por lo tanto, se concluye que hay una mejoría en las áreas evaluadas posterior al comienzo de la intervención

	PCL-EC_Evaluacion Pre	PCL-EC_Evaluacion Post	PCL-EE-VI_Evaluación Pos	PCL-EE-FC_Evaluación Pre	PCL-EE-FC_Evaluacion Post	PCL-EE-MC_Evaluación Pre	PCL-EE-MC_Evaluacion Post	PCL-EE-T_Evaluacion Pre	PCL-EE-T_Evaluacion Pos
	NCC-DIS	NCC-DIS	NCC-DIS	NCC-DIS	NCC-DIS	NCC-DIS	NCC-DIS	NCC-DIS	NCC-DIS
Valid	12	12	12	12	12	12	12	12	12
Missing	0	0	0	0	0	0	0	0	0
Mean	27.750	32.083	21.667	22.417	24.000	31.083	32.583	16.750	18.250
Std. Deviation	5.445	4.889	3.676	2.575	2.747	2.811	2.429	5.486	5.496
Minimum	15.000	25.000	17.000	20.000	22.000	28.000	29.000	5.000	9.000
Maximum	35.000	38.000	28.000	26.000	31.000	36.000	36.000	27.000	27.000

Tabla 1: Análisis Descriptivo de muestras emparejadas entre Momento 1 (pre intervención) y Momento 2 (post intervención)

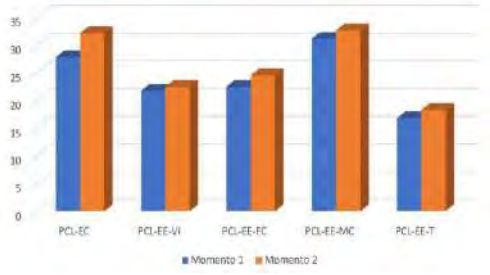


Figura 1: Comparación de Medias

Measure 1		Measure 2	t	df	p
PCL-EC_Evaluacion Pre	-	PCL-EC_Evaluacion Post	-5.922	11	< .001
PCL-EE-VI_Evaluación Pre	-	PCL-EE-VI_Evaluacion Post	-3.693	11	0.004
PCL-EE-FC_Evaluación Pre	-	PCL-EE-FC_Evaluación Post	-9.101	11	< .001
PCL-EE-MC_Evaluación Pre	-	PCL-EE-MC_Evaluacion Post	-3.447	11	0.005
PCL-EE-T_Evaluacion Pre	-	PCL-EE-T_Evaluacion Post	-1.915	11	0.082

Tabla 2: Prueba t de Student

CONCLUSIÓN

Podemos sostener que la herramienta PCL-DIS-NCC es sensible al incremento atribuido a la intervención. Esta herramienta de evaluación es capaz de medir diferentes componentes lingüísticos en su carácter receptivo y expresivo, obteniendo un perfil comunicativo-lingüístico del usuario a partir de sus habilidades. El uso del PCL-DIS-NCC facilitará la planificación de la intervención a medida que se crea un perfil individual del usuario con cada sesión de evaluación, siendo un proceso fundamental para actuar con la población con TEA y adaptarse a su desarrollo desde un enfoque logopédico

REFERENCIAS

- American Psychiatric Association (APA) (2013) Diagnostic and Statistical Manual of Mental Disorders. 5th ed. *Washington, DC: American Psychiatric Publishing*.
- Calleja Reina, M., Luque, M.L., & Rodríguez Santos, J.M. (2021). Protocolo de Valoración del Perfil Comunicativo Lingüístico de personas con necesidades complejas de comunicación y discapacidad intelectual (PCL-DIS-NCC). En M. Calleja Reina (Ed.), *Necesidades complejas de comunicación y enfermedades minoritarias* (pp. 30-35). McGraw Hill Education.
- González-Mercado, Y. M., Rivera-Martínez, L. B., & Domínguez-González, M. G. (2016). Autismo y evaluación. *Ra Ximhai*, 12(6), 525-533.
- Reynoso, C., Rangel, M. J., & Melgar, V. (2017). Autism spectrum disorder: Etiological, diagnostic and therapeutic aspects. *Revista Médica del Instituto Mexicano del Seguro Social*, 55(2), 214-222

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G.9 V Congreso Internacional de Innovación Docente e Investigación (CIDICO), 27 – 02 December 2023, Sevilla, Spain.

A contribution was presented at the V Congreso Internacional de Innovación Docente e Investigación (CIDICO) titled: "Estimulación Asistida del Lenguaje con la herramienta digital EC+ en el desarrollo de habilidades sociales en trastorno del espectro autista". In addition to reusing EC+, this study evaluates the social domain of participants with ASD after receiving aided augmented input, highlighting the impact of these strategies on social skills as well.

