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A lexical-cognitive approach to the consequences of the coronavirus crisis for the emotions and perceptions of the Spanish population aged 65 and over

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Abstract: The COVID-19 pandemic has devastated health systems, economies, and societies. Considered a high-risk group, the elderly have been amongst the most affected. Using word association tests, we access the perceptions held by a group of individuals aged 65 and over, pre-stratified by gender and level of education, regarding certain aspects of the situation we now face. We interpret the vocabulary provided during the tests as a network of connections. Thus, we can create the metastructure of the mental lexicon and consider it the reflection of the collective perceptions associated with five cognitive categories: *pandemic, old age, society, future*, and *politics*. For this, we use a model that allows us to construct cognitive prototypes based on the theory of fuzzy sets. Previous results warn of the emotional consequences that have affected the entire population. However, we are now also able to prove that the older generation is experiencing unprecedented feelings of loneliness and neglect due to the circumstances. This could exacerbate the worry, fear, and uncertainty imposed on this group by the *new normal*. Finally, we suggest concrete actions for both health workers in contact with groups of elderly individuals and the research community that generally uses attitudinal surveys.

Keywords: Lexical associations, mental representations, aging people, collective cognitive prototypes, coronavirus, cognitive consequences

Résumé : La pandémie de coronavirus a ravagé systèmes de santé, économies et sociétés. Les personnes âgées, considérées comme un ensemble à haut risque, ont été parmi les plus touchées. À l'aide de tests d'association lexique, on accède aux perceptions d'un groupe d'individus âgés de 65 ans et plus, stratifiés selon le sexe et le niveau d'éducation, concernant quelques aspects de la situation à laquelle nous sommes confrontés aujourd'hui. On interprète le vocabulaire fourni lors les tests

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comme un réseau de connexion. Ainsi, on peut créer la structure du lexique mental et le considérer comme le reflet des perceptions collectives associées à cinq catégories cognitives : *pandémie*, *vieillesse*, *société*, *avenir* et *politique*. Pour se faire, on utilise un modèle qui nous permet de construire des prototypes cognitifs basés sur la théorie des ensembles flous. Les résultats précédents avertissent des conséquences émotionnelles qui ont affecté la population. Néanmoins, on est en mesure de confirmer que la génération plus âgée éprouve des sentiments de solitude et de négligence en raison des circonstances. Cela pourrait aggraver l'inquiétude, la peur et l'incertitude imposées à ce groupe par la «nouvelle normalité». Enfin, on propose des actions concrètes tant pour les travailleurs de la santé qui sont en contact avec des groupes de personnes âgées que pour la communauté des chercheurs qui utilisent normalement des enquêtes attitudinales.

Mots-clés : associations lexicales, conséquences cognitives, coronavirus, personnes âgées, prototypes collectifs cognitifs, représentations mentales

Resumen: La pandemia de la COVID-19 devastó los sistemas de salud, las economías y las sociedades. Considerados como un grupo de alto riesgo, la población de mayor edad ha sido uno de las más afectados. A través de pruebas de asociación léxica, hemos podido acceder a las percepciones compartidas por un grupo de personas españolas de 65 años en adelante, previamente estratificadas por género y nivel educativo, sobre determinados aspectos de la situación generada por la pandemia. Interpretamos el vocabulario obtenido a través de las pruebas como una red de conexiones. Así, podemos generar la metaestructura del léxico mental y considerarlo reflejo de las percepciones colectivas asociadas a las cinco categorías cognitivas estudiadas: pandemia, vejez, sociedad, futuro y política. Hemos creado un modelo que nos permite construir prototipos cognitivos basados en la teoría de conjuntos difusos. Trabajos previos advierten de las consecuencias emocionales que han afectado a toda la población. Sin embargo, ahora también podemos demostrar que la generación de mayores está experimentando sentimientos de soledad y abandono sin precedentes. Esto podría acrecentar la preocupación, el miedo y la incertidumbre que la llamada 'nueva normalidad' impone a este grupo etario. Finalmente, sugerimos acciones concretas tanto para los trabajadores de la salud en contacto con grupos de adultos mayores, como para la comunidad investigadora que habitualmente utiliza encuestas actitudinales.

Palabras clave: asociaciones lécicas, consecuencias cognitivas, coronavirus, personas mayores, prototipos cognitivos comunitarios, representaciones mentales

1 Introduction

The crisis resulting from COVID-19 has devastated health systems, economies, and societies across the world. Spain has been amongst the most affected countries since the pandemic took hold, both in terms of the number of those falling ill with or dying of the disease and in terms of the disastrous socioeconomic consequences following the outbreak in March 2020. Experts warned early on that the tragedy we have faced will change the way we perceive human relationships and the world, and that this will lead to a new reality for which we are most likely not yet entirely prepared, since fundamental aspects previously considered beyond question will be affected, including even individual rights and freedoms (Žižek, 2020; Ávila-Muñoz et al., 2020, 2021).

The principal aim of this paper is to discover, describe, and analyse, using word association tests, how the proportion of the Spanish population aged 65 and over perceives the situation we now face due to the pandemic. More severely affected by the disease, they constitute a particularly vulnerable age group and have been considered by experts to be one of the main high-risk groups since the beginning of the pandemic. We consider the lexical networks obtained via the tests to constitute a metastructure. This represents concepts and conceptualisations related to the cognitive stimulus used as the point of departure for each test, and it can be interpreted as a snapshot of the collective cognitive perception. A set of objectives derives from the principal aim. First, to analyse the vocabulary that the study sample associates with the stimuli chosen for the word association tests. These stimuli attempt to be in consonance with two basic principles: universality and consistency. They represent thematic areas, or cognitive categories, that are easily identifiable by any individual, irrespective of his or her condition or situation (principle of universality) and with a degree of consistency that ensures univocal association among the participants (principle of consistency). Second, to identify the relationship between the cognitive conceptualisations – obtained by studying the organisational structure of the word lists provided by the participants – and gender and level of education. Third, we propose to study the cognitive prototypes associated with the metastructures produced by the participants for the stimuli. Fourth, we hope to identify areas of sensitivity or perceptions acquired by the study sample in response to the crisis, since the stimuli are all closely related to the crisis and its consequences. Fifth, we would like to inform the relevant parties of the need to introduce standards for preventative healthcare and administrative processes, that will provide society with the tools it needs to recover from the potential consequences of this crisis and to cope more effectively with future crises.

In line with the results of previous research focussing on other age groups (Ávila-Muñoz et al., 2020; Ávila-Muñoz, 2022), we expect to identify a particularly pessimistic

collective perception of the current situation and the future. Restrictions on movement, social distancing measures, and the risk of a resurgence in the number of cases as well as of the emergence of mutated variants of the virus, seem to have left people feeling vulnerable and insecure, a fact that is almost certainly affecting their day-to-day lives and the way they interact with others. This negative perception may even be more evident among the population under study here, and it may cause emotional and cognitive changes that could, in turn, lead to the elderly experiencing anxiety and a lack of control over the routines that would otherwise allow them to live out their lives in the healthy and balanced manner they desire.

