The Cognitive Awareness Scale for Basic and Instrumental Activities of Daily Living to measure Self-awareness after Acquired Brain Injury: Preliminary evidence of its validity.

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Abstract

Objective: There is a crucial need for reliable tools to measure impaired self-awareness (ISA) in patients with acquired brain injury (ABI) across cognitive-functional domains. The aim of this study was to assess the psychometric properties of the Cog-Awareness ADL Scale, which is a novel self-proxy discrepancy method for measuring ISA in both basic and instrumental activities of daily living. **Methods:** This multicenter study included 54 patients (no-low ISA n = 33; severe ISA, n = 21) from four outpatient rehabilitation units in Málaga-Granada, Spain, and 51 healthy controls. The participants and proxy raters completed the Cog-Awareness ADL Scale and the Patient Competency Rating Scale (PCRS). Agreement between both scales was assessed using Spearman's correlations and the Bland-Altman plot. Group comparisons were made on measures of SA, cognitive abilities and demographic variables. Sensitivity and specificity were analysed by ROC curve analysis. **Results:** Convergent validity was supported by strong correlations with the PCRS and its subscales (rho's ranging from 0.51 to 0.80, $p < 0.01$ for all). The Bland-Altman plot confirmed measurement agreement (only 3.70% of the scores were outside the 95% limits). External validity was demonstrated by effectively discriminating between healthy controls and ABI patients with no-low and severe ISA on each discrepancy index while controlling for cognitive/demographic variables. The Cog-Awareness ADL Scale showed optimal diagnostic accuracy (AUC = 0.95, sensitivity = 0.90, specificity = 0.90). **Conclusions:** The Cog-Awareness ADL Scale proved to be a feasible, valid, and clinical tool to assess ISA across different cognitive-functional domains, in Spanish ABI-patients.

Keywords: Activities of daily living, Self-awareness, Executive functions, Occupational therapy, Executive functions, Neuropsychology, Neuropsychological Assessment

Introduction

People with brain injury sometimes experience difficulties in performing essential activities of daily living (ADL), which can lead to a loss of dependence and poor quality of life (Wise et al., 2005). ADL refers to the skills required to meet basic needs such as eating, bathing, and mobility – i.e. basic ADL (b-ADL) – as well as activities that involve higher cognitive demands and social interaction, such as preparing meals, managing finances, or taking medication – i.e. instrumental ADL (i-ADL) – (Edemekong et al., 2014; Romero-Ayuso et al., 2021). Impaired performance in ADL can result from several cognitive impairments, with deficits in executive functions (EFs) and self-awareness (SA) being particularly important (Ciurli et al., 2010; Bivona et al., 2019; Prigatano and Sherer, 2020; Villalobos et al., 2020, 2021; Schmidt and Ownsworth, 2022). Impaired self-awareness (ISA) refers to the inability to accurately identify one's deficits and their impact on daily functioning (Prigatano, 2009). Research suggests that approximately 30%-50% of individuals experience some level of ISA following traumatic brain injury (TBI), leading to long-term negative outcomes, such as poorer functional recovery and limited participation (Toglia and Kirk, 2000; Hart et al., 2009; Hartman-Maeir et al., 2009; Bivona et al., 2019; Hurst et al., 2020; Dromer et al., 2021a). Recent studies have also highlighted the mediating role of SA in the relationship between executive deficits and ADL (Villalobos et al., 2020).

SA has been conceptualised as a *multifaceted construct*, emphasising the need to differentiate its various components. The Pyramid Model of Awareness, proposed by Crosson et al. (1989) describes SA as a hierarchical structure comprising intellectual awareness, emergent awareness, and anticipatory awareness. According to this model, these levels build upon each other, with intellectual awareness serving as the foundation for subsequent levels. In contrast, Toglia and Kirk (2000) proposed an alternative model considering SA as a dynamic rather than a hierarchical construct. This model distinguishes between *offline awareness*, which involves understanding task characteristics and having knowledge of one's own abilities, and *online awareness*, which is actively engaged during task performance through self-monitoring and self-evaluation of task demands. Recent research has also explored the *multidimensional* nature of SA, suggesting that its manifestation may vary depending on the type of information or task being examined (Toglia and Goverover, 2022). For example, Prigatano and Altman (1990), found that SA appeared to be more impaired following TBI when patients were asked about abstract, non-visible information such as cognition or emotions, compared to more observable behaviors such as ADL or physical difficulties. Similar findings have been consistently reported, indicating lower levels of SA related to cognitive and emotional impairments compared to physical impairments in individuals with TBI (Sherer et al., 1998b; Hart et al., 2004; Malouf et al., 2014). However, it is important to note that these domains may not be completely separate, but rather interdependent. Numerous studies have demonstrated the dependence of

ADL on various cognitive factors. The observed dissociation of SA across cognitive and functional domains (see Dromer et al., 2021 for a recent review) may be due to differences in the level of abstraction within the measurement items, rather than indicating truly different levels of ISA for different domains. Therefore, more research is needed to further disentangle potential confounding between item abstraction and the presence of different domains affected by ISA. The use of assessment tools that explore different cognitive difficulties within the same ADL contexts may contribute to a better understanding of this issue.

Recent review studies have also raised a debate about the level of SA demonstrated by patients while performing tasks of varying complexity (Toglia and Goverover, 2022). To the best of our knowledge, only two studies have addressed this issue. One performance-based study assessed ABI patients' SA, through the discrepancy between therapists' ratings and patients' prediction and estimation of performance on ADL tasks of varying complexity, both before and after completing the task (Rotenberg-Shpigelman et al., 2014). The results indicated that ABI patients faced greater SA challenges when engaging in i-ADL tasks compared to b-ADL tasks. Similarly, Abreu et al. (2001) found fewer SA deficits in simpler tasks, such as meal preparation and upper body dressing, compared to a more complex task, such as money management. These studies suggest that individuals with ABI may have difficulties in accurately predicting and evaluating their performance on complex i-ADL tasks due to increased cognitive demands that leave fewer cognitive resources for error detection. However, these studies have primarily focused on measuring anticipatory/emergent SA. Thus, it remains unexplored whether offline SA differs between b-ADL and i-ADL.

Although several assessment tools are available to measure offline SA, many of them lack the necessary psychometric and conceptual properties for clinical and research purposes. Recent systematic reviews conducted by Smeets et al. (2012) and Dromer et al. (2021a) identified three methods that demonstrate acceptable psychometric and conceptual properties. These include the Self-Awareness of Deficit Interview (SADI, Fleming et al., 2009) and self-proxy discrepancy methods that compare patients' self-report of their abilities with a proxy-report, such as the Patient Competency Rating Scale (PCRS, Prigatano et al., 1998) and the Awareness Questionnaire (AQ, Sherer et al., 2009). More recently, Bivona et al. (2020) introduced a novel assessment tool called the Self-Awareness Multilevel Assessment Scale (SAMAS). This tool aims to thoroughly assess SA across different levels—namely declarative, emergent, and anticipatory—within different domains such as motor, cognitive, and psycho-behavioural, thus, overcoming some important limitations of prior tools. However, these instruments provide overall measures of cognitive and/or ADL functioning without differentiating specific cognitive aspects of SA or examining different levels of ISA across ADL tasks of different difficulty (i.e., b-ADL vs. i-ADL). Therefore, it is still necessary to develop novel instruments that can effectively capture multiple cognitive manifestations during ADL performance and accurately differentiate between basic and more complex tasks such as i-ADL (Hurst et al., 2020; Merchán-Baeza et al., 2020; Brown et al., 2021).