The contribution is included on the following page.

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Estimulación Asistida del Lenguaje con la herramienta digital EC+ en el desarrollo de habilidades sociales en trastorno del espectro autista

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Proyecto Herramienta digital para evaluar comunicación y lenguaje en personas con necesidades complejas de comunicación: comunicación inclusiva. II Plan Propio de Investigación y Transferencia, UMA (Referencia B2-2022_02)
Proyecto Red Temática de Investigación: *Prácticas eficientes de comunicación inclusiva en poblaciones con enfermedades infrecuentes* (COMIN-ENIN). II Plan Propio de Investigación y Transferencia, UMA (Referencia D5-2022_01)
Comunicación inclusiva (Comin) para personas con enfermedades minoritarias y necesidades complejas de Comunicación (Referencia B4-2023-18)

INTRODUCCIÓN

La Estimulación Asistida del Lenguaje impulsa la comunicación expresiva y la comprensión mediante estímulos visuales. Es posible complementar este método de intervención con las Tecnologías de la Información y de la Comunicación (TIC), como la aplicación EC+ (Luque et al., 2018) y los recursos multimodales que ofrece. EC+ se adapta a las necesidades y habilidades de los usuarios, beneficiando a niños con trastorno del espectro autista (TEA) con alteraciones sociales.

OBJETIVO

Evaluar el impacto de EC+ combinado con lenguaje asistido en niños con TEA a nivel social.

MÉTODO

- **Sujetos:** Tres niños de 6 años diagnosticados de TEA mínimamente verbales y cuya lengua materna es el español.
- **Instrumentos:** Escala Vineland-3 para evaluar el componente social y una tablet con la aplicación EC+ instalada.
- **Procedimiento:** La intervención se llevó a cabo en sesiones clínicas estructuradas donde un logopeda señalaba los símbolos pictográficos que ofrece EC+ junto a la estimulación del lenguaje oral, proporcionando el input correspondiente, haciendo extensiones y reforzando las respuestas correctas.

RESULTADOS

Los datos fueron analizados mediante el programa estadístico SPSS versión 27. En el momento 1 encontramos una diferencia de medias de 15.67 (t=8.88, p>.005) y en el momento 16, la diferencia de medias fue 52.67 (t=43.82, p<.005). Se observa un aumento significativo en las habilidades sociales a lo largo de las 16 semanas en las que se han registrado las puntuaciones.

Estadísticas para una muestra

	N	Media	Desviación estándar	Media de error estándar
Momento 1	3	15,67	3,055	1,764
Momento 16	3	52,67	2,082	1,202

Prueba para una muestra

	Valor de prueba = 0					
	t	gl	Sig. (bilateral)	Diferencia de medias	95% de intervalo de confianza de la diferencia	
					Inferior	Superior
Momento 1	8,882	2	,012	15,667	8,08	23,26
Momento 16	43,821	2	,001	52,667	47,59	57,84

Tamaños de efecto de una muestra

		Estimadores	Estimación de puntos	Intervalo de confianza al 95%	
				Inferior	Superior
Momento 1	d de Cohen	3,055	5,128	,607	9,656
	corrección de Hedges	5,415	2,893	,342	5,447
Momento 16	d de Cohen	2,082	25,300	3,986	48,616
	corrección de Hedges	3,690	14,274	2,249	27,428

Tabla 1: Comparación de medidas del Rango de Social



Figura 1: Comparación de medias en Momento 1 – Momento 16

CONCLUSIONES

La intervención combinada de Estimulación Asistida del Lenguaje y EC+ ha demostrado ser efectiva en el desarrollo de habilidades sociales en TEA, promoviendo una mejor adaptación en contextos naturales y sociales, lo que implica una innovación docente que produce nuevas formas de interacciones sociales.

REFERENCIAS

- Chicano, F., & Luque, G. (2017). A mobile application and academic portal to support professionals working with people having severe intellectual or developmental disabilities. *Procedia-Social and Behavioral Sciences*, 237, 568-575.
- Guillén, S. G., Rojas, D. G., & Fernández, S. J. (2016). Uso de las TIC en el Trastorno de Espectro Autista: aplicaciones. *Edmetic*, 5(2), 134-157.
- Luque Polo, G., Postigo Pinazo, E., Calleja Reina, M., & Chicano, F. (2018). EC+ (1.0) [Aplicación móvil]. Google Play. https://play.google.com/store/apps/details?id=es.uma.ecplusproject.ecplusandroidapp&hl=es_419

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G.10 IX Congreso Internacional en Contextos Psicológicos, Educativos y de la Salud (CICE), 11 – 14 December 2023, Sevilla, Spain.