In order to approximate the perceptions held by the participants regarding this new reality, we will perform both quantitative and qualitative analysis of the data obtained via the word association tests. However, this will only be the first step in a more detailed process, as this type of test also gives access to prototypical collective categorisations (Hernández-Muñoz et al., 2006; Ávila-Muñoz and Villena-Ponsoda, eds, 2010; Ávila-Muñoz, 2016). We will therefore also analyse how the participants actually perceive the five cognitive categories referenced in the stimuli used for the tests – now that we have spent a few months living the 'new normal'. The five categories chosen for the tests and presented in the form of initial lexical-cognitive stimuli are as follows: *pandemia 'pandemic'*, *vejez 'old age'*, *sociedad 'society'*, *futuro 'future'*, and *política 'politics'*.

2 Theoretical framework

2.1 Background. Studies of lexical availability

The theoretical model used in this work arose from reflection on the underlying meaning of studies of lexical availability, which are of long-standing tradition in Hispanic research. Such studies seek to gather the vocabulary associated with specific, frequent communicative situations. Lexical availability research was first conducted during the middle of the twentieth century to supplement classical works based on lexical frequency, mainly used in the area of foreign language teaching (Davies, 2005; Lonsdale and Le Bras, 2009).

To obtain the word frequency of a particular language, linguists use methods that favour accessing the statistically most stable lexicon. In other words, lexical frequency lists basically include the words speakers use when building a message regardless of the topic the message is about. As is well known, we tend to use a reduced number of lexical and structural units which are, of course, the most frequent. In fact, the variable 'frequency of use' is one of the most relevant factors in language processing, both in production and decoding.

Nevertheless, availability dictionaries can turn out to be adequate complements to balance frequency repertoires – which are excessively biased towards non-thematic lexicon –, since they reflect the lexical flow as used by speakers in specific communicative situations. Such lists are based on the concept of 'frequent situation', which is quite different from the one underlying lists of 'frequent words'. Thus, the idea of the available lexicon is founded on the motto that certain very commonly used words in a particular language are related to and constrained by the occurrence of certain topics. To obtain the available vocabulary – which, as stated, is *not* the most frequent – we carry out association tests based on a certain number of centres of interest (CI), around which specific related vocabulary emerges. It is assumed that this vocabulary is the speakers' potential lexicon included in their active lexical competence, and they use it whenever a particular and frequent topic turns up during conversation. The overall number of words within the list of available vocabulary for a specific CI is constrained by the speakers' reaction time – two minutes for each association stimulus as far as both current and traditional research is concerned (Samper Padilla, 1998).

It seems apparent that words that come the earliest to the memory will be the most available and, hence, the ones occupying the first positions in the availability lists. In sum, speakers' available lexicon is part of their mental lexicon but it does not occur in everyday linguistic interactions unless a specific topic does establish so. To obtain available lexicon lists, a mathematical formula based on the so-called Lexical Availability Index (LAI) is used. Broadly speaking, the LAI is a numerical index that endeavours to relate the frequency and order of the words on the lists provided by the participants for a CI (Ávila-Muñoz and Villena-Ponsoda, eds, 2010; Callealta Barroso and Gallego Gallego, 2016).

2.2 From lexical availability to lexical compatibility. A necessary transformation of theory

The thought process that led to the development of the compatibility index (ICL) and that is used as the methodological basis for this work, was developed in response to the search for theoretical justification, which has been ongoing since the first studies of lexical availability were conducted (Gougenheim et al., 1956). Although the LAI is mathematically precise, the studies that use this index do not provide a solid explanation of the nature of the underlying mathematical model, an issue that is overcome by using the ICL (Ávila-Muñoz and Villena-Ponsoda, eds, 2010). The theoretical justification used in the present work led to the development not only of the ICL but also of other, complementary elements based on the interpretation of the data obtained, allowing research to go beyond the concept of 'lexical availability'. By using the ICL,

these elements can be combined to produce a theoretical framework that facilitates subsequent development through the use of a certain model. This model provides practical results in the sense that they are similar and comparable to those provided by the LAI, since both indices represent the same information – only that the ICL does so while being based on a solid theoretical model.

The concept of 'lexical availability' builds on a simple assumption: members of the same speech community have certain vocabulary in common associated with frequently observed cognitive prototypes (Villena-Ponsoda and Ávila-Muñoz, 2010). As the LAI characterises the words themselves, we have adapted it for our theoretical framework, so that it may characterise the community. The transformation occurs via the following premises (Villena-Ponsoda et al., forthcoming):

1. The stimulus that activates the association process is an access point to a network of lexical elements perceived by the individual as interrelated as well as related to the concept referenced in the stimulus, traditionally known as a centre of interest.
2. The structure that is produced is subjective and inherent to the individual, meaning it cannot be strictly extrapolated to others.
3. For various reasons, including both social and cultural factors, individuals within the same speech community construct similar lexical structures. We consider this shared sociocultural metastructure to constitute the shared lexicon. A change in the group of speakers would therefore most likely produce a change in the structure of the shared lexicon.
4. When a group of individuals is asked to provide a list of available vocabulary from a stimulus, they first access words most closely related to the concept referenced. Each individual then moves through his or her lexical network towards words less closely related to the original access point, providing more accessible words before those that are less accessible. There is the possibility that, should an individual feel he or she has moved too far from the stimulus, he or she will re-enter his or her network via a new access point (Ávila-Muñoz and Sánchez-Sáez, 2011).
5. Due to the above, collective cognitive prototypes can be constructed, reflected in lexical metastructures consisting of a nucleus of vocabulary that is shared and accessible to all speakers, as well as a periphery that is accessible to individuals depending on an increasing degree of lexical diversity. The transition from nucleus to periphery is not abrupt but gradual.

The theoretical model that underlies the present work and explains the nature of the ICL results from the last premise. Due to the format of the association tests, these premises exhibit limitations. Although we assume that lexicon is structured as a multiconnected network, determining its layout would go beyond the scope of any

study. We therefore resort to a simplified representation, in which a collective prototype consists of a network of words organised by degree of accessibility. In this way, the need for the provision of information about the nature of the connections is deliberately removed, and the focus is guided towards determining the ease with which words provided during a test can be accessed.

In our view, the theoretical approach that best translates the model underlying lexical availability into a consolidated mathematical framework, that allows for the theoretical model used in this work and the construction of the new index, the ICL, is fuzzy set theory (Zadeh, 1965; Zimmermann, 2001) and, in particular, possibility theory (Zadeh, 1978). The latter of these two offers established and contrasted tools for the characterisation of words. In broad terms, fuzzy sets are a generalisation of set theory in which the compatibility of an element with the concept represented by the set is considered, instead of the absolute belonging of the element. In classical set theory, a certain function describes whether an element belongs to a (sub)set or not. This function assigns the value of 1 to elements that do belong to the set and a value of 0 to elements that do not belong to the set. However, in fuzzy set theory, an element can be assigned any value between 1 and 0 in accordance with its degree of compatibility with the concept represented by the set. For extreme cases, 1 and 0 still hold the same meaning as in classical set theory, but fuzzy set theory allows us to establish different levels of compatibility between elements and their set, rather than simply considering the classical dichotomy of belonging or not belonging. In the present work, the concept of a 'set' corresponds to that of 'category', and the structure of such a set is common to the members of a speech community due to a collective process that we call 'categorisation'.

