Mental health symptoms and verbal fluency in elderly people: Evidence from the Spanish Longitudinal study of aging

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Abstract

Objectives: Depression and loneliness are highly prevalent in old age. Moreover these mental health symptoms adversely affect language processes of the elderly. We examined the relationship between depression and loneliness with verbal fluency in people aged 50 years or older.

Method: Research data were collected during the pilot study of the Longitudinal Aging Study in Spain (ELES) in which a representative sample of non-institutionalized Spanish older people was assessed. Here, the cross-sectional data for 962 participants were analysed using hierarchical regressions, controlling for age, education level, overall cognitive functioning, social networks and satisfaction with family.

Results: Higher levels of cognitive functioning were associated with higher verbal fluency. Females showed higher levels of phonological fluency. Neither depression nor loneliness were significant predictors of phonological fluency but loneliness was a significant predictor of semantic fluency. For mild levels of loneliness, the rate of decline in semantic fluency slows in the oldest ages. In contrast, for severe loneliness the rate of decline in semantic fluency increases in the oldest ages.

Conclusions: Depressive symptoms, loneliness and cognitive impairment are all prominent in ageing and therefore their impact on ageing needs to be better understood. Early detection of loneliness, along with the implementation of intervention for individuals diagnosed with loneliness is advisable in order to avoid negative repercussions for the linguistic abilities of these individuals.

Keywords: loneliness; depression; verbal fluency; older Spanish adults; ELES study

Introduction

Depression and loneliness affect physical, mental, and social health as well as quality of life of older people (Brown & Astell, 2012). For this reason, it is important that the impact of these factors in aging is better understood. In Spain, 46.7% of elderly Spaniards indicated that they have some depressive symptoms and 36.7% indicated feeling lonely (IMSERSO, 2009). Furthermore, 12.8% of Spaniards surveyed in 2011 who were over 65 years of age had been diagnosed with chronic depression (IMSERSO, 2012). Apart from loneliness and depressive symptoms, older people also experience changes in cognitive functioning as part of the aging process. Among the mental abilities that change with aging are language processes (Facal, et al., 2009).

Cognitive status in older people: Language processes

Perhaps surprisingly, it appears that not all language abilities are altered during aging (Maseda et al., 2014). Many researchers agree that aging primarily affects language production – for example, access to the lexicon, which is mental storehouse of familiar words (Burke & Shafto, 2004). Verbal fluency – a task which requires access to the lexicon – is defined as the ability to produce words which belong to a specific semantic category or which begin with a specific phoneme. It has been shown that the linguistic aspects of naming and verbal fluency are sensitive to cognitive impairment (Cuetos et al., 2015). Accordingly, these tasks constitute an important tool for assessing the cognitive status of older adults and for distinguishing between different types of dementia (Esteves et al., 2015). Changes in verbal fluency have also been shown to be associated with factors such as age, educational level and/or socioeconomic status (Kemper et al., 2001).

With respect to age, it has been found that as individuals grow older they generally demonstrate poorer performance on verbal fluency tests compared to younger older-adults

(Esteves et al., 2015; Van der Elst et al., 2006). Nevertheless, there is no agreement within the literature regarding whether or not phonological and semantic fluency are equally affected by age. Some studies have identified age-related decline only in semantic fluency (Benito-Cuadrado et al., 2002) while others have found age-related differences in both phonological and semantic fluency tests (Esteves et al., 2015; Van der Elst et al., 2006).

Part of the problem with attempting to interpret these studies is that many methodological variations exist between them. For example, not all of the cited studies controlled for educational level – a factor which may have a higher impact on verbal fluency than age (Esteves et al., 2015). Thus, although the link between education and verbal fluency is not clear (Van der Elst et al., 2006), it would seem important to control for both education level and age in any study which examines verbal fluency.

Findings regarding the association between gender and verbal fluency are also contradictory. Some studies have found no gender differences in either semantic or phonological fluency (Benito-Cuadrado et al., 2002; Van der Elst et al., 2006) while others have found women perform better on verbal fluency tests, specifically on phonological fluency (Bolla et al., 1990; Weiss et al., 2006). Assuming that gender differences do exist, what could be the underlying cause? The idea that there are neuroanatomical differences between men and women in areas of the brain known to be associated with language has recently been discredited (Wallentin, 2009). Hence, some authors claim that these gender difference are due to the use of different processing strategies. For example, Troyer, Moscovitch, and Winocur (1997) suggested that good performance on verbal fluency tasks requires the generation of words within subcategories, which is known as clustering (for example, generating the names of domestic animals), before switching to a different subcategory once the first is exhausted (for example, switching to generating the names of African animals). Weiss et al. (2006) claimed that women better balanced clustering and

switching in the phonemic verbal fluency task, and this resulted in more responses being generated. Regardless of the explanation, it would seem important to control for gender in any study examining both phonemic and semantic fluency.