The present study

To address the aforementioned limitations, our research group has developed the Cog-Awareness ADL Scale as part of a comprehensive assessment protocol to evaluate the main components of SA in Spanish ABI patients (Merchán-Baeza et al., 2020), following the model of Toglia and Kirk (2000). The scale consists of a 31-item questionnaire designed to measure offline awareness across different cognitive and functional domains. This is an adaptation of the Cog-ADL Scale, an informant-based tool previously developed in our lab that allows the measurement of several cognitive domains (e.g. task schema, error detection, problem-solving, or task self-initiation, among others) across a range of b-ADL and i-ADL. The authors used the error coding system typically used in performance-based ADL studies with similar populations (Humphreys and Forde, 1998; Giovannetti et al., 2002; Schwartz et al., 2002) to develop specific items reflecting these types of cognitive errors in the context of a range of ADLs of varying complexity. This tool has demonstrated good psychometric properties in individuals with mild cognitive impairment, dementia, and healthy older adults (see Rodríguez-Bailón et al., 2015; Montoro-Membila et al., 2022 for further details).

The Cog-Awareness ADL Scale brings significant innovations to the field. Firstly, it includes multiple cognitive items related to each ADL (see Table 1). This comprehensive approach allows for the assessment of SA across different cognitive aspects that influence different ADL tasks within a single tool, providing a notable advantage over the other SA scales. Secondly, it measures the same cognitive items in both b-ADL and i-ADL, allowing for the identification of potential differences in SA between simple and complex tasks that cannot be attributed solely to variations in cognitive processes. Moreover, it provides numerous examples of each cognitive error type, enhancing the informant's ability to envision and differentiate between the various cognitive impairments that may affect each ADL. By incorporating concrete situations within each ADL, the scale reduces the inherent abstraction that is often associated with items addressing cognitive processes in other SA questionnaires, such as PCRS and AQ (Brown et al., 2021). The structure of the scale also provides flexibility for different research or clinical purposes. In addition to calculate a general discrepancy index, it also allows for the separate investigation of more specific b-ADL and i-ADL discrepancy indexes. From a clinical perspective, the scale can be used to measure SA even in cases where patients are no longer engaged in i-ADLs following ABI. In such situations, SA can still be assessed by focusing on their performance in b-ADLs. Supplementary material shows the entire tool and illustrates how these different cognitive-functional items were instantiated in each AD (see measures section for more details).

The overall aim of the present study was to validate the Cog-Awareness ADL Scale as a clinical measure of offline SA in Spanish patients with ABI enrolled in a multicenter study. The first objective was to assess its psychometric adequacy by examining its convergent validity and level of agreement with PCRS, which is a well-established measure of offline SA. We expected significant correlations between the discrepancy indexes of the Cog-Awareness ADL Scale (total, b-ADL, and i-ADL) and PCRS. Specifically, we expected strong correlations between the total, b-ADL, and i-ADL discrepancy indexes and PCRS total discrepancy, as well as in its cognitive and ADL domains. The second objective was to assess its external validity, that is, the extent to which it can discriminate between healthy controls and patients with ABI. We hypothesised that patients with severe ISA, as determined by PCRS (see measures section for details), would have higher discrepancy scores on the Cog-Awareness ADL Scale (total, b-ADL, i-ADL) compared with patients with no or low ISA and healthy participants. The sensitivity of the scale was also determined using ROC curve analysis. We expected the scale to have good sensitivity and specificity for detecting ABI patients with severe ISA, establishing it as a reliable measure of SA in the Spanish population. Finally, this study aimed to provide initial insights into the potential utility of the Cog-Awareness ADL Scale for investigating domain-specific SA, specifically differences in SA levels between b-ADL and i-ADL. Based on previous research on online SA described above, we expected that patients with severe ISA would show greater SA deficits for i-ADL compared to b-ADL tasks.

Materials and methods

Participants

We recruited ABI patients who were undergoing cognitive/occupational rehabilitation in four outpatient units in Málaga and Granada, Spain. To be eligible, patients had to be over 18 years of age and have a confirmed ABI diagnosis from a neurological report at least 3 months prior to the study. There was no restriction on the time elapsed since the onset of the ABI. Patients with hemineglect and significant motor/sensory impairments were excluded, as these may largely affect their ability to perform ADL. In addition, patients with language deficits were excluded to ensure the reliability of our study results. This is because language deficits may make it difficult for patients to understand scale instructions and provide verbal responses. Treating clinicians' judgement, supported by diagnostic/clinical reports, was used to make these exclusion decisions. An additional criterion was the presence of a reliable informant who could provide accurate information about the patient's performance in daily life. This ensured an accurate assessment of SA using the PCRS and the Cog-Awareness ADL Scale. A total of 69 patients met the inclusion criteria, although 15 were excluded for lack of a reliable informant. Thus, the final sample consisted of 54 ABI patients (19 women) and 54 relatives, of whom 39 (72.1%) were partners (30 wives, 8 husbands and 1 girlfriend), 7 (13%) were daughters, 3 (5.6%) were sons, 2 (3.7%) were mothers, 2 (3.7%) were sisters, and 1 (1.9%) was a brother. The healthy control (HC) group consisted of 71 community-dwelling volunteers recruited from the same geographic area as the patients using snowball sampling conducted by the researchers. The exclusion criteria for the HC group were: absence of a reliable informant, global cognitive decline as determined by psychometric assessment during eligibility screening, and clinically significant ISA based on the PCRS discrepancy score (see method section for details). Twenty participants were excluded: 2 with clinically significant ISA and 18 for lack of a reliable informant. The final HC group consisted of 51 participants (25 women). Ethical approval for the study was obtained from the Andalusian Ethics Committee for Biomedical Research (AnosognosiaAVD2017, 3/01/2017, 0056-N-17). All participants and their families received written and verbal information about the study and provided their informed consent before participating. Information on the racial and ethnic background of the sample was not available for this study.

Measures

The Cog-Awareness ADL Scale: offline-awareness

The main novelty of the proposed scale in relation to its predecessor (i.e. the Cog-ADL Scale) was the inclusion of two versions: one to be completed by a direct caregiver (informant version) and the other by the patient (patient version). An index of SA can be derived from the discrepancies between the two scores. Furthermore, the Cog-Awareness ADL Scale included a separate form to be completed by the direct caregiver. This additional form consists of specific questions designed to gather information about the patient's level of functioning and support needs related to each task included in the scale. By gathering information from the caregiver, the assessment can gain a more complete understanding of the patient's abilities, limitations, and assistance needs across various ADLs (see supplementary material for more details). It also included a reduced number of ADL tasks: two b-ADL (personal care, getting dressed) and two i-ADL (cooking and managing finances/shopping). This modification is intended to improve feasibility and reduce administration time. The selection of activities was based on a principal component analysis (PCA) as previously reported (Rodríguez-Bailón et al., 2015, Montoro-Membila et al., 2022), confirming the classical division between b- and i-ADL proposed by the American Occupational Therapy Association (2014).