One of the tools that the incorporation of fuzzy set theory allows us to use is the determination of the characteristic degree of compatibility of the fuzzy set, either through the FEV (*Fuzzy Expected Value*) or its variation, the WFEV (*Weighted Fuzzy Expected Value*). In this way, we can establish, for example, numerical limits for the degree of belonging as well as parameters for differentiating between words that are 'very characteristic' and 'not so characteristic' of the set being analysed. Thus, we have succeeded in defining an objective limit between the superior and inferior levels of membership of the fuzzy set. This limit directly relates the degree of compatibility of the words with the characteristic degree of compatibility of a selected set of words, which is the factor that has allowed us to parameterise the differentiation process (Ávila-Muñoz and Sánchez-Sáez, 2014).

2.3 Lexical availability, compatibility, fuzzy set theory, prototype, collective categorisation

In short, the ICL has been constructed as a parameter that is able to measure, between 0 and 1, the compatibility of each word provided with the fuzzy set. This fuzzy set is produced by analysing the metastructure that results from considering the entirety of the word lists provided for a stimulus and the relationships between the words on those lists.

As can be observed above, the LAI is an excellent indicator of the degree of prototypicality of a word within its CI, since this index can transcend the simple nature of the vocabulary and relates to the collective conceptual categorisation (*prototype theory*: Wittgenstein, 1953; Rosch, 1978; Lakoff, 1987). Through the simple change of perspective described, we can transform the LAI (which characterises the words provided) into the ICL (which characterises the community). Although the transformation itself is simple, the theoretical-methodological consequences are crucial for the present work:

A. The availability of a word within a CI responds, in essence, to the concept of 'accessibility'. In fact, the organisational structure of the words on the lists provided by each participant could be interpreted, *grosso modo*, as a representation of the access to their personal lexicon. Obtaining the structure of this lexical network for each individual would, of course, be an impossible task, since it is presumed to be determined by a multitude of uncontrollable biographical factors. Furthermore, its structure is dynamic and in a state of continuous change, influenced by speakers' interaction with their environment.
B. Based on individual word lists, the LAI allows us to produce a quantitative estimate of the structure of the accessibility to the lexicon in a given CI for a population. The quantification of accessibility is what measures the concept of the availability of each word in the CI, once all the words provided by the individual members of the population have been combined. The shared metastructure constitutes the collective categorisation of the CI for the population (fuzzy set).
C. The associations between the words as well as each words' degree of accessibility determine how to represent the structure of the lexicon in the CI. In this representation, the words located closest to the prototype will have a higher degree of accessibility (or in other words, a higher ICL).
D. In short, the words located closest to the nucleus will present a higher degree of prototypicality, and they will be the ones that are included in the levels of maximum compatibility of the fuzzy set.

3 Methodology

3.1 Sample

A total of 600 individuals over the age of 65 and from across Spain (native Spanish speakers) took part in this research. The number of women who participated was slightly higher than the number of men (women: N = 324, 54 %; men: N = 276, 46 %). The sample was pre-stratified by level of education, as shown in table 1. The distribution of the levels of education was based on the results of the study of the Spanish adult population up to the age of 65 conducted by the National Statistics Institute (INE) in 2013. Although the present study focusses on the proportion of the population aged 65 and over, we adjusted our sample as far as possible to the information provided by the INE for the oldest age group considered in its study (55-64 years).

Table 1: The pre-stratified sample of speakers for the present study (aged 65). A comparison with the distribution suggested by the INE (National Institute of Statistics, NIS) for the proportion of the population aged 55-64

	Group 1 Early years, primary, and 1st cycle of secondary education (levels 0–2)		**Group 2 2nd cycle of secondary education (levels 3–4)**		**Group 3 Higher education (levels 5–6)**	
	M	**F**	**M**	**F**	**M**	**F**
INE (2013)	59.4 %	65.7 %	17.4 %	16.9 %	23.2 %	17.4 %
This study	59.4 % (N = 164)	65.4 % (N = 212)	17.3 % (N = 48)	17.2 % (N = 56)	23.1 % (N = 64)	17.2 % (N = 56)

3.2 Data collection

The standard practice has always been to use in-person tests to collect data for the study of lexical associations (Banerjee, 2020; Nanda et al., 2020; Seligman et al., 2022). However, we chose instead to use Google Forms as the method for data collection due to the conditions imposed, such as the social distancing measures in place when the survey was conducted (October-December 2020), as well as the high degree of vulnerability of the population under study and its increased risk of severe illness from the virus.

The questionnaire was divided into two sections: the first contained questions aimed at gathering basic sociological information about the participants (principally gender, age, level of education, and place of birth); the second comprised the

word association test, for which participants were asked to write down the words they associated with five cognitive categories, presented to them via the following stimuli: *pandemia 'pandemic'*, *vejez 'old age'*, *sociedad 'society'*, *futuro 'future'*, and *política 'politics'*. The questionnaire was sent to several care homes, retirement homes, and associations for senior citizens across Spain, accompanied by preliminary information with the aim of establishing initial contact. Once the various organisations had informed us of their willingness to participate in the investigation, we contacted the individuals in charge to detail our objectives and methodology, so that the questionnaires could be completed under the necessary controlled conditions and supervision, in order to guarantee the reliability of the data obtained and the accuracy of the analysis to follow.

Resorting to an electronic format for data collection gave rise to a number of methodological differences in comparison to previous studies, which affected the nature of the data obtained, both in terms of quality and quantity. Firstly, supervision of the tests was left to the employees at each participating organisation. Secondly, the tests were presented in the form of open lists, with no restrictions on the duration of the tests or the space available to the participants for each stimulus. During in-person word association tests, participants are usually influenced by a time limit that determines how long they can spend on each stimulus. A limit of approximately two minutes is generally adopted. As demonstrated by Ávila-Muñoz and Sánchez-Sáez (2011), this allows participants to focus on a stimulus for the set amount of time and to move through their lexical network in different directions and different ways. The result tends to be an elevated number of words provided per stimulus, as individuals will have re-entered their lexical network repeatedly via the initial stimulus. These new access points become apparent during qualitative analysis of the data.