The association between depression and loneliness with verbal fluency in older people

Generally, it has been found that depression negatively affects abilities such as executive functions, attention, processing speed and episodic memory (Bauermeister & Bunce, 2015; Pantzar et al., 2014). In the case of language processes, previous studies indicate that depression is associated with deficits in verbal fluency, use of vocabulary, and word recognition (Bunce et al., 2012; Ganguli et al., 2009; Henry & Crawford, 2005; Pantzar et al., 2014). In particular, performance on tests of verbal fluency, considered valid markers of executive function, are especially sensitive to depressive illness (Norris et al., 1995). This is unsurprising given the similarities between the cognitive demands of fluency tasks and the deficits associated with depression (attention, concentration, retrieval and speed).

Several studies report a relationship between deficits on both verbal fluency measures (e.g., Brown et al., 1994) in the presence of depression. In particular, it has been found that semantic fluency was associated with a larger deficit than phonological fluency in depression (Christensen et al., 1997), which suggests that depression may be particularly associated with a degraded semantic store. Additionally, it has been found that older people diagnosed with depression, but without cognitive impairment, who subsequently experienced an improvement in their mood also improved their performance on a word recognition task (Bunce et al., 2012). Nevertheless, it is important to note that depression is a heterogeneous disorder and different factors could moderate these associations, for instance age, education, or the severity of the depression (Henry & Crawford, 2005).

Loneliness is another mental health problem that has been shown to be associated with a greater likelihood of dementia and cognitive impairment (Holwerda et al., 2014; Wilson et al., 2007). Specifically, compared to seniors who indicated that they never or rarely felt alone, seniors who indicated that they sometimes, or often, felt alone scored lower on processing speed and visual memory tasks (O'Luanaigh et al., 2012). Loneliness is also associated with skills such as attention, orientation, abstraction and semantic fluency, even when age and number of years of schooling are controlled (Tzang et al., 2015). Additionally, it has been found that interventions aimed at reducing loneliness also show a beneficial effect on cognitive functioning (Ybarra et al., 2008).

Specifically in regard to the relationship between verbal fluency and loneliness, few studies have been carried out and the results are mixed. Schnittger et al. (2012) reported that verbal fluency was a significant risk factor of social loneliness. Although, O'Luanaigh et al. (2012) also reported a relationship between loneliness and verbal fluency, this result just failed to reach significance (p = .079) after controlling for a range of demographic factors along with depression and social networks. Finally, Shankar et al. (2013) found that greater loneliness was significantly associated with low levels of verbal fluency at baseline, but not at a 4 year follow-up. The paucity of studies and the mixed results to-date suggest further research looking at the relationship between verbal fluency and loneliness is needed. Of note, each of these studies found that social/family isolation were significant risk factors, and for this reason it would seem important to control for the feeling of isolation, or for the level of satisfaction with social/family networks in any study which examines verbal fluency.

Thus, given that depression and loneliness in many cases co-occur in older people, and given that each of these mental health problems has a different effect on cognitive functioning (e.g., Royall, Palmer, Chiodo, & Polk, 2012), it is important to continue studying the unique impact of these factors on the cognitive status of the elderly (Bunce et al., 2012). It

would also be advantageous to study the impact of mental health problems on cognitive abilities which have received less attention in the literature, such as language processes. In particular, given the relevance of loneliness for cognitive functioning, it is important to continue studying its relationship with specific cognitive skills, such as verbal fluency skills, given that it is relevant to the context of social interaction. Consequently, the present study places a greater focus on the specific domains of language production as opposed to global cognitive scores, which is a more common approach when studying the effects of aging.