INSERT TABLE 1 ABOUT HERE

Administration. The questionnaire can be self-administered or, if required, the examiner can read each item aloud and record the patient's responses. In either case, the therapist should always verify that all the answers have been provided. The informant version can be self-administered by the direct caregiver. To ensure that caregivers were completing the scale on behalf of the patient, the wording of each item in the informant's version was modified (e.g. from ‘I am able to notice whether the given change is correct’ to ‘He/she is able to notice whether the given change is correct.). This modification was accompanied by clear verbal instructions indicating that they were completing the questionnaire on behalf of the patient.

Scoring system. Firstly, the informant independently rates the frequency and level of assistance required by the patient for each b- and i-ADL before and after the brain injury. Frequency is rated as: 1 = “never”, 2 = “sometimes”, 3 = “weekly”, and 4 = “daily”. Similarly, the degree of assistance is rated as: 1 = “someone does the activity for him/her”, 2 = “with a lot of help”, 3 = “with little help”, and 4 = “completely by him/herself”. Since the scale is designed to measure a patient's current level of SA and functionality, activities that are no longer performed due to physical or cognitive disability, or irrelevance, are not considered for scoring. In a second step, both the patient and the informant are asked to indicate on a 4-point Likert scale, within each ADL-category (considering only those activities that are in the patient's repertoire), how often the patient exhibits the cognitive-functional errors presented in each item (1 = “never”, 2 = “sometimes”, 3 = “quite often”, 4 = “always”). The clinician is expected to clarify the content of each item at any time. For each version (patient-informant), each item score within an ADL-category is then summed to create a subcategory score (b-ADL$_{SCORE}$ and i-ADL$_{SCORE}$). Both scores are also summed to produce a TOTAL$_{SCORE}$. An ABSOLUTE$_{SCORE}$ is also calculated for each subcategory, by estimating the maximum possible score according to the number of activities performed by the participant (see below for an example). Scores are inverted, for items that ask about limitations rather than capacities. Lower scores represent greater impairment.

Indexes. The *Cog-Awareness ADL Scale* provides discrepancy indexes for each of the two ADL categories (b-ADL$_{DISCREPANCY}$ and i-ADL$_{DISCREPANCY}$) and a Total$_{DISCREPANCY}$, by considering the TOTAL$_{SCORE}$ and the ABSOLUTE$_{SCORE}$. This enables comparisons between all participants, including those who no longer perform some of the ADLs proposed in the scale. For example, if a participant performs only three activities (two b-ADLs and one i-ADL), and the patient's version has a TOTAL$_{SCORE}$ of 72 and an ABSOLUTE$_{SCORE}$ of 84, the Cog-ADL$_{PATIENT'S\ INDEX}$ will be 85.7% (TOTAL$_{SCORE}$/ ABSOLUTE$_{SCORE}$ * 100). In contrast, if the informant has a TOTAL$_{SCORE}$ of 43 and an ABSOLUTE$_{SCORE}$ of 84, the Cog-ADL$_{INFORMANT'S\ INDEX}$ will be 51.1%. All indexes are expressed as percentages, with lower scores indicating greater functional disability. Total$_{DISCREPANCY}$ is obtained by subtracting the Cog-ADL$_{PATIENT'S\ INDEX}$ from the Cog-ADL$_{INFORMANT'S\ INDEX}$ (34.6% in the cited example). The same can be done for each ADL category, considering only the b-ADL items (b-ADL$_{DISCREPANCY}$) or the i-ADL items (i-ADL$_{DISCREPANCY}$). Higher scores indicate greater discrepancy. The scale also provides the Independence$_{INDEX}$, which serves as a measure of the patient's functionality. This index is derived from the questions on the scale (degree of assistance that the patient requires for both b-ADL and i-ADL), although it is independent from those used to calculate the discrepancy. As the other indexes, it only considers the activities that the patient performs at the time of assessment. Consequently, it calculates a total score and an absolute score using the same procedure as described above. It is expressed as a percentage, with lower scores indicating a higher level of dependence.

Patient Competency Rating Scale: offline awareness

This 30-item *self-proxy rating discrepancy scale* is used to measure an individual's SA across four subscales: ADL (eight items), cognitive (eight items), interpersonal (seven items) and emotional (seven items) (Prigatano et al., 1998). It requires the patients and their caregivers to independently rate the ease with which the patient is able to perform each functional situation on a 5-point Likert scale ranging from 1 = "Can't do" to 5 = "Can do with ease". Scores range from 30 to 150 points, with higher scores indicating greater perceived competence. The level of SA is determined based on the discrepancy between the patient's self-rating and the caregiver's rating. To classify patients with severe ISA, this study applied the double criterion proposed by Bivona et al. (2019): a) patient's self-rating score of at least 100 points (indicating minimal self-perceived difficulties); and b) positive discrepancy score of at least 20 points. The PCRS has demonstrated excellent psychometric properties, and has been validated in Spanish-speaking populations (Prigatano et al., 1998).

Neuropsychological assessment

The Rey Auditory-Verbal Learning Test (RAVLT, Schmidt, 1996) is used to assess the participant's short- and long- term memory. EFs are measured with the semantic fluency test, in which participants are asked to name as many animals as possible within 60 s (Ardila et al., 2006), and the INECO Frontal Screening (IFS, Torralva et al., 2009), which is a brief and easy-to-administer screening test that has proved to be sensitive in exploring response inhibition, set shifting, abstraction, and working memory, after ABI (Pinasco et al., 2021). In this study, a Cognitive$_{INDEX}$ was additionally calculated from the average Z-scores of all neuropsychological tests. This index was used as a dependent variable in some of the statistical analyses presented in the data analysis section.

Procedure

Participants who met the eligibility criteria underwent a testing session that lasted approximately 1 hour. The assessment was conducted by the treating clinician at each rehabilitation center, such as a clinical neuropsychologist or occupational therapist. This set of clinicians was blinded to the specific objectives and hypotheses of the study. The assessment process consisted of the following steps: a) the participants and their caregivers were informed about the study and provided their informed consent; b) an interview was conducted to gather clinical and sociodemographic information; and c) the assessment took place in a quiet room, following specific administration guidelines for each measure. During the assessment, the patient's primary caregiver completed the informant-caregiver version of the PCRS and the Cog-Awareness ADL Scale in a separate room. For the healthy control group, the assessment was conducted at the Mind, Brain, and Behaviour Research Center (CIMCYC) of the University of Granada and the Faculty of Health Sciences of the University of Málaga. The assessment was administered by the principal investigators, Cognitive Neuroscience Master's students, and final year OT students. All assessors received thorough training in the administration of the tools described above.