However, in the electronic word association tests we used for this study and that had no set time limit, we observed that when participants had moved through their lexical network once and had written down the words most closely related to the prototype, they immediately moved on to the next stimulus. They did this without re-entering their lexical network to try and find any possible alternative networks which might be indirectly linked to the initial stimulus (Ávila-Muñoz et al., 2020, 2021). For our investigation, this meant the number of words provided by the participants for each stimulus was lower. The average number of words provided per stimulus was 6.78 compared to an average of more than 20 provided in most conventional studies of lexical availability. Furthermore, the indirect associations identified were infrequent, and overall, the vocabulary was very closely related to the initial stimulus. Logically, this has a positive effect on the uniqueness of our results, since it has allowed us to construct collective prototypes that are more reliable and precise.

3.3 Tools for analysis

As described, the shared lexicon was obtained using a methodology based on lexical compatibility, a theoretical approach employing the creation of an effective model that facilitates access to collective perceptions and the construction of collective sociocognitive prototypes (Ávila-Muñoz and Villena-Ponsoda, eds, 2010; Ávila-Muñoz and Sánchez-Sáez, 2011; Ávila-Muñoz, 2016). This model, the theory of which is described in Ávila-Muñoz and Sánchez-Sáez (2011), also served to develop DispoCen, a freely accessible and intuitive library of tools implemented in R (Ávila-Muñoz et al., 2021). This library uses fuzzy set theory to automatically calculate the degrees of belonging of a group of elements (the words provided on lists of available vocabulary for a Cɪ) to a specific set (the metastructure produced by the participants for the same Cɪ). For the present work, an electronic file was created for each stimulus, as is required by the programme to process the data. The file contained the digital codification of the social characteristics of each participant followed by the words they had provided.

The social determinants affecting the vocabulary obtained were analysed separately using two additional auxiliary tools. The first was DispoGrafo (Echeverría et al., 2008), which was used to gain access to the semantic networks within each category (Collins and Quilian, 1969; Stayvers and Tenenbaum, 2005) and to display these as diagrams. The second was an online tool (https://www.wordclouds.com/, accessed on 3 January 2021) that was used to display all the words provided for a stimulus and to reflect their frequency by making words appear either larger or smaller.

4 Analysis of the data

4.1 Collective perception of each category

The model produced by DispoCen establishes an initial zone of maximum compatibility for each category (the limit of which is defined here by the index of maximum compatibility, IC), with further levels expanding progressively outwards and away from the nucleus and corresponding to different zones of compatibility. By way of example, in the model produced for the category *pandemic*, the IC is 0.92, meaning that the vocabulary with an ICL of 0.92 or higher is included within the zone of maximum compatibility, namely: *enfemedad 'disease'*, *muerte 'death'*, *coronavirus 'coronavirus'*, *virus 'virus'*, *confinamiento 'lockdown'*, *aislamiento 'isolation'*, and *miedo 'fear'*. Although still very compatible with the initial stimulus, the other words provided for this category fall within the secondary zones (*terror 'dread'*, *mascarilla 'face mask'*, *tristeza 'sadness'*, *inseguridad 'insecurity'*, *descon-*

trol 'chaos', *encierro 'confinement'*, etc.). For the quantitative analysis and the subsequent comparative analysis of groups within the sample, we considered only the vocabulary within the zone of maximum compatibility in each case to facilitate comparison, since this is the most compatible with the category referenced. By the same token, it is these words that therefore reflect the collective perception.

Table 2 shows the vocabulary that belongs to the zone of maximum compatibility of each category according to the models produced in each case by DispoCen. The vocabulary for each category is listed in decreasing order of ICL, and the IC used as the degree of maximum compatibility in each case is indicated.

Table 2: General findings. Zones of maximum compatibility

Category	Most compatible words	IC
Pandemic	*enfermedad 'disease'*, *muerte 'death'*, *coronavirus 'coronavirus'*, *virus 'virus'*, *confinamiento 'lockdown'*, *aislamiento 'isolation'*, *miedo 'fear'*	0.92
Old age	*soledad 'loneliness'*, *angustia 'worry'*, *muerte 'death'*, *enfermedad 'disease'*, *arruga 'wrinkle'*, *abandono 'neglect'*, *inseguridad 'insecurity'*, *aburrimiento 'boredom'*, *tristeza 'sadness'*	0.87
Society	*insolidaridad 'no solidarity'*, *ruptura 'rupture'*, *egoísta 'selfish'*, *juventud 'youth'*, *enfrentamiento 'conflict'*	0.92
Future	*soledad 'loneliness'*, *miedo 'fear'*, *mal 'bad'*, *muerte 'death'*, *angustia 'worry'*, *abandono 'neglect'*	0.85
Politics	*mentira 'lie'*, *aburrimiento 'boredom'*, *pensión 'pension'*, *pobreza 'poverty'*, *engaño 'deceit'*, *pelea 'argument'*	0.90

The collective perceptions include very negative and dispiriting vocabulary that reflects a high degree of pessimism in the study sample, with the words[1] *disease* (pandemic), *loneliness* (old age), *no solidarity* (society), *loneliness* (future), and *lie* (politics) presenting the highest ICL for their respective categories and therefore appearing in first position for each.

4.2 Analysis of semantic networks

An analysis of the semantic networks within each category allows for an even more detailed analysis of the collective perception of the pandemic and its consequences held by the individuals under study (Collins and Quilian, 1969; Collins and Loftus,

1 From now on, for the sake of simplicity and convenience, we will be mentioning/listing items in translation only.

1975; Steyvers and Tenenbaum, 2005). Since the mental lexicon is articulated and structured as an interconnected network, we can examine the cognitive reflection represented by the organisational structure of the words on the lists, so as to interpret, for example, how the proportion of the Spanish population aged 65 and over experienced the period of lockdown, their expectations of the future, and how they perceive politics.

4.2.1. Pandemic. Very significant and insightful are the direct lexical relations between the words located around *disease*, the most compatible with this category, and *coronavirus*, an additional key word in our study. In association with *disease*, participants noted down *death*, *worry*, and *sadness*, and to a lesser degree of association they provided *uncertainty*, *global*, *sadness*, *anxiety*, *lockdown*, and *fear*. Of these, the latter two were linked with the key word *coronavirus*, which, in turn, triggered words more closely related to personal protection and other ways of referring to the disease and its pathogen, namely *face mask*, *COVID-19*, and *virus*.

Table 3 shows that the most frequent direct association (words immediately followed one by the other in the lists) was between *disease* and *death* (N = 28), followed by associations that frequently featured the words *death* and *fear*.

Table 3: Most frequent associations within the category *pandemic*

Frequency of association	Association
28	disease, death
20	disease, virus
19	crisis, disease
19	fear, uncertainty
18	death, fear
18	death, lockdown
18	COVID-19, lockdown
16	COVID-19, coronavirus
13	crisis, virus
9	disease, coronavirus
5	disease, confinement
5	disease, fear
5	death, virus
5	worry, fear
5	fear, anxiety
5	fear, lockdown
5	virus, lockdown

Table 3: (continued)

Frequency of association	Association
5	lockdown, quarantine
4	disease, lockdown
4	death, sadness
4	fear, virus
4	fear, unknown
4	coronavirus, face mask

4.2.2. Old age. For this category, the most compatible word was *loneliness*, which was almost always associated with negative emotions: *worry*, *neglect*, *anxiety*, *sadness*. The most frequent association was between *loneliness* and *worry* (N = 18), followed by associations frequently featuring the words *neglect* and *sadness* (table 4).