Accordingly, the main objective of this study was to explore the relationship between the mental health symptoms of depression and loneliness on verbal fluency in older people, specifically phonological and semantic fluency, controlling for age, education level, gender and overall cognitive functioning. Although similar studies have been carried out in English speaking populations, they are usually of a much smaller sample size and consequently cover a narrower range of ages (e.g. Bunce et al, 2012; O'Luanaigh et al., 2012; Tzang et al., 2015). We are aware of just one other study that has examined loneliness with a large sample size (Shankar et al. 2013). However, language and culture are known to affect performance on verbal fluency tasks (Van der Elst et al., 2006). In particular, Kempler et al. (1998) found that Hispanic participants produced significantly less responses in a semantic fluency task compared to Chinese, Vietnamese and English speakers, and these authors attributed this difference to the diverse characteristics of each language (see Kempler et al., 1998 for a detailed explanation). Thus, although many studies have been carried out in English, it is important to explore these issues in other languages. To our knowledge, this is the first large sample study that has investigated the relationship between depression and loneliness states and verbal fluency in Spanish speaking elderly.

A further goal of this study was to explore the effects of aging on verbal fluency. In the case that either loneliness or depression influenced verbal fluency, we were interested in

exploring how age moderated these relationships. It is plausible that any detrimental relationship between these mental health symptoms and verbal fluency is likely to be worse in the oldest-old when frailty and dependence increase (Shmotkin et al., 2014). Consequently, we were interested in comparing whether this deterioration was comparable for individuals in the third and fourth ages. Although there is no clear agreement as to the exact boundaries, Smith (2000) defines the third-age to mean individuals aged between 65 and 80 years of age, while fourth-age refers to individuals who are aged 80 plus. Although several studies have looked at how traits such as depression affect other cognitive abilities over time (for example, Bunce et al., 2012) to our knowledge, this is one of the first studies which has looked for non-linear effects of age.

Method

Participants

The cross-sectional data reported in the present study are taken from the pilot study of the Spanish longitudinal ageing project (ELES), which was approved by the ethics committee of the Spanish National Research Council. The target population for the ELES study was community-dwelling native Spanish speaking individuals aged 50 years-old or older living in Spain. Although more details about the study design, sampling, measures, and data quality of the ELES study are available elsewhere (Rodríguez Laso et al., 2013; Rojo-Pérez et al., 2012; Teófilo et al., 2011), a summary in English can be found in the online Supplementary Materials. The final sample retained for analysis in the present analysis consisted of 962 individuals with a mean age of 64.3 years (range 50 – 98), 503 of which 503 were females.

Materials

Depression

The short form of the Center for Epidemiologic Studies Depression Scale (CESD-10; Andresen et al., 1994) was used to evaluate depression. The instrument consists of 10 items which ask about the presence of symptoms known to be related to depression, and in the ELES questionnaire the valid responses were restricted to "yes" or "no" only, with one point was awarded for each yes response. The resulting variable had a range of 0 to 10 with higher scores indicating more evidence of depression.

Loneliness

The shortened version of the de Jong Gierveld loneliness scale (de Jong Gierveld & van Tilburg, 2006) was used to evaluate loneliness. This instrument consists of six items with 3 items forming an emotional subscale and 3 items forming a social subscale. The scores were summed resulting in a variable with a range from 0 (no evidence of loneliness) to 6 (severe loneliness).

Verbal Fluency

The Multilingual Aphasia Examination of Benton and Hamsher (1989) was used to evaluate verbal fluency. This test includes semantic and phonological components.

Semantic Fluency

This is an open ended test in which participants were required to name as many animals as they could in one minute. One point was awarded for each name, although repetitions, derivations (dogs if dog was also produced), redundant names (such as white cow, black cow, etc.), and proper names (such as Bambi) were excluded from the total.

Phonological Fluency

This is an open ended test in which participants were required to provide as many words as they could in one minute which begin with the phoneme /s/. One point was awarded for each word, although people and place names, repetitions and derivations were excluded from the total.

Cognitive Functioning

The Spanish version of the Mini-Mental State Examination (MMSE) was used (Lobo et al., 2001). The total score obtained provides an index of overall cognitive functioning. Scores can range between 0 and 30 and with higher scores corresponding to better cognitive functioning.

Education

The questionnaire contained an item designed to determine the highest level of education obtained by each participant. Ten levels of response were permitted, ranging from "illiterate" through to "have obtained a doctoral degree".

Family Networks

The questionnaire contained one question related to the respondents' satisfaction regarding the relationships with their children, and another question regarding their satisfaction regarding relationships with other family members. Each question used a scale from 0 to 10, and these were averaged to create a single variable representing satisfaction with family networks. Higher scores indicated higher levels of satisfaction.