A contribution was presented at the IX Congreso Internacional en Contextos Psicológicos, Educativos y de la Salud (CICE) titled: "La sensibilidad de la Escala Vineland-3 para evaluar las áreas afectadas en niños con trastorno del espectro autista". This study aims to introduce the Vineland-3 scale by presenting its features and sensitivity in assessing the communicative, social, and behavioral components of children with ASD who have complex communication needs.

The contribution is included on the following page.

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La sensibilidad de la Escala Vineland-3 para evaluar las áreas afectadas en niños con trastorno del espectro autista

Antonio Javier Zurita Díaz
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IX Congreso Internacional en Contextos Psicológicos, Educativos y de la Salud

Proyecto *Herramienta digital para evaluar comunicación y lenguaje en personas con necesidades complejas de comunicación: comunicación inclusiva*. II Plan Propio de Investigación y Transferencia, UMA (Referencia B2 -2022_02)
Proyecto Red Temática de Investigación: *Prácticas eficientes de comunicación inclusiva en poblaciones con enfermedades infrecuentes* (COMIN-ENIN). II Plan Propio de Investigación y Transferencia, UMA (Referencia D5 -2022_01)
Proyecto Puente en la Universidad de Málaga: Comunicación inclusiva (Comin) para personas con enfermedades minoritarias y necesidades complejas de Comunicación (Referencia B4 -2023-18)

INTRODUCCIÓN

El **trastorno del espectro autista (TEA)** representa un diagnóstico complejo cuyo proceso de evaluación es continuo, con un enfoque prescriptivo y de carácter multiaxial, delimitado por la observación de las carencias conductuales en las áreas de interacción social, las habilidades comunicativas y el rango comportamental, considerados los signos de alarma más frecuentes en esta población. Para ello se usan diferentes escalas de cribado, entrevistas y mediciones sobre el desarrollo general, entre las que destaca la **Escala de Comportamiento Adaptativo Vineland-3** (Sparrow, Cicchetti & Saulnier, 2016). La Escala Vineland-3, en su versión adaptada para habla inglesa y española, tiene como objetivo medir la conducta desde el nacimiento hasta la edad adulta a partir de cinco dominios: la comunicación, las habilidades de la vida diaria, la socialización, las habilidades motoras y los comportamientos disruptivos.

OBJETIVO

Medir la sensibilidad de la Escala Vineland-3 como método de evaluación del rango comunicativo, social y comportamental en niños con TEA.

MÉTODO

- **Sujetos:** Diez niños entre seis y ocho años diagnosticados de TEA mínimamente verbales y con español como lenguaje materno.
- **Instrumentos:** Se ha usado la escala Vineland-3 para evaluar el componente comunicativo, social y comportamental, este último a partir de la cuantificación de conductas disruptivas.
- **Procedimiento:** La evaluación se llevó a cabo en sesiones clínicas estructuradas en dos momentos diferentes (semana 1 y semana 7) con el que medir la evolución de los participantes pre y post intervención basada en el lenguaje asistido.

RESULTADOS

Los datos fueron analizados mediante el programa estadístico JASP. Se observan diferencias significativas en las áreas evaluadas entre el momento 1 y el momento 2 ($p < 0.05$), lo que implica una mejora en los participantes tras la intervención.

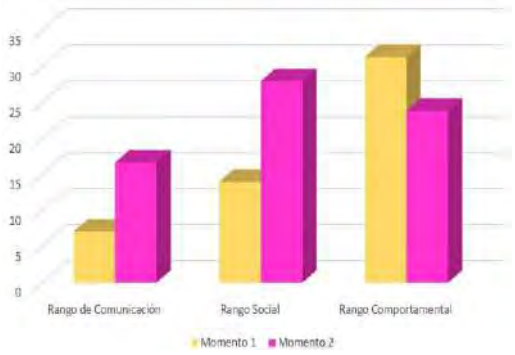


Figura 1: Comparación de Medias

	Rango de Comunicación_Evaluación Pre	Rango de Comunicación_Evaluación Post	Rango Social_Evaluación Pre	Rango Social_Evaluación Post	Rango Comportamental_Evaluación Pre	Rango Comportamental_Evaluación Post
	Vineland-3	Vineland-3	Vineland-3	Vineland-3	Vineland-3	Vineland-3
Valid	10	10	10	10	10	10
Missing	0	0	0	0	0	0
Mean	7.100	16.700	14.000	28.000	31.400	23.900
Std. Deviation	3.178	6.093	4.190	8.438	7.105	6.574
Minimum	3.000	8.000	8.000	10.000	19.000	13.000
Maximum	11.000	25.000	21.000	37.000	39.000	33.000