A detailed analysis of table 4 could point towards feelings of worry and fear suffered by the study sample during the period of confinement resulting from the outbreak of the coronavirus. Highly frequent associations such as *death* and *disease*, or *sadness* and *loneliness* warn of the psychological consequences that the pandemic could cause in this proportion of the population. Other associations such as *depression* and *death*, *worry* and *trauma*, or *worry* and *fear* are also highly significant and a cause for concern.

Table 4: Most frequent associations within the category *old age*

Frequency of association	Association
18	loneliness, worry
7	death, disease
6	insecurity, neglect
5	sadness, loneliness
5	stress, death
4	boredom, insecurity
4	sadness, stress
4	stress, worry
4	loneliness, death
3	depression, death
3	loneliness, sadness
3	loneliness, boredom

Table 4: (continued)

Frequency of association	Association
3	loneliness, anxiety
3	loneliness, neglect
3	worry, trauma
3	trauma, worry
3	worry, sadness
3	worry, boredom
3	worry, fear
3	stress, pension
3	pension, anxiety
3	confinement, prison
3	confinement, house
3	confinement, working from home
3	house, home
3	loneliness, family

4.2.3. Society. The most frequent associations in this category all have one common denominator: *no solidarity*. In some cases, this word resulted in participants noting down highly negative and pessimistic words such as *selfish* and *disaster*. Other interesting associations include those related to *youth*, namely *selfish*, *careless*, *insecurity*, and *foolish*. These reflect the negative perception held by the older generation towards the younger (table 5).

Table 5: Most frequent associations within the category *society*

Frequency of association	Association
15	no solidarity, selfish
7	no solidarity, disaster
6	insecurity, youth
5	youth, selfish
5	youth, careless
4	youth, foolish
4	sadness, rupture
4	rupture, conflict
4	conflict, politics

4.2.4. Future. In this category, one association stands out due to its frequency compared to the rest: that of *loneliness* with *fear*. As can be observed in table 6, other associations with frequently provided vocabulary are not very encouraging either: *worry*, *fear*, *stress*, *crisis*. Among the most frequent associations, only that between *uncertainty* and *hope* seems more positive than the negativity observed so far.

Table 6: Most frequent associations within the category *future*

Frequency of association	Association
15	loneliness, fear
6	crisis, unemployment
6	worry, uncertainty
5	bad, uncertainty
4	pandemic, worry
4	uncertainty, bad
4	worry, fear
4	fear, family
3	stress, crisis
3	crisis, pandemic
3	crisis, worry
3	loneliness, depression
3	loneliness, worry
3	depression, pandemic
3	uncertainty, hope
3	death, disease

4.2.5. Politics. The most compatible word in this category was *lie*. Figure 1 is a representation of the words with which it was associated, and it reveals the negative perception of the study sample towards politics. The direction of each arrow shows the direction of the association, and therefore the order in which the words appeared on the lists: *boredom*, *manipulation*, *improvisation*, *confrontation*, *corruption*, and *control* are words that led to *lie*. The associations arising from *lie* were *Pedro Sánchez* (name of the prime minister of Spain at the time of data collection), as well as *row*, and *power*.

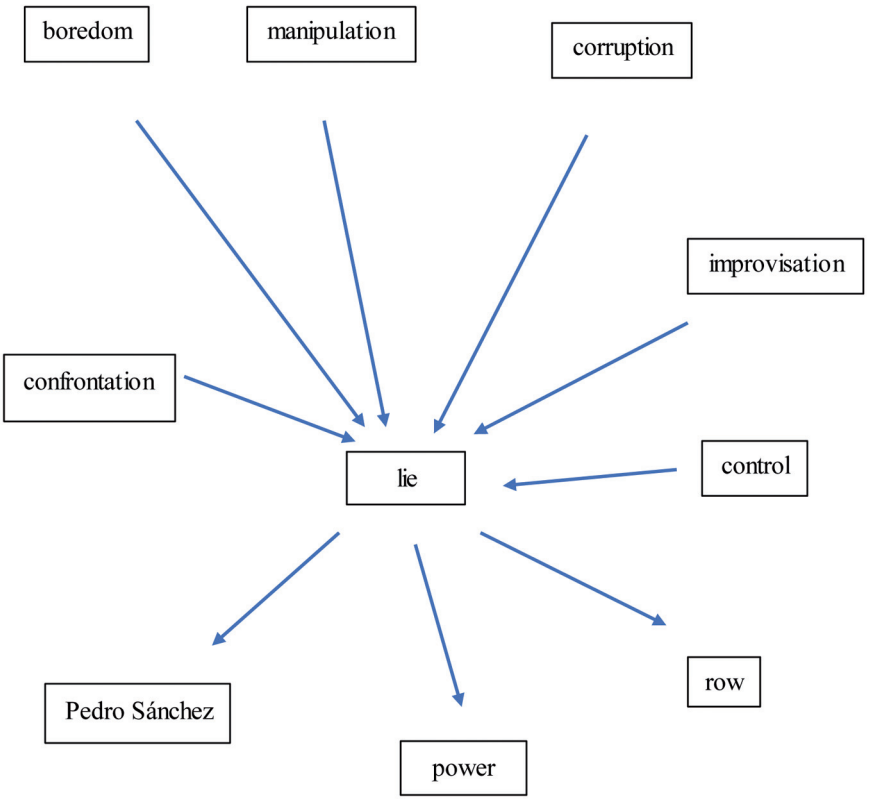

Figure 1: The most frequently observed associations with *lie*, the word most compatible with the category *politics*

4.3 Social determinants: gender and level of education

The sample was stratified by gender and level of education, two of the most relevant sociolinguistic variants, so as to understand the possible impact of social factors on the perceptions identified.

4.3.1. Gender. The zones of maximum compatibility by gender are similar in essence. However, some relevant and noteworthy differences can be observed in each category.

A. Pandemic: Although the zones of maximum compatibility of both groups contain words with a highly negative connotation (*disease*, *death*, *fear*), the words unique to the female group reveal a slightly higher degree of objectivity (*global*, *uncertainty*) than those unique to the male group, which include more negative evaluations (*dread*).

B. Old age: Worry caused by loneliness, boredom, insecurity, and feelings of neglect, is common to both groups. Likewise, both groups also noted down the words *death* and *disease*. The word *wrinkle* was only provided by the female group, whilst *pension* was unique to the male group.

C. Society: This category is perceived very negatively by both genders, with both groups providing *no solidarity*, *selfish*, and *conflict*. Here, *ruin* and *danger* were unique to the male group, whereas only the female group provided the word *fear*.

D. Future: The female group appears to perceive this category more positively if we observe the words unique to their zone of maximum compatibility (*respect*, *hope*). The male group was the only one to provide words related to financial matters (*pension*, *ruin*).