INSERT FIGURE 1 ABOUT HERE

Data analysis

The data were analysed using R Studio software (version 1.3.1093). Descriptive statistics and appropriate nonparametric tests were performed based on the distribution of the data. To assess the ***convergent validity*** of the Cog-Awareness ADL Scale, firstly, Spearman's correlations were performed in the ABI sample, between its three discrepancy indexes (b-$ADL_{DISCREPANCY}$, i-$ADL_{DISCREPANCY}$, and $Total_{DISCREPANCY}$) and the discrepancy index of each of the PCRS subscales. The significance level was set at 0.05 with Bonferroni's correction for multiple comparisons. The r_s coefficients < 0.30 were considered as weak correlations, 0.31 - 0.7 as moderate correlations, and > 0.70 as strong correlations (González, M., Villegas, Atucha, & Fajardo, 2020). Then, we examined the agreement between the $Total_{DISCREPANCY}$ scores on the Cog-Awareness ADL Scale and the PCRS using the Bland-Altman approach (2010), as implemented in the blandr R package (version 0.5.1; Datta, 2018). For each participant we calculated the difference between both scores (y-axis), and plotted it against the mean of the same two scores (x-axis). With this method, 95% of the data points are expected to fall within the adjusted 95% limits of agreement. Proportional bias refers to a situation in which one measurement is consistently higher or lower than the other. This bias has the potential to affect the agreement between the two rating scales. To evaluate the presence of such bias, we conducted a linear regression analysis. To assess its ***external validity***, the ABI sample was firstly divided into two groups: *no-low ISA* and *severe ISA*, based on the PCRS discrepancy score, as described in the measures section (see Figure 1). Group differences in continuous variables were assessed using the Mann-Whitney U and Kruskal-Wallis rank sum tests. The categorical variables were analysed using Chi-square analysis. Performance on the three discrepancy indexes was compared among the three groups (HC, no-low ISA, severe ISA) using Quade's test, which is a non-parametric alternative to ANCOVA (Quade, 1967). Demographic, clinical, and functional variables that showed significant group differences were selected as covariates. Post-hoc analyses used Tukey-adjusted *p*-values as recommended by McHugh, (2011) to account for unequal group sizes between the groups. To assess the ***diagnostic accuracy*** of the Cog-Awareness ADL Scale, a ROC curve analysis was performed on the entire sample using the pROC R package (version 1.18.0; Robin et al., 2011). The Area Under the Curve (AUC) values were interpreted following the suggestion of Fischer et al. (2003) (> .90 high accuracy; .70 to .90 moderate accuracy; .50 to .70 low accuracy). The optimal cut-off point was determined based on sensitivity, specificity, and Youden's index formula (Youden, 1950), where a higher index indicates maximisation of sensitivity and specificity. The state variable in the ROC curve analysis was the presence of severe ISA according to the PCRS discrepancy score, and the test variable was the Cog-Awareness ADL Scale $Total_{DISCREPANCY}$ score. Finally, the paired-samples Wilcoxon test was performed to explore potential differences in SA levels of functional deficits between b-ADL and i-ADL in patients with severe ISA.

Results

Convergent validity

Spearman's rho showed a large positive and significant correlation between the Cog-Awareness ADL Scale and the PCRS $Total_{DISCREPANCY}$ scores, as well as for each of its subscales ($p < .01$). The Bland-Altman results for the level of agreement between the $Total_{DISCREPANCY}$ scores of both scales are shown in Figure 2. Due to the different units of both scores, Z scores were used to avoid creating an artificial proportional error. Visual inspection of the graph revealed that few scores (3.70%) were outside the 95% upper and lower limits of agreement. A linear regression analysis was also performed to examine the relationship between the difference (dependent variable) and the mean scores on the scales (independent variable). The analysis yielded a non-significant *p*-value ($p > 0.95$), indicating the absence of proportional bias. This suggests a high level of agreement between the Cog-Awareness ADL Scale and the PCRS $Total_{DISCREPANCY}$ scores. Correlation analyses performed for the $b\text{-}ADL_{DISCREPANCY}$ and $i\text{-}ADL_{DISCREPANCY}$ scores with each PCRS subscale showed consistent results, as shown in Table 2.

INSERT TABLE 2 ABOUT HERE

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Group differences across demographic, clinical, neuropsychological and functionality measures

Table 3 shows the demographic and clinical characteristics of the three groups: HC (n = 51), no-low ISA (n = 33), and severe ISA (n = 21). Age was not significantly different between groups (p = .18). However, there were significant differences in education level and gender. Post-hoc analyses revealed a higher proportion of participants with lower education in the severe ISA group compared to the no-low ISA group, and a marginal difference compared to the HC group (p = 0.54). Significant differences were also found in the proportion of male and female participants in the severe ISA group compared to the no-low ISA and HC groups (p < 0.001 for each comparison). Regarding the clinical variables, there were no statistically significant differences between the two ISA groups in time since injury onset (p = 0.65) or etiology (p = 0.69). However, significant differences were found in the proportion of patients' lesion location.

A series of Kruskal-Wallis rank sum tests were performed to examine group differences in performance on neuropsychological tests and the $\text{Cognitive}_{\text{INDEX}}$. Each group served as a between-subjects factor, and each neuropsychological test was the dependent variable. Prior to creating the $\text{Cognitive}_{\text{INDEX}}$, non-parametric correlation analyses confirmed significant correlations between all test scores (ranging from 0.56 to 0.74, all p < 0.001). The test scores were then converted to Z-scores based on the sample mean and standard deviation, and the average Z-score was calculated. The $\text{Cognitive}_{\text{INDEX}}$ showed high reliability (α = .89). As shown in Table 3, the no-low ISA and severe ISA groups did not differ significantly from each other on any of the neuropsychological measures, although their performance was significantly lower than that of the HC group. Significant differences were also observed in the $\text{Independence}_{\text{INDEX.}}$ All participants were involved in all b-ADL (the two tasks) from the Cog-Awareness ADL Scale. However, more variability was found in the number of i-ADL tasks performed in each group (see Table 4). A chi-squared analysis, examining the relationship between the participant groups (HC, no-low ISA, and severe ISA) and the number of instrumental ADL activities from the Cog-Awareness ADL Scale performed by the participants (zero tasks, one task or two tasks), showed a significant result ($\chi 2$ = 43.91, p < .001, Cramer's V = .45 (medium effect size)). Upon closer examination, we found that the severe ISA group had a greater percentage of participants engaging in zero or only one task (48% and 24%, respectively) compared to the no-low ISA group (30% and 15%, respectively), and the HC group, in which all participants performed both tasks (100%).

INSERT TABLE 3 ABOUT HERE

INSERT TABLE 4 ABOUT HERE

External validity

To compare group differences in the three discrepancy indexes of the Cog-Awareness ADL Scale, a Quade's test was performed, with covariates including education level, gender, the $\text{Cognitive}_{\text{INDEX}}$, and the $\text{Independence}_{\text{INDEX}}$ (variables that showed significant differences in previous analyses). As expected, a significant difference between the groups was observed for the $\text{Total}_{\text{DISCREPANCY}}$ score. Post-hoc comparisons with Tukey's correction showed that both the HC and the no-low ISA groups had significantly lower $\text{Total}_{\text{DISCREPANCY}}$ scores compared to the severe ISA group. Additionally, when the specific discrepancy indexes were analysed for the $\text{b-ADL}_{\text{DISCREPANCY}}$, the same pattern of results emerged, as shown in Table 5. However, for the $\text{i- ADL}_{\text{DISCREPANCY}}$ score, although differences in a similar direction were observed, they did not reach statistical significance among the three groups.