Tabla 1: Análisis Descriptivo de muestras emparejadas entre Momento 1 (pre intervención) y Momento 2 (post intervención)

Measure 1		Measure 2	t	df	p
Rango de Comunicación_Evaluación Pre	-	Rango de Comunicación_Evaluación Post	−5.949	9	< .001
Rango Social_Evaluación Pre	-	Rango Social_Evaluación Post	−8.835	9	< .001
Rango Comportamental_Evaluación Pre	-	Rango Comportamental_Evaluación Post	6.582	9	< .001

Tabla 2: Prueba t de Student

CONCLUSIONES

Dado sus características, la Escala Vineland-3 resulta ser un instrumento de evaluación que **puede ser beneficioso en contextos educativos, psicológicos y de la salud**. Dicha herramienta es receptiva a las mejoras derivadas de la intervención, generando un perfil comunicativo, social y conductual del individuo basado en sus habilidades. Todo ello facilitará la planificación de la metodología de trabajo al proporcionar un perfil individual actualizado, lo cual es esencial para llevar a cabo la intervención en personas TEA y así ajustarse a sus necesidades y a su desarrollo.

REFERENCIAS

- Sparrow, S. S., Cicchetti, D. V. & Saulnier, C.A. (2016). Vineland Adaptive Behavior Scales, Third Edition (Vineland-3). *San Antonio, TX: Pearson.*
- Roselló, B., Berenguer, C., & Baixauli, I. (2018). El funcionamiento adaptativo de niños con trastorno del espectro autista: impacto de los síntomas y de los problemas comportamentales y emocionales. *International Journal of Developmental and Educational Psychology*, 3(1), 247-257.
- Belva, B. C., Matson, J. L., Sipes, M., & Bamburg, J. W. (2012). An examination of specific communication deficits in adults with profound intellectual disabilities. *Research in Developmental Disabilities*, 33(2), 525-529.

G.11 International Conference on Teaching and Education (TECONF 2024), 17 – 19 May 2024, Liverpool, England.

A contribution was presented at the International Conference on Teaching and Education (TECONF 2024) titled: "Development of expressive skills in children with autism spectrum disorder through aided augmented input and technological resource". This study follows previous procedures, focusing on the effects of the aided augmented input strategy using EC+ on expressive skills, as measured by the PCL-DIS-NCC protocol. The scales used included variety of interlocutors (PCL-EE-VI), communication functions (PCL-EE-FC), communication modes (PCL-EE-MC), and conversational topics and preferences (PCL-EE-T).

The contribution is included on the following page.

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DEVELOPMENT OF EXPRESSIVE SKILLS IN CHILDREN WITH AUTISM SPECTRUM DISORDER THROUGH AIDED AUGMENTED INPUT AND TECHNOLOGICAL RESOURCE

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University of Malaga

Digital Tool Project for Assessing Communication and Language in Individuals with Complex Communication Needs: Inclusive Communication. II Plan Propio de Investigación y Transferencia. UMA (Reference B2-2022_02)
Research Thematic Network Project: Prácticas eficientes de comunicación inclusiva en poblaciones con enfermedades infrecuentes (COMIN-ENIN). II Plan Propio de Investigación y Transferencia. UMA (Reference DS-2022_01)
Inclusive Communication (Comin) for Individuals with Rare Diseases and Complex Communication Needs (Reference B4-2023-18)

INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition (APA, 2013) characterized, among other things, by alterations in communication and language processes. In this regard, intervention strategies based on **augmentative and alternative communication (AAC)** models have been designed, incorporating visuospatial resources compatible with **Information and Communication Technologies (ICT)** (Voss et al., 2019). Within this methodology, **aided augmented input** is included. In this approach, the interlocutor jointly uses oral and visual input, employing graphic symbols such as pictograms along with spoken language (Pereira et al., 2020). The aim of this study was to assess the effects of assisted language stimulation on the expressive skills of children with ASD using an ICT tool.