Figure 2 shows the relations between the words provided by each gender for the stimulus *future*. To produce the two diagrams, first a word of reference unique to each sociolect was chosen: *pension* for the male group and *hope* for the female group. The first group associated its central word *pension* with *money*, *wellbeing*, *life*, and *entitlement*, although it was also associated with *dignity*, *peril*, *politics*, and *deceit*. The second group associated the word *hope* with *health*, *life*, *public healthcare*, *family*, and *grandchild*. The female group appears to have focussed here on the future of third persons, whereas the male group focussed rather on their own future financial stability. As mentioned above, the arrows show the direction of the association, meaning that, on the lists, *wellbeing* always followed the word *pension*, whilst *hope* was always preceded by *life*. The order of association between the following words was unclear: *pension* and *money*, *pension* and *politics*, *pension* and *danger*, *pension* and *entitlement*, and *hope* and *public healthcare*.

E. Politics: The zones of maximum compatibility are very negative for both genders: *lie*, *boredom*, *deceit*, *argument*. Unique to the female group were the names of people: *Pedro Sánchez* and *Casado* (surname of the leader of the political opposition in Spain at the time of data collection). The male group was the only one to include a political acronym: *PSOE* (initials of the Spanish Socialist Workers' Party to which the Prime Minister of Spain Pedro Sánchez belonged at the time of data collection).

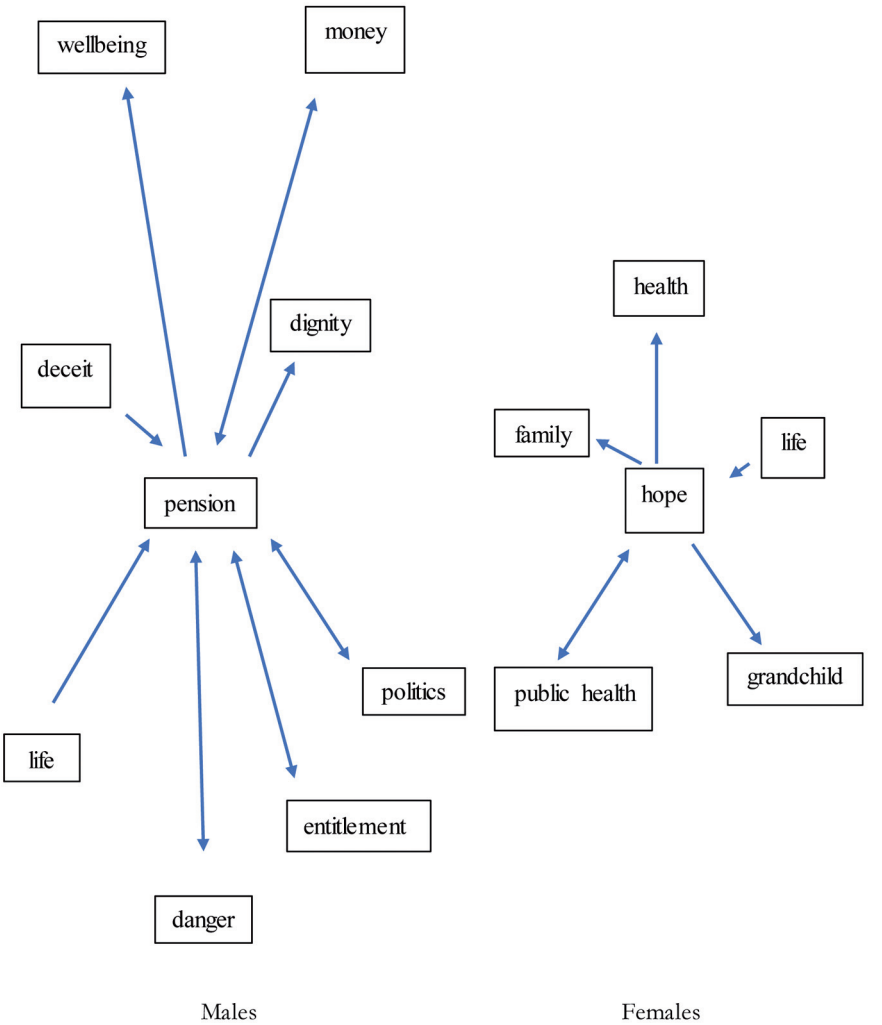

Figure 2: Diagram of the associations for *future*, by gender

4.3.2. Level of education. The results of the qualitative analysis by level of education are rather interesting, as were those of the analysis by gender. Since the zones of maximum compatibility by level of education show predictable similarities, we will focus here on the presentation and analysis of the words that we identified as unique to this zone for each group, or that were included in this zone for two of the groups considered but not for the third, as was occasionally the case.

A. Pandemic: The collective perceptions unique to the members of group 1 are very different to those of group 3. Group 1 provided emotional words such as *dread* and *panic*, whilst group 3 provided more objective words: *contagion*, *public healthcare*. Groups 1 and 2 have two words in common that are not present in the zone of maximum compatibility for group 3: *shit* and *toilet paper*.

B. Old age: Although all three groups provided words that suggest worry and insecurity, there is one word unique to group 3 that stands out: *loneliness*. Figure 3 shows the lexical associations with this word, which could be significant since it was not provided by the other groups. The word was associated with *neglect*, *worry*, *family*, and *partner*. The direction of association is also highly significant here, as both *family* and *partner* led to the participants noting down *loneliness*, whilst *loneliness* led in turn to *neglect*, and no definite order could be identified for the association between *worry* and *loneliness*.

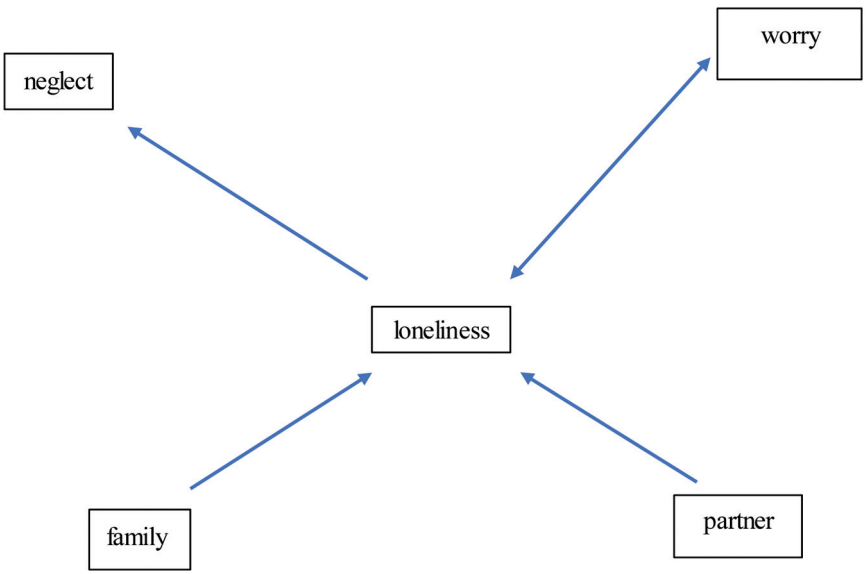

Figure 3: The associations with *loneliness*, the word unique to group 3 within the category *old age*

C. Society: All three groups perceive this concept highly negatively. The word *shit* is unique to group 2. *Crap*, a similarly contemptuous word, was unique to group 1. Only group 3 mentioned a more objective and less emotionally charged word, namely *capitalist*.