INSERT TABLE 5 ABOUT HERE

Diagnostic accuracy

A ROC curve was then performed (see Figure 3), and the AUC was 0.95 (95% CI = [0.89 –1]; SE = .02, $p < .001$). This indicates that there is a 95% probability that a randomly selected participant with ISA will have higher discrepancy scores than a randomly selected participant without ISA (Hajian-Tilaki, 2013). The predictive utility of the Cog-Awareness ADL Scale was also examined by calculating its sensitivity and specificity. Using a cut-off point of > .06, the scale showed a sensitivity of 0.90 (95% CI = [0.76 –1]) and a specificity of 0.90 (95% CI = [0.84 –0.96]). The positive predictive value was 0.70 (95% CI = [0.53-0.87]). This means that, among participants identified as having ISA based on the PCRS, there is a 70% probability that the Cog-Awareness ADL Scale will correctly identify them as having ISA. Conversely, the negative predictive value was 0.97 (95% CI = [0.93 –1]), meaning that there is a 97% chance that a participant without ISA on the PCRS will be correctly identified as not having ISA on the Cog-Awareness ADL Scale. Youden's Index (0.80) and accuracy (0.90, 95% CI = [0.90 –.91]) were also calculated as measures of test performance. Using this criterion, there were 19 true positives, 76 true negatives, 8 false positives, and 2 false negatives.

INSERT FIGURE 3 ABOUT HERE

Differences in SA levels between b-ADL and i-ADL in patients with severe ISA

While all participants with severe ISA completed the b-ADL tasks, only 11 of them completed the i-ADL task. Therefore, the results for these patients are presented. The paired-samples Wilcoxon test showed a significant difference in the levels of SA (Z = 8.00, $p = 0.024$). In patients with severe ISA, the i-$ADL_{DISCREPANCY}$ score (Mdn = 30%) was higher than the b-$ADL_{DISCREPANCY}$ score (Mdn = 16%), as shown in Figure 4.

INSERT FIGURE 4 ABOUT HERE

Discussion

Convergent validity

The Cog-Awareness ADL Scale showed a strong correlation with PCRS, which is a well-established scale for assessing SA, with acceptable psychometric and conceptual properties (Smeets et al., 2012; Dromer et al., 2021a). The strong correlation between the discrepancy scores of both instruments (globally and in each subscale) suggests a positive association between the existing scale and the newly developed scale. Surprisingly, the correlation between the Cognitive Awareness ADL scale and the ADL-subscale of the PCRS, although strong, had the lowest coefficient compared to others PCRS subscales, especially on the b-ADL subscale. One possible explanation may be related to the PCRS's design, which appears to prioritize questions about i-ADL over b-ADL. Another explanation is that the PCRS is a scale that assesses the person's ability to perform an activity or behaviour, even if he/she does not currently perform it (i.e. potential ability rather than actual ability). In contrast, the Cog-ADL scale requires the person to actually perform the activity in order to answer the items. If the activity is not performed, the items are not answered. Therefore, the absence of the need for hypothesizing about others' or one's ability, as required by the Cog-ADL Scale, might explain the comparatively lower correlations between the two scales. This difference is particularly noticeable in the ADL-subscale of the PCRS, where it is clear whether the person performs the activity or not, unlike other sections such as the emotional, cognitive or interpersonal subscales, which do not involve this kind of hypothesising as they relate to different aspects of the person's daily life.

However, it is important to point out that a strong correlation does not necessarily mean that these scales provide equally accurate estimates of true values (Bland and Altman, 2010). The Bland-Altman plot showed that the majority of the differences observed between the scales in the $Total_{DISCREPANCY}$ scores fall within the 95% confidence limits, indicating an acceptable level of agreement. We believe that this is an important finding in favour of the psychometric robustness of the present scale for measuring SA in ABI patients. This is consistent with several studies indicating that agreement examinations are needed to estimate the amount of error in the development and evaluation of health status scales and classification procedures (Terwee et al., 2007; Kottner et al., 2011; Boateng et al., 2018).

In addition, it is important to note that, while these previous instruments are reliable and feasible for routine use in assessing SA, they have limitations in capturing the extent to which cognitive factors contribute to variations in SA across different aspects of daily life. The limited number of items addressing the cognitive domain in these instruments has received considerable attention in clinical and research settings (Bivona et al., 2020; Brown et al., 2021; Dromer et al., 2021a; Toglia and Goverover, 2022). Conversely, the Cog-Awareness ADL Scale provides a comprehensive and complete approach isolating the cognitive processes that impact activities of daily living, by incorporating multiple cognitive items that have proved to be important in predicting functional performance in previous research with performance-based ADL tasks. In addition, the fact that it provides numerous examples of each cognitive error type within the same ADL contexts may facilitate more realistic responses from patients and caregivers and reduce subjectivity. By addressing the cognitive domain in such detail, the Cog-Awareness ADL Scale effectively reduces the inherent abstraction that is often associated with items related to cognitive processes in other self-proxy rating discrepancy scales (Brown et al., 2021). Furthermore, the importance of our scale lies in its unique structure, as it effectively differentiates between b- and i-ADLs. This novel design allowed us, for the first time, to examine the distinct relationship between the discrepancy in b- vs. i-ADLs and each subscale of the PCRS. Specifically, our results indicate that discrepancy in both b- and i-ADLs are associated with the different aspects measured by the PCRS. This suggests that our scale has the ability to capture all cognitive and functional dimensions related to ISA. This provides a comprehensive view of ISA, thus contributing to a more thorough understanding of patients' condition and their ability to assess their own deficits.

Sociodemographic, clinical, neuropsychological and functional differences among groups:

Regarding neuropsychological measures, the two patient groups showed cognitive deficits in all cognitive areas with lower performance in most neuropsychological tests and the $\text{Cognitive}_{\text{INDEX}}$ compared to that obtained by the HC, this was an expected outcome as cognitive dysfunction is a common adverse consequence after ABI (Whyte et al., 2011). More importantly, the two ABI patients' groups did not differ from each other in any of these neuropsychological measures, except in their level of ISA (greater discrepancy index effect for the severe ISA group than for the no-low ISA and HC groups). We consider that this is a significant finding, as it demonstrates that patient groups specifically differ in their genuine

SA abilities, and that these cannot be attributed or confounded with group differences in other cognitive processes. The Cog-Awareness ADL Scale also allowed us to test the relationship between ISA and patients' functional dependence. Chi-squared analyses on the proportion of participants performing or not performing each ADL from the Scale showed that, while all patients continued to perform both b-ADL, a larger proportion of patients from the severe ABI group performed none or only one of the two i-ADL and very few performed both, compared to the no-low and HC groups, where most of them continued to perform the two i-ADL. Altogether, these findings revealed that the presence of ISA after ABI is specifically prone to alter dependence in i-ADL. To the best of the authors' knowledge, no prior scales have allowed testing this task differentiation.

External Validity

Group comparisons confirmed the expected results. In this study, the patients with severe ISA had significantly higher **Total$_{\text{DISCREPANCY}}$** scores than the patients with no-low ISA and the HC, suggesting a greater tendency for patients with severe ISA to overestimate their functional abilities on the Cog-Awareness ADL Scale. These findings are consistent with previous studies examining SA in participants with various ABI populations and healthy controls using other self-proxy discrepancy tools such as PCRS or AQ (Prigatano et al., 1998; Sherer et al., 2003; Noé et al., 2005; Bivona et al., 2019). As expected, the patients with severe ISA had significantly higher discrepancy scores in the b-ADL subcategory compared to the patients with no-low ISA and the HC. However, in the i-ADL subcategory, although there was a pattern of higher discrepancy scores in patients with severe ISA, the observed difference, surprisingly, did not reach statistical significance. This finding may be attributed to the fact that several patients in our sample did not participate in the i-ADL tasks, reducing the sample to only 11 patients in the severe ISA group. This limited sample size could potentially have affected the ability of the test to detect significant differences in the i-ADL tasks, especially given the observed variability in the data within each group. Indeed, sample size and variability are two important factors known to affect the statistical power of various tests (Rusticus and Lovato, 2014).