METHOD

This study involved twelve children with ASD, aged between 6 and 11 years (M=7.20, SD=1.75), who had complex communication needs. A process of intervention based on assisted language was carried out over 30 structured sessions of 45 minutes each, using the EC+ application (Luque Polo et al., 2018). This free ICT tool is designed for devices such as tablets and smartphones with IOS and Android systems. It stands out for its multimodal representation of items, including written words, pictograms, real images, and a video with a sign language interpreter performing the sign of the word while pronouncing it. During the intervention, the EC+ application was used on a 10.8-inch Huawei MediaPad5 M5Pro Tablet, specifically selected for its ability to facilitate effective user interaction. The evaluation of the expressive component was conducted at two points: before (Moment 1) and after (Moment 2) the intervention, using the **Protocol for Assessment of the Communicative Profile of Individuals with Intellectual Disabilities and Complex Communication Needs (PCL-DIS-NCC)**. The scales used were variety of interlocutors **(PCL-EE-VI)**, communication functions **(PCL-EE-FC)**, communication modes **(PCL-EE-MC)**, and conversational topics and preferences **(PC-EE-T)**.

RESULTS

The Expressive Scale data were analyzed using the SPSS ® Statistics version 27.0 software. The performance was compared across the two different evaluation moments among the participants. The required significance level was p<.001.

Paired samples test

	Mean	Standard Deviation	Mean standard error	95% confidence interval of the difference: Lower	Upper	t	df	Sig. (bilateral)
Par 1	-3,700	1,703	,539	-4,918	-2,482	-6,871	9	<,001
Par 2	-2,000	1,155	,365	-2,826	-1,174	-5,477	9	<,001
Par 3	-2,600	2,514	,795	-4,341	-,859	-3,270	9	,010
Par 4	-1,100	1,197	,378	-1,955	-,245	-2,911	9	,017

Table 1: Descriptive analysis of paired samples between Moment 1 (Pre-Intervention) and Moment 2 (Post-Intervention)

Figure 2: QR to EC+ web

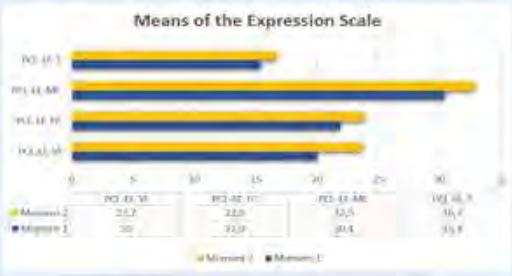


Figure 1: Comparison of Means of the Expression Scale

- There are significant differences in the scores obtained in **PCL-EE-VI** (t=-6.87, p<.001 [95% CI -4.91, -2.48]).
- There are significant differences in the scores obtained in **PCL-EE-FC** (t=-5.47, p<.001 [95% CI -2.82, -1.17]).
- No significant differences were observed in the scores obtained in **PCL-EE-MC** (t=-3.92, p>.001 [95% CI -3.94, -1.05]).
- There are also significant differences in the scores obtained in **PCL-EE-T** (t=-2.11, p<.001 [95% CI -2.69, 0.09]).

CONCLUSIONS

Statistically significant findings from the Expressive Scale were observed in **PCL-EE-VI, PCL-EE-FC,** and **PCL-EE-T**. These results may indicate that the combination of visual and auditory stimuli during the EC+ intervention leads to a more detailed transmission of the message, resulting in increased interest shown by orienting their body towards the interlocutor, looking directly at objects represented in the pictograms, pointing more frequently, and naming words more easily, while also increasing preferences for items used during therapy and with whom they communicate. There were no significant differences in **PCL-EE-MC**; however, a positive trend in the results was also observed. EC+ combined with aided augmented input could be an interesting tool in the education of children with ASD. Study limitations could be reduced by extending the intervention duration and increasing the sample size.

REFERENCES

- American Psychiatric Association (APA) (2013) Diagnostic and Statistical Manual of Mental Disorders. 5th ed. *Washington, DC: American Psychiatric Publishing*.
- Calleja Reina, M., Luque, M.L., & Rodríguez Santos, J.M. (2021). Protocolo de Valoración del Perfil Comunicativo Lingüístico de personas con necesidades complejas de comunicación y discapacidad intelectual (PCL-DIS-NCC). En M. Calleja Reina (Ed.), *Necesidades complejas de comunicación y enfermedades minoritarias* (pp. 30-35). McGraw Hill Education.
- Luque Polo, G., Postigo Pinazo, E., Calleja Reina, M., & Chicano, F. (2018). EC+ (1.0) [Mobile app]. Google Play. https://bit.ly/3ravvgV
- Pereira, E. T., Montenegro, A., Rosal, A., & Walter, C. (2020). Augmentative and Alternative Communication on Autism Spectrum Disorder: Impacts on Communication. *CoDAS*, 32(6).
- Voss, C., Schwartz, J., Daniels, J., Kline, A., Haber, N., Washington, P., ... & Wall, D.P. (2019). Effect of wearable digital intervention for improving socialization in children with autism spectrum disorder: a randomized clinical trial. *JAMA Pediatrics*, 173(5), 446-454.