D. Future: The words common to the three groups are highly negative in this category as well, and only two optimistic words can be found, unique to group 2:

hope and *peace*. Figure 4 shows that *hope* was closely related to a possible solution to the public health crisis brought on by the outbreak of COVID-19, since it was associated with the words *vaccine*, *medicine*, *health*, and *doctor*.

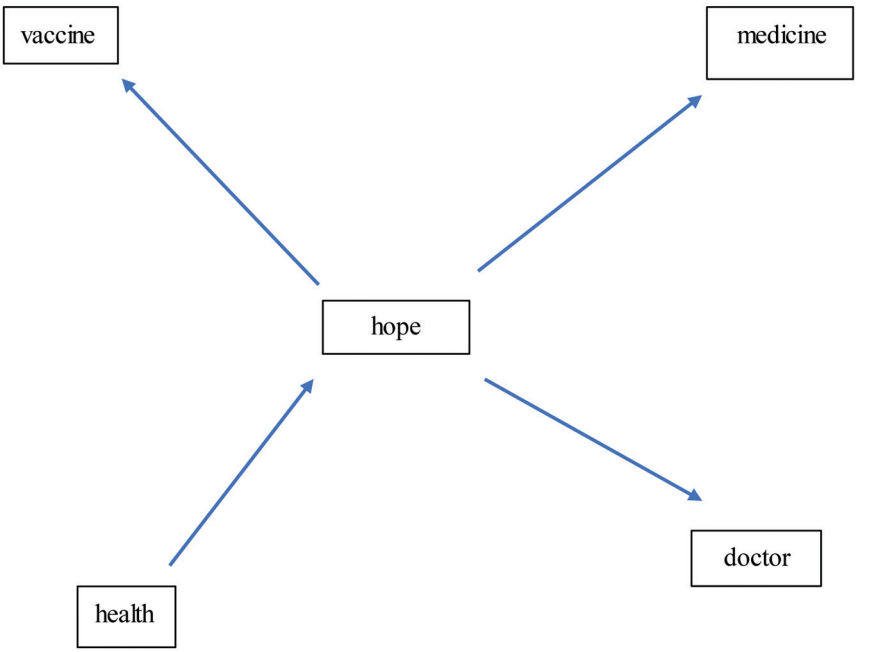

Figure 4: The associations with *hope*, the word unique to group 2 within the category *future*

E. Politics: The words unique to group 1 in this category were *repulsive* and *shit*. Group 2 was the only one to provide the political acronym *VOX*, and group 3 the only one to provide the word *manipulation*, which for the other groups appears only in zones located a great distance from the zone of maximum compatibility.

5 Discussion

If we compare the zones of maximum compatibility obtained here with those obtained in a previous study by Ávila-Muñoz et al. (2022) based on a sample of university students (aged 18–32), the pessimistic perception identified here for the population aged 65 and over becomes even more apparent. The same methodology was used in the present work as in the previous study.

Table 7 displays the most compatible words identified for the three categories used in both studies: *pandemic*, *future*, and *politics*.

Table 7: A comparison between two samples for the categories *pandemic*, *future*, and *politics*

	Individuals aged 65 and over		**University students (18-32 years)**	
Category	Most compatible words	IC	Most compatible words	IC
Pandemic	*disease* *death* *coronavirus* *virus* *lockdown* *isolation* *fear*	0.92	*dread* *death* *disease* *virus* *lockdown* *coronavirus* *crisis*	0.92
Future	*loneliness* *fear* *bad* *death* *worry* *neglect*	0.85	*uncertainty* *fear* *bleak* *crisis* *work* *worry* *unemployment*	0.89
Politics	*lie* *boredom* *pension* *poverty* *deceit* *argument*	0.90	*lie* *corruption* *confrontation* *manipulation* *repulsion* *deceit*	0.91

If we focus on the words provided only by the older group of individuals for the categories *pandemic* and *future*, it is evident that the feelings of isolation, neglect, and loneliness are more noticeable in this age group. Also exclusive to this group is the association of *death* with the *future*, as opposed to the words provided only by the university students, which focus on the realm of work, including words such as *work*, *unemployment*, and *crisis*. Although the vocabulary associated by both groups with *politics* is highly negative, *boredom* and financial concerns (*pension*, *poverty*) are very predominant in the older age group and are not at all present in the vocabulary associated with this category by the university students, who instead focus on more ideological (*manipulation*) and emotional aspects (*repulsion*).

The comparison with an even younger population emphasises both the differences in the results and the pessimism observed in the collective categorisations of the sample under study here. In Ávila-Muñoz (2022), we use the same methodology as in the present study to access the reflections of the collective perceptions of a

group of 600 pre-university students (aged 16–17). The data was collected during the same period as for the present study, and again, five stimuli were used. However, for the purpose of comparison, we will focus here only on the results obtained for the four categories used in both studies: *pandemic*, *future*, *politics*, and *society*.

Table 8 shows the most compatible words identified for the categories used in both studies.

Table 8: A comparison between two samples for the categories *pandemic*, *future*, *politics* and *society*

	Individuals aged 65 and over		**Pre-university students (16-17 years)**	
Category	Most compatible words	IC	Most compatible words	IC
Pandemic	*disease* *death* *coronavirus* *virus* *lockdown* *isolation* *fear*	0.92	*COVID-19* *confinement* *coronavirus* *boredom* *face mask* *vaccine*	0.86
Future	*loneliness* *fear* *bad* *death* *worry* *neglect*	0.85	*crisis* *university* *work* *parties* *normality* *family* *unemployment*	0.85
Politics	*lie* *boredom* *pension* *poverty* *deceit* *argument*	0.90	*argument* *dictatorship* *Pedro Sánchez* *repression* *lie* *deceit* *corruption*	0.91
Society	*no solidarity* *rupture* *selfish* *youth* *conflict*	0.92	*social distancing* *repression* *injustice* *protest* *equality* *no soledarity* *change*	0,81

As can be observed, the differences in each category are even more apparent. Overall, the younger group does not hold overly negative perceptions, not even within

the category *pandemic*, where this group provided words that were more descriptive than emotional. Possibly the only reference here to emotions is *boredom*, which may have been a consequence of the period of confinement and the restrictions on movement in place at the beginning of the pandemic and, thus, at the time of data collection. It is clear that, at least for this category, the younger group does not share the feeling of fear associated by the older group with the disease and death.