Diagnostic accuracy

The diagnosis of ISA is crucial for the management of ABI patients, as it affects daily functioning and influences treatment decisions and prognosis. In our study, we aimed to evaluate the diagnostic accuracy of the Cog-Awareness ADL Scale in identifying ABI patients with and without ISA using a ROC curve analysis. To the best of our knowledge, ROC analysis has only been used for the diagnostic accuracy of one SA tool, i.e., SADI, which is a validated semi-structured interview (Ownsworth et al., 2019), but not for a *self-proxy rating discrepancy scale*. The results of the ROC curve analysis indicate that the Cog-

Awareness ADL Scale has excellent sensitivity and specificity with a cut-off score of > .06, which is consistent with the convention proposed by Fischer et al. (2003). This indicates that the majority of ABI patients identified as having severe ISA by PCRS were correctly identified by the Cog-Awareness ADL Scale. It should be noted that, although the number of false positives was higher than the number of false negatives, we prioritised minimising false negatives in our study to prevent the negative consequences associated with underdiagnosis of ISA, such as delayed intervention (Trevethan, 2017). In this regard, as previously reported (Smeets et al., 2012; Dromer et al., 2021b; Sansonetti et al., 2021; Toglia and Goverover, 2022), the development of sensitive diagnostic tools with acceptable psychometric properties to accurately determine the level of ISA in patients with ABI is essential for their early rehabilitation to increase motivation and engagement, improve functional outcomes, and prevent long-term consequences.

Do SA levels vary across tasks?

Another interesting finding of this study is that individuals with severe ISA showed a significantly reduced ability to accurately predict their cognitive performance on i-ADL tasks compared to b-ADL tasks. This finding adds valuable insights to the ongoing discussion in recent studies, highlighting the need to investigate the potential variability of ISA manifestations observed between patients and within the same individual depending on task characteristics such as familiarity and task complexity (Toglia and Kirk, 2000; Merchán-Baeza et al., 2020; Dromer et al., 2021a; Toglia and Goverover, 2022). As described above, to our knowledge, only a few performance-based studies have addressed the effect of task type on the level of SA, also finding greater challenges in SA when ABI patients faced more complex i-ADL tasks (Abreu et al. 2001; Rotenberg-Shpigelman et al. 2014). The novel structure of the Cog-Awareness ADL Scale, which distinguishes between b-ADL and i-ADL, seems to be the first tool to address the issue of task complexity in offline SA. Indeed, as was mentioned above, it seems that the inherent complexity of i-ADL tasks, including higher cognitive and social demands, may lead to a reduced ability of individuals with severe ISA to anticipate steps, foresee errors, and accurately evaluate their performance. These findings have important clinical implications for at least two reasons. Firstly, they underscore the importance of considering different task demands and contextual factors when assessing SA after ABI, as suggested by Toglia and Kirk, (2000). Secondly, as emphasised by Robertson and Schmitter-Edgecombe (2015), the offline component of SA has significant implications for an individual's assessment of task difficulty, which may hinder their effort and engagement in certain tasks, thus affecting their commitment in treatment programmes. However, this finding, should be interpreted with caution, as it is based on a small sample size of patients with severe ISA in whom both discrepancy indices for b-ADL and i-ADL tasks could be calculated. Therefore, although these findings are meaningful and provide valuable insights within the specific context of our study population, their generalisability may be limited. Although this limitation could not have been anticipated prior to the study, replication with a larger sample of severe ISA patients would provide further validation and increase the robustness of the results. Nevertheless, the fact that such a reduction in the sample of severe SA ABI patients performing frequent IADL took place seems to be a relevant finding that highlights the impact of SA on complex functionality and the importance of addressing the specific needs of individuals with severe ISA to enhance their ability to carry out daily activities effectively.

Limitations and future directions

While our multicenter study provides preliminary evidence supporting the validity of the Cog-Awareness ADL Scale for identifying ABI patients with and without ISA in both research and clinical settings, it is important to acknowledge some limitations. Firstly, the factor structure of the Cog-Awareness ADL Scale could not be assessed due to the sample size. Conventional guidelines suggest having a ratio of 5 to 10 participants per item (Kyriazos, 2018), which would recommend a sample size of 155-310 participants for the Cog-Awareness ADL Scale. Therefore, a larger study is needed to confirm and establish the factor structure of the Cog-Awareness ADL Scale. Future studies should also include test-retest and inter-rater reliability analyses, which could not be included in the present study due to COVID-19 restrictions on sample access that were present when the study was conducted. Secondly, due to the heterogeneous nature of our sample, we were unable to examine whether different etiologies, other clinical factors such as severity of impairment, or lesion location may result in different profiles of SA levels. Future studies with a larger sample of participants may be able to divide patients into subgroups with more homogeneous clinical profiles in order to distinguish between different SA levels. In addition, future investigations using this scale with larger samples could focus on assessing the extent to which SA levels differ among specific cognitive domains (i.e., are patients with ISA less aware of specific cognitive items, such as those related to inhibition, problem-solving or task initiation, than to others? Are potential deficits in SA in specific cognitive domains related to damage into specific brain regions? Gaining insight into these variations seem crucial for advancing our understanding of SA in the context of ABI (Dromer et al., 2021a; Villalobos et al., 2021; Toglia and Goverover, 2022) and for tailoring personalised interventions to improve patient outcomes (Smeets et al., 2012). We consider that the inherent structure of the Cog-Awareness ADL Scale seem promise to start answering these relevant questions. Furthermore, in our study, we were not able to assess the participants' emotional and psychological functioning. The influence of emotional and social factors on SA has received considerable attention in recent systematic reviews by Brown et al. (2021) and Dromer et al. (2021b). It is important for future development of the scale to address this limitation and include additional items to assess these factors, in order to gain a more comprehensive understanding of other potential subdomains of SA.

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Disclosure statement

We have no known conflict of interest to disclose.

Data availability statement.

The data that support the findings of this study are available from the corresponding author, DS-F, upon reasonable request.

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Author Contributions

DS-F: Methodology; Investigation; Formal analysis; Visualisation; Writing–Original Draft; Writing–Review & Editing.

MJF: Conceptualisation; Methodology; Visualisation; Writing–Review & Editing; Supervision.

AN-E: Methodology; Investigation

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Appendix 1.