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G.12 VII Congreso Internacional de Lingüística Clínica (CILC2024), 19 – 21 June 2024, Salamanca, Spain.

A contribution was presented at the VII Congreso Internacional de Lingüística Clínica (CILC2024) titled: "Efectos de la estimulación asistida del lenguaje en las habilidades expresivas de niños con trastorno del espectro autista". This study follows previous procedures, focusing on the effects of the aided augmented input strategy using ARASAAC on expressive skills, as measured by the PCL-DIS-NCC protocol.

The contribution is included on the following page.

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EFECTOS DE LA ESTIMULACIÓN ASISTIDA DEL LENGUAJE EN LAS HABILIDADES EXPRESIVAS DE NIÑOS CON TRASTORNO DEL ESPECTRO AUTISTA

CILC 2024
VII CONGRESO INTERNACIONAL DE LINGÜÍSTICA CLÍNICA

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Universidad de Málaga y Universidad Autónoma de Madrid

Proyecto *Herramienta digital para evaluar comunicación y lenguaje en personas con necesidades complejas de comunicación: comunicación inclusiva*. II Plan Propio de Investigación y Transferencia. UMA (Referencia B2-2022_02)

Proyecto Red Temática de Investigación: *Prácticas eficientes de comunicación inclusiva en poblaciones con enfermedades infrecuentes* (COMIN-ENIN). II Plan Propio de Investigación y Transferencia. UMA (Referencia DS-2022_01)

INTRODUCCIÓN

El **trastorno del espectro autista (TEA)** es una alteración del neurodesarrollo (APA, 2013) caracterizado, entre otras cosas, por alteraciones en el proceso de comunicación y lenguaje. Para el desarrollo de la intervención comunicativa y lingüística en personas con TEA se deben utilizar recursos de carácter visoespacial. En este sentido, se han elaborado estrategias basadas en modelos de **comunicación aumentativa y alternativa (CAA)**, entre las cuales se encuentra la **estimulación asistida del lenguaje**. En esta metodología, el interlocutor usa de manera conjunta un input de naturaleza oral y otro de naturaleza visual, pudiendo utilizar símbolos gráficos como pictogramas (O'Neill, Light & Pope, 2018) al tiempo que se usa lenguaje oral. El **objetivo de este trabajo** fue evaluar los efectos de la intervención asistida del lenguaje en las habilidades expresivas de niños con TEA.

MÉTODO

En este estudio participaron doce niños diagnosticados con TEA con edades entre 6 y 11 años (M=7.67; DT=1.96) con necesidades complejas de comunicación con los que se desarrolló un proceso de intervención basado en el lenguaje asistido durante 32 sesiones clínicas estructuras de 45 minutos donde se usaron pictogramas del Portal Aragonés de Comunicación Aumentativa y Alternativa (ARASAAC). La evaluación del componente expresivo se llevó a cabo en dos momentos diferentes: Momento 1 (pre intervención) y Momento 2 (post intervención) mediante el **Protocolo de Valoración del Perfil Comunicativo Lingüístico de personas con Discapacidad Intelectual y Necesidades Complejas de Comunicación** o **PCL-DIS-NCC** (Calleja, Luque & Rodríguez Santos, 2021). Las escalas utilizadas fueron la variedad de interlocutores (PCL-EE-VI), las funciones de la comunicación (PCL-EE-FC), los modos de comunicación (PCL-EE-MC) y los temas y preferencias conversacionales (PC-EE-T).

RESULTADOS

Los datos de la **Escala Expresiva** fueron analizados con el programa SPSS ® Statistics versión 27.0. Se comparó el rendimiento a lo largo de los dos momentos diferentes de evaluación entre los participantes. El nivel de significación requerido fue p<.001.



Tabla 1: Análisis Descriptivo de muestras emparejadas entre Momento 1 (Pre-Intervención) y Momento 2 (Post-Intervención)

La diferencia de medias entre el Momento 1 y el Momento 2 de evaluación es de 2.17 puntos (DT= 1.74) para PCL-EE-VI, 3.34 puntos (DT= 3.05) para PCL-EE-FC, 4 puntos (DT= 2.86) para PCL-EE-FC, 14.67 puntos (DT=1.43) para PCL-EE-MC y 6.83 puntos (DT= 3.83) para PCL-EE-T.