In the category *future*, the differences are even plainer. The younger group is only moderately concerned about what is to come, reflected in the words *crisis* and *unemployment*. The other words they provided here reflect longing (*parties*) or medium to long-term plans for the future (*university*, *work*, *normality*, *family*). The collective perceptions identified for both groups in this category are clearly very different and even reflect opposing views.

The zones of maximum compatibility of the two groups for *politics* and *society* could be considered more similar, since feelings of mistrust and lack of solidarity feature in both. However, the younger group additionally seems fed up with the restrictions on movement (*dictatorship*, *repression*).

The data indicate that, although the pandemic caused by COVID-19 has affected the population in general, it does not seem to have affected all age groups in the same way. The pessimistic perception held by the population aged 65 and over and caused by the pandemic is a subject that we feel should be taken very seriously at the global level. In essence, our results corroborate the findings for other adult populations across the world, where medium-term emotional consequences of the pandemic are also beginning to be recorded. By way of example, Humboldt et al. (2022) have researched the role of negative emotions on the personal development of adults aged 65 and over, within different communities in Mexico, Italy, Portugal, and Spain, during the months of May to September of 2020. Their work reveals evidence that suggests a link between negative emotions and the personal development of the population under study.

The consequences of such negative perceptions could end up being very serious for the affected population and could even put lives at risk (Silva et al., 2022; Gaggero et al., 2022; Gournellis and Efstathiou, 2021).

Overall, the studies conducted to date advise that special attention should be paid to this high-risk population, to secure their subjective conditions of well-being (subjective well-being, SWB), since SWB could even play a role in the prevention of COVID-19. Kashefi et al. (2022), for example, analyse the development of the SWB of people aged 60 and over since the beginning of the pandemic, as well as the relationship between the SWB and the risk of falling ill with the disease. They used a demographic questionnaire and the SWB scale of Keyes and Magyarmo to measure the emotional, psychological and social well-being of a sample, that consisted of both individuals hospitalised with COVID-19 and individuals with no history of the

disease. Their conclusions show that just a one-unit increase in SWB reduces the risk of contracting COVID-19 by 4 %. Both emotional and social well-being have thus proved to be predictor variables of the risk of contracting the disease and moderators of its consequences.

6 Conclusions

In this paper, in order to determine how the coronavirus crisis has affected the Spanish population aged 65 and over, we have used a lexical approach based on a mathematical methodology employing the theory of fuzzy sets: the determination of the characteristic degree of compatibility of a fuzzy set, through the FEV (Fuzzy Expected Value). This methodology had previously proved effective at establishing the collective categorisations related to stimuli for a specific population. Our approach allowed us to establish limits for the degree of belonging as well as objective parameters for identifying words that were 'very characteristic' in each of the five cognitive categories chosen for this work: *pandemic*, *old age*, *society*, *future*, and *politics*.

The results obtained corroborate the initial hypothesis and even offered certain data that brought unexpected insights. The semantic relationships identified have given us a very graphic idea of the pessimism and fear that the population under study suffered during the worst moments of the pandemic and the period of confinement, what little hope they have in the future, and their concerning disappointment in politics and society.

If we observe the zones of maximum compatibility determined using the FEV for each category, we can conclude that the older generation distrusts politics and is incredibly concerned about pensions and financial stability, as well as about the uncertainty the future holds due to the disease, their feelings of neglect and loneliness, and death. The crisis caused by the coronavirus and its social and economic consequences has left them with worries that have caused them to associate old age with disagreeable feelings of neglect, loneliness, uncertainty, sadness, and boredom.

Regarding the comparisons made between the different groups according to the social variables chosen for this work, certain differences can be observed that are worth noting. The zone of maximum compatibility for the male group tended towards including vocabulary related to more material aspects. Words related to finance were only provided by the male group, whereas the female group tended to focus instead on family, by mentioning vocabulary that invokes emotions and feelings.

In terms of education, the groups with the highest level of formal education seem to have a more objective perception of the pandemic and its effects, and of politics, society, and the future. Vocabulary that invokes emotions or is descriptive was typically provided by the groups with a lower level of education. It is curious,

however, that it is generally those with a higher level of education that feel lonelier, worried, and neglected by their relatives.

The results of our work could be put to use in various sectors and applied in different ways in certain fields. Firstly, it is evident that they create a space for reflection and discussion about how society currently treats its older members. The analysis of the data obtained shows that this proportion of society is worried, scared, and uncertain about these new circumstances that have resulted from the pandemic. It is possible that the entire population has suffered in the same way from the improvised situation that surprised Western society in March 2020. However, the population under study also feels a deep and alarming sense of loneliness and neglect. Secondly, professionals working in the field of geriatrics should be aware of the traumas and conflicts that this crisis may have imposed on the elderly. If not resolved, these could cause emotional repercussions and psychological imbalances with unforeseen consequences. From the perspective of psychological care and the management of emotions, we should ask ourselves whether the elderly in our society have at their disposal the tools they need to overcome the posttraumatic conflicts of this crisis, and that will allow them to view the future in the knowledge that they have the necessary emotional balance and internal peace. Thirdly, the relevant authorities should heed the demands of a population that is calling for significant changes first and foremost in the areas of politics and financial stability during this last stage of their lives. Ultimately, this is a group of people that has been particularly affected by an out-of-control situation that seems to have considerably diminished their expectations of the future and that has left them feeling pessimistic and tense, largely due to their feelings of neglect and loneliness.

We believe it would be highly advantageous to produce a diachronic study in future to identify which words and concepts have remained, which have faded, and which, by contrast, have been consciously added to the lexicon of the speakers because of their experiences during the COVID-19 pandemic. It would also be interesting to repeat this study with the focus on different age groups, as it is highly likely that the older proportion of the population is seeing more consequences, not only due to how seriously they are affected by the virus itself, but also due to certain collateral effects associated with the pandemic that may have affected them specifically, as an age group, such as financial instability, and feelings of neglect and loneliness. These circumstances could be making it more difficult for this particularly vulnerable group to adapt to what has been coined the ‘new normal’. Beyond this, we may soon also analyse the influence that level of education and social media could be having on the perception of reality observed in the present work for this age group. It is, of course, highly likely that social media is having a considerable effect on the attitudes of younger people, but the attitudes of the population aged 65 and over may also be affected.

Finally, our recommendations are intended for two groups of professionals. On the one hand, we urge health workers and specifically primary-care workers to pay close attention to the medium and long-term consequences that the pandemic may have for the elderly. As we have shown, everything points towards negative perceptions that could affect the conditions of well-being that are vital in this proportion of society and that could, in extreme cases, put lives at risk. On the other hand, we recommend that the research community that generally uses questionnaires as a method to access the attitudes of a population towards a phenomenon, should consider applying the methodology used as the basis for this work to other countries, languages and cultures. Results could then be compared, making it possible to identify any similarities. We believe that obtaining collective categorisations through the analysis of lexical metastructures presented in the present work, could represent an interesting complement to traditional attitudinal surveys. After all, the attitude of an individual towards an event is a direct result of his or her conceptualisation.

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