Table 1. General structure of the Cognitive Awareness Scale for Basic and Instrumental Activities of Daily Living

	The Cog-Awareness ADL Scale	
Cog-functional abilities measured	***Item 1. Action schema***: ability to complete all necessary steps of the task in the correct order. ***Item 2. Distraction***: ability to avoid distraction and grabbing or making tangential actions toward irrelevant objects which were not necessary for the task. ***Item 3. Object selection***: ability to select the proper objects to perform the task without replacing them with others. ***Item 4. Semantic knowledge***: Ability to recognise the use of the objects. ***Item 5. Error detection***: ability to detect their own errors. ***Item 6. Problem solving***: ability to solve any unexpected situation occurring during the execution of an ADL. ***Item 7. Task self-initiation***: ability to self-initiate a task in an autonomous manner. ***Item 8. Calculation****:* ability to perform mathematical operations accurately and efficiently. ***Item 9. Memory:*** ability to acquire, retain, and recall information effectively. ***Item 10. Inhibition:*** ability to control one's immediate desires or impulses and make decisions that consider the potential consequences.	
	b-ADL	**i-ADL**
Activities	Personal care (items 1-7)	Cooking (items 1-7)
	Getting dressed (items 1-7)	Managing finances/shopping (items 1-10)
Number of items	14	17

Note: b-ADL = basic activities of daily living; i-ADL = instrumental activities of daily living

Table 2. Spearman correlations between the Cognitive Awareness Scale for Basic and Instrumental Activities of Daily Living and the Patient Competency Rating Scale discrepancy indexes for the patient sample

	Cog-Awareness ADL Scale		
PCRS - Discrepancy	**Total$_{DISCREPANCY}$ (n = 54)**	**b-ADL$_{DISCREPANCY}$ (n = 54)**	**i-ADL$_{DISCREPANCY}$ (n = 32)**
Total	0.80**	0.78**	0.69**
ADL-subscale	0.58**	0.55**	0.61**
Emotional- subscale	0.74**	0.70**	0.65**
Cognitive- subscale	0.67**	0.63**	0.64**
Interpersonal- subscale	0.64**	0.66**	0.51**

Note: PCRS = Patient Competency Rating Scale; ADL = activities of daily living; b-ADL = basic activities of daily living; i-ADL = instrumental activities of daily living

Bonferroni's corrected significance levels: * = < .05; ** = < .01

Table 3. Comparison between participants in each group on demographic and clinical variables.

	HC (Group 1) n = 51	No-low ISA (Group 2) n = 33	Severe ISA (Group 3) n = 21	Test[1]	Group differences[2]	Effect size
Demographic-clinical variables						
Age (Years)						
Mean (SD)	53 (± 17)	56 (± 11)	59 (± 13)	χ^2 (2) = 3.44	ns.	$\eta^2 = .03$
Range	19-81	31-75	25-81			
Education (Years)						
Mean (SD)	11 (± 3)	11 (± 3)	9 (± 3)	χ^2 (2) = 7.16*	2 > 3*	$\eta^2 = .07$
Range	6-17	5-17	4-17			
Gender (n, %)						
Female	25 (49%)	17 (52%)	2 (10%)	χ^2 (2) = 11.36**	1 > 3*** 2 > 3***	ϕ = .30
Evolution (Months)						
Mean (SD)	-	14 (± 12)	20 (± 21)	U = 200	ns.	$r_{bis} = .08$
Range	-	3-48	3-76			
Etiology (n, %)						
Stroke	-	25 (83%)	12 (76%)	χ^2 (3) = 1.44	ns.	ϕ = .00
Tumour	-	2 (7%)	2 (12%)			
TBI	-	2 (7%)	2 (12%)			
Infection	-	1 (3%)	0 (0%)			
Lesion location (n, %)						
Left Hemisphere	-	14 (58%)	3 (25%)	χ^2 (2) = 5.85*	-	ϕ = .33
Right Hemisphere	-	6 (25%)	8 (67%)			
Bilateral	-	4 (17%)	1 (8%)			
Neuropsychological measures[3]						
INECO	25 (± 3)	19 (± 6)	18 (± 5)	χ^2 (2) = 34.8***	1 > 3*** 1 > 2***	$\eta^2 = .35$
RAVLT-short term	48 (± 10)	37 (± 13)	30 (± 10)	χ^2 (2) = 30.3***	1 > 3*** 1 > 2***	$\eta^2 = .30$
RAVLT-long term	10 (± 3)	7 (± 4)	5 (± 4)	χ^2 (2) = 23.6***	1 > 3*** 1 > 2**	$\eta^2 = .23$

Semantic Fluency	22 (± 6)	15 (± 6)	14 (± 5)	χ^2 (2) = 27.7***	1 > 3*** 1 > 2***	η^2 = .28
$\text{Cognitive}_{\text{INDEX}}$	.45 (±.61)	-.44 (±.86)	-.82 (±.70)	χ^2 (2) = 39.1***	1 > 3*** 1 > 2***	η^2 = .39
Functionality measures(%)[4]						
$\text{Independence}_{\text{INDEX}}$	99 (± 3)	74 (± 20)	62 (± 15)	χ^2 (2) = 74.8***	1 > 3*** 1 > 2* 2 > 3***	η^2 = .71

Note: HC = Healthy Controls; ISA = Impaired Self-Awareness; RAVLT = Rey Auditory Verbal Learning Test
Significance levels: * = < .05; ** = < .01; *** = < .001
[1] Kruskal-Wallis rank sum test and Mann-Whitney U test for continuous variables; Chi-squared test for categorical variables.
[2] Differences between groups were evaluated with Tukey's post hoc tests
[3] Mean raw scores
[4] Derived from the Cog-Awareness ADL Scale. Lower scores (%) represent lower functional level

Table 4. Frequency of participants from each group that perform each type of activity.

	HC (n = 51)	No-low ISA (n = 33)	Severe ISA (n = 21)
b-ADL, n(%)			
2 tasks	51 (100%)	33 (100%)	21 (100%)
1 task	-	-	-
0 tasks	-	-	-
i-ADL, n(%)			
2 tasks	51 (100%)	18 (55%)	6 (29%)
1 task	-	5 (15%)	5 (24%)
0 tasks	-	10 (30%)	10 (48%)

Note: HC = Healthy Controls; ISA = Impaired Self-Awareness; b-ADL = basic activities of daily living, i-ADL = instrumental activities of daily living

Table 5. Comparison between participants in each group on the three discrepancy indexes of the Cognitive Awareness Scale for Basic and Instrumental Activities of Daily Living.

	HC (Group 1) n = 51	**No-low ISA** (Group 2) n = 33	**Severe ISA** (Group 3) n = 21	**Test**[1]	**Group differences**[2]	**Effect size**
Cog-Awareness Total (%)						
Mean (±SD)	0 (± 3)	2 (± 8)	21 (± 11)			
Range	-11 to 10	-13 to 29	0 to 38	$F = 6.55^{**}$	$1 < 3^{*}$ $2 < 3^{**}$	.11
Median (IQR)	0 (-1, 1)	2 (-1, 4)	20 (13, 29)			
Cog-Awareness b-ADL (%)						
Mean (±SD)	0 (± 2)	2 (± 8)	18 (± 10)			
Range	-5 to 7	-13 to 21	-5 to 38	$F = 6.04^{**}$	$1 < 3^{*}$ $2 < 3^{**}$	.11
Median (IQR)	0 (0, 0)	2 (-2, 5)	16 (13, 25)			
Cog-Awareness i-ADL (%)[3]						
Mean (±SD)	0 (± 6)	3 (± 10)	29 (± 18)			
Range	-16 to 20	-10 to 43	4 to 54	$F = 2.06$	ns.	.05
Median (IQR)	0 (-2, 2)	0 (-2, 3)	31 (15, 43)			

Note: HC = Healthy Controls; ISA = Impaired Self-Awareness; b-ADL = basic activities of daily living, i-ADL = instrumental activities of daily living

[1] Quade's ANCOVA, selecting years of education, gender, $Cognitive_{INDEX}$ and functionality as covariates

[2] Differences between groups were evaluated with Tukey's post hoc tests.