Figura 1: Comparación de Medias de la Escala de Expresión

- No se observan diferencias significativas en las puntuaciones obtenidas en PCL-EE-VI (t=-4.29, p>.001 [IC 95% -3.27, -1.05])
- Tampoco hay diferencias significativas en las puntuaciones obtenidas en PCL-EE-FC (t=-3.78, p>.001 [IC 95% -5.27, -1.39])
- Sí se observan diferencias significativas en las puntuaciones obtenidas en PCL-EE-MC (t=-35.39, p<.001 [IC 95% -15.57,-13.75])
- También hay diferencias significativas en las puntuaciones obtenidas en PCL-EE-T (t=-6.17, p<.001 [IC 95% -9.26, -4.39])

CONCLUSIÓN

Los hallazgos estadísticamente significativos de la Escala Expresiva se observaron en PCL-EE-MC y en PCL-EE-T. Estos resultados pueden indicar que la combinación de estímulos visuales y auditivos durante la intervención produce una transmisión más detallada del mensaje, implicando en estos casos un mayor interés al orientar su cuerpo hacia el interlocutor, mirar directamente los objetos representados en los pictogramas, señalar con más frecuencia y nombrar palabras con mayor facilidad, aumentando al mismo tiempo sus preferencias por ítems utilizados durante la terapia. No hay diferencias significativas en PCL-EE-VI y PCL-EE-FC, sin embargo, se observa una tendencia positiva en los resultados. Las limitaciones del estudio se podrían reducir aumentando el tiempo en el que se ha desarrollado la intervención y aumentando la población.

REFERENCIAS

- American Psychiatric Association (APA) (2013) Diagnostic and Statistical Manual of Mental Disorders. 5th ed. *Washington, DC: American Psychiatric Publishing*.
- Calleja Reina, M., Luque, M.L., & Rodríguez Santos, J.M. (2021). Protocolo de Valoración del Perfil Comunicativo Lingüístico de personas con necesidades complejas de comunicación y discapacidad intelectual (PCL-DIS-NCC). En M. Calleja Reina (Ed.), *Necesidades complejas de comunicación y enfermedades minoritarias* (pp. 30-35). McGraw Hill Education.
- O'Neill, T., Light, J., & Pope, L. (2018). Effects of interventions that include aided augmentative and alternative communication input on the communication of individuals with complex communication needs: a meta-analysis. *Journal of Speech, Language, and Hearing Research: JSLHR*, 61(7), 1743–1765.
- Torrero, V., & Ruiz, C. (2021). Language and communication in preschool children with autism and other developmental disorders. Children, 8(3), 192.

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G.13 Language, Metacognition and Decision Conference (LMDC 2024), 18 October 2024, Coimbra, Portugal.

A contribution was presented at the Language, Metacognition and Decision Conference (LMDC 2024) titled: “Enhancing expressive and receptive skills in children with autism spectrum disorder using aided augmented input”. The data included in this study were presented at the Faculdade de Psicologia e da Ciências da Educação at the University of Coimbra during the author's international research stay.

The contribution is included on the following page.

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Enhancing expressive and receptive skills in children with autism spectrum disorder using aided augmented input

Antonio Javier Zurita Díaz, Marina Calleja Reina & Ana Paula Couceiro Figueira
University of Málaga & University of Coimbra
Poster's identification number: 07

Digital Tool Project for Assessing Communication and Language in Individuals with Complex Communication Needs including Communication. II Plan Propio de Investigación y Transferencia, UMA (Reference B2-2022_02). Research Thematic Network Project: Prácticas eficientes de comunicación incluyente en población con enfermedades infecciosas (COPAN-ENIN). II Plan Propio de Investigación y Transferencia, UMA (Reference 05-2022_01). Incluyente Communication (Covid-19 Pandemic) and Rare Diseases and Complex Communication Needs (Reference B4-2020-10).

INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder (APA, 2013) that, among other aspects, involves difficulties in communication and language processes. To address this, intervention strategies based on **augmentative and alternative communication (AAC)** models have been developed, incorporating visuospatial tools that are compatible with **Information and Communication Technologies (ICT)** (Durán Cuartero, 2021). One of the methods used is **aided augmented input**, where the communication partner integrates both spoken language and visual input, using graphic symbols like pictograms alongside verbal communication (Muttiah et al., 2022). This study aimed to evaluate the impact of aided augmented input on the expressive and receptive abilities of children with ASD through the use of an ICT-based tool.