[3] In this analyses sample size for the no-low ISA group was n = 23 and for the severe ISA group was n = 11, as not all participants performed i-ADL.

Significance levels: * = < .05; ** = < .01; *** = < .01

Greater mean scores (%) represent greater ISA

Figure 1. Sampling Flow Chart

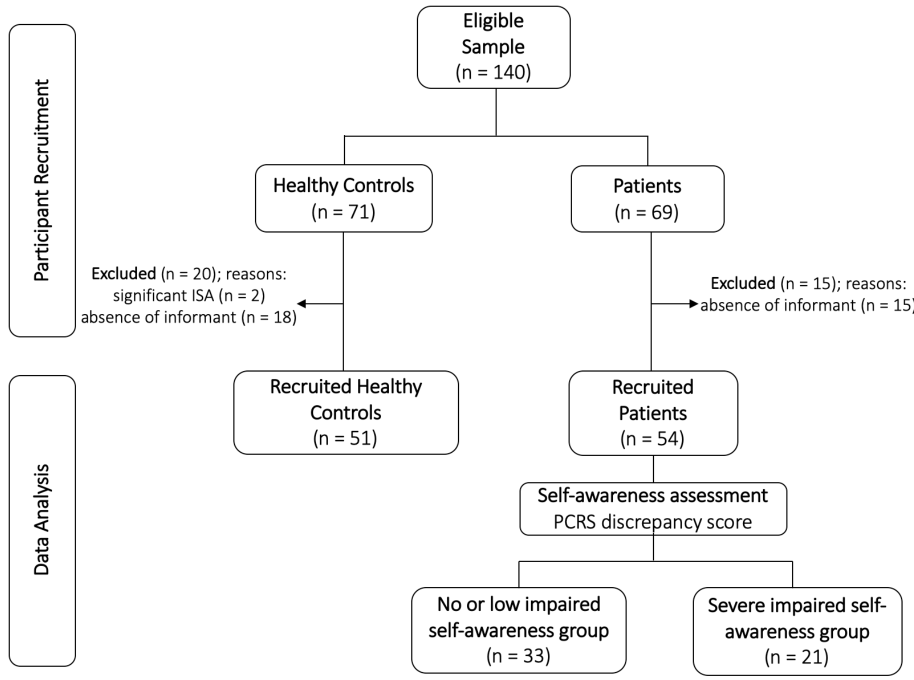

Figure 2. Bland-Altman plot of agreement between the Cognitive Awareness Scale for Basic and Instrumental Activities of Daily Living and the Patient Competency Rating Scale (PCRS) in the patient sample (*n= 54*). The middle line represents the mean difference in the Total$_{DISCREPANCY}$ scores of both scales. The upper and lower dashed lines represent the upper and lower 95% confidence limits.

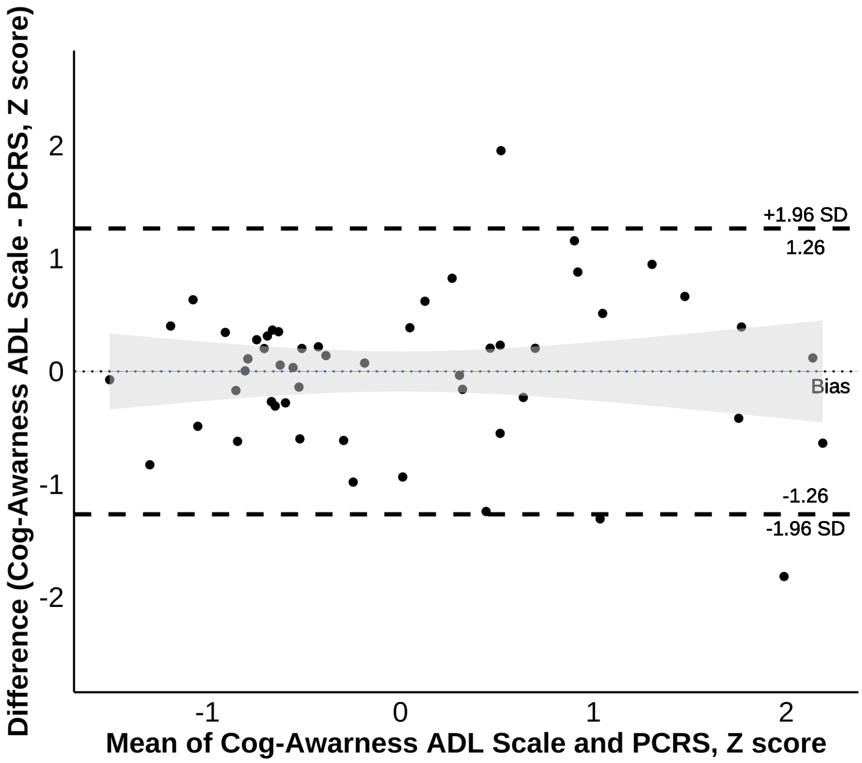

Figure 3. Area under the curve (AUC) demonstrating the optimal sensitivity (true positive rate) and specificity (true negative rate) of the Cognitive Awareness Scale for Basic and Instrumental Activities of Daily Living relative to the Patient Competency Rating Scale (*n= 105*).

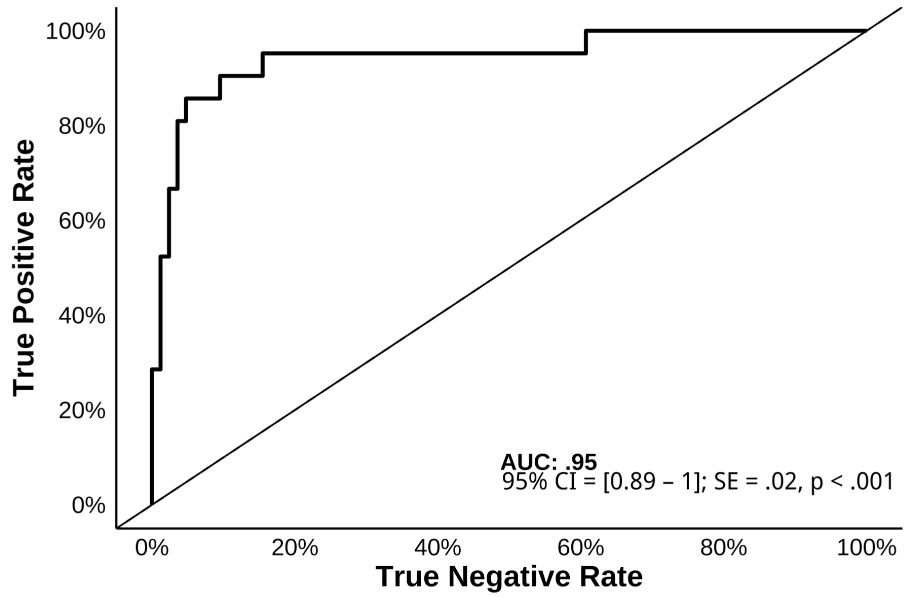

Figure 4. Visualization of group and individual change between patients with severe impaired self-awareness (*n= 11*) for the discrepancy index across basic (b-ADL) and instrumental activities of daily living (i-ADL).