METHOD

- **Participants:** The study included ten children diagnosed with ASD, aged 6 to 12 years (M=8.50, SD=2.36), all of whom had minimal verbal abilities.
- **Tools:** An intervention process utilizing aided augmented input strategy was implemented across 30 structured sessions, each lasting 45 minutes, with the use of the EC+ application (Luque Polo et al., 2018). This free ICT tool, developed at the University of Málaga, is compatible with devices such as tablets and smartphones that operate on iOS and Android systems. It is notable for its multimodal presentation of content, which includes written text, pictograms, photographs, and videos featuring a sign language interpreter demonstrating the sign for the word while articulating it.
- **Evaluation:** The assessment of the expressive component was conducted at two stages: before the intervention (Moment 1) and after 10 weeks of consistent use (Moment 2). This was done using a Spanish assessment tool called Protocol for Assessment of the Communicative Profile of Individuals with Intellectual Disabilities and Complex Communication Needs (**PCL-DIS-NCC**) (Calleja Reina et al., 2021).

Receptive Scale	• **PCL-EC** = Comprehension Scale	
Expressive Scale	• **PCL-EE-VI** = Variety of Interlocutors • **PCL-EE-MC** = Communication Modes	• **PCL-EE-FC** = Communication Functions • **PCL-EE-T** = Topics and Preferences

Table 1: Receptive and Expressive Scale from PCL-DIS-NCC.

Figure 1: QR to EC+ web.

RESULTS



Figure 2: Comparison of Means of Receptive and Expressive Scales.

- **PCL-EC (Receptive):** The mean difference was 9.4 points, showing significant differences (t=33.00, p<.001 [95% CI 28.78, 33.02]).
- **PCL-EE-VI (Expressive):** The mean difference was 4.1 points. No significant differences were observed in the scores (t=23.52, p<.001 [95% CI 20.79, 25.21]).
- **PCL-EE-FC (Expressive):** The mean difference was 3.9 points, and no significant differences were found in the scores (t=24.66, p>.001 [95% CI 23.62, 28.38]).
- **PCL-EE-MC (Expressive):** The mean difference was 12.6 points, showing significant differences in the scores (t=46.57, p<.001 [95% CI 31.30, 34.50]).
- **PCL-EE-T (Expressive):** The mean difference was 4 points, with no significant differences in the scores (t=24.25, p>.001 [95% CI 19.68, 23.72]).

CONCLUSIONS

The combined intervention of aided augmented input and EC+ has proven effective in improving expressive and receptive skills in children with ASD, particularly on the Comprehension Scale and Communication Modes. While no significant differences were found in the other scales, a positive trend was observed that could develop over time. This approach represents an innovative teaching method that promotes new forms of interaction and communication.

REFERENCES

Communication Needs (CCN) [Intervención incluyente en personas con Necesidades Complejas de Comunicación y Discapacidades Neurológicas]. In El Ciprés Editorial (Ed.), Intervención en Necesidades Complejas de Comunicación (pp. 21-42). Ciprés Editorial.
Calleja Reina, M. (2021). Intervención en personas con necesidades complejas de comunicación: Protocolo PCL-DIS-NCC. International Journal of Technology and Education Innovation, 7(1), 107-124.
Luque Polo, F., Delgado Morán, S., Tortosa Martínez, J., & Checura, S. (2018). EC+ [Aplicación móvil].
Muttiah, N., Drager, K., & Laubscher, E. (2022). Aided augmented input for children with autism spectrum disorder: A systematic review. International Journal of Language & Communication Disorders, 57(3), 548-564.
Zurita Díaz, A. J., & Calleja Reina, M. (2024). Tecnología de apoyo para la comunicación aumentativa y alternativa en personas con trastorno del espectro autista: Revisión sistemática. Revista Española de Educación Especial, 37(1). https://doi.org/10.7203/REEE.37.27654

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G.14 Other contributions at international conferences

In addition to the presentations included in this appendix, oral communications and seminar presentations have also been delivered. Those directly related to the doctoral thesis were presented at the following international conferences:

- Congreso Internacional Virtual, Ubicuo y Social: Aprendizaje con TIC (USATIC 2023), 3 – 7 July 2023, Zaragoza, Spain.
- VII Congreso Internacional de Intervención e Investigación en Salud (VII CIIIS), 22 – 23 February 2024, Almeria, Spain.
- VI Congreso Online Internacional de Inclusión Social y Educativa (CIISE'24), 24 – 25 May 2024, Vizcaya, Spain.
- IV Congreso Iberoamericano de Investigación en Sociedad, Educación y Psicología (CIISEP), 25 – 27 September 2024, Universidad de Atacama (Chile), Instituto Tecnológico de Sonora (México), Universidad de Burgos, Universidad del País Vasco (España) y UNIMINUTO (Colombia): The presentation at this conference was a finalist among the best communications submitted.
- 1ª Conferência Internacional Phelan-McDermid Portugal, 16 – 11 November 2024, Coimbra, Portugal.
- VIII Congreso Internacional de Intervención e Investigación en Salud (CIIIS), 20 – 21 February 2025, Murcia, Spain.

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