Social Networks

The questionnaire contained one question related to the respondents' satisfaction regarding the relationships with their friends, and another question regarding their satisfaction regarding relationships with their neighbours. Each question used a scale from 0 to 10, and these were averaged to create a single variable representing satisfaction with social networks. Higher scores indicated higher levels of satisfaction.

Procedure

The procedure and order of tasks was identical for all participants. An initial phone call was used to recruit the participants. In a second phone call demographic data and

household characteristics were collected. Individuals received a subsequent home visit by a nurse during which cognitive functioning was assessed and some physical variables were gathered. The nurse left a questionnaire for the participant to fill out alone. This included a number of scales, including loneliness and depression evaluations, evaluated in that order. In a final home visit, a battery of tests was administered which included the semantic and phonological fluency tasks. The self-administered questionnaire was retrieved in that visit, and if the participant had been unable to complete the questionnaire, the interviewer assisted in the completion at that moment.

Results

Descriptive statistics for the 962 participants included in the regression analyses are shown in the right half of Table 1. Just 191 (19.9%) participants scored above 3 on the CESD-10, a cut-off commonly used to indicate the possible presence of depression. (Kohout, Berkman, Evans, & Cornoni-Huntley, 1993). Based on the recommended cut-offs for the de Jong Gierveld loneliness scale (van Tilburg, 2011), 482 participants (50.1%) showed evidence for mild depression while 87 participants (9.0%) showed evidence for severe depression.

To gain an initial impression of the relationships between the variables we performed correlation analyses, the results of which are shown in the left half of Table 1. The first two columns indicate that the relationships for all variables are extremely similar for phonological- and semantic-fluency, with the exception of education (r_{phon} = .48; r_{sem} = .36). Unsurprisingly, lower age, higher education and higher cognitive function were all associated with higher levels of fluency. With respect to the two mental health symptoms of interest to this study, higher scores on the loneliness and depression scales were associated with reduced fluency, although the strength of these relationships was weak. This suggests that the

correlations found between the mental health symptoms and verbal fluency may not persist once the control variables are taken into account. Weaker still were the relationships between family and social networks with verbal fluency. Gender was not correlated with either type of verbal fluency, although we note that women in the sample demonstrated significantly higher levels of depression, significantly lower levels of education and cognitive functioning, along with significantly more satisfaction with social and family networks, although the strength of these relationships was weak in all cases.

Insert Table 1 about here

To further explore these relationships, a series of hierarchical regression analyses were carried out, separately for phonological- and semantic-fluency. Age, education, cognitive function, gender and satisfaction with family and social networks were included in the model as control variables. Age was coded such that the value 0 represented 50 years. Consequently, the interpretation of this coefficient is the effect of age for every year over 50. Gender was coded such that coefficient represents the change in verbal fluency for females, compared to males. One of the stated goals of this study is to explore possible differences between the third and fourth age on the variables of interest and this was achieved by adding a quadratic term for age to the regression models, thus allowing us to detect non-linear effects (for a justification, see the Supplementary Materials). A summary of the models is presented in Table 2.

Insert Table 2 about here

It can be seen from Table 2 that the model explained just over 30% of the variance in phonological fluency. However, only the control variables education, cognitive function and gender were significant predictors. Unsurprisingly, both higher education and higher cognitive function were associated with higher phonological fluency. Additionally, women demonstrated significantly higher phonological fluency than men. Somewhat surprisingly given the significant correlation seen earlier, age did not prove to be a significant predictor of phonological fluency after controlling for the other variables. With regards to the two mental health symptoms, no significant relation was found (all *p*s > .5) which indicates that the weak but significant correlations found for depression and loneliness were not explaining any variance in phonological fluency beyond that accounted for by the control variables. The interactions between age and the two mental health symptoms also failed to explain any independent variance in phonological fluency.

Given the similarity found in the correlation results for phonological- and semantic-fluency, we expected that the two regression analyses would also be similar. However this did not prove to be the case. As with phonological fluency, higher levels of education and cognitive function were associated with higher levels of semantic fluency. However, the relationship with age was significant for the linear term (b = -0.271) and just failed to reach significance for the quadratic term (b = 0.005, p = .066). Taken together the negative and positive co-efficients indicate that the level of semantic fluency present in the Spanish population is lower for older ages, but that the differences tend not to be as great with

increasing age. Unlike phonological fluency, there was no significant effect of gender on semantic fluency. There was also no significant effect found for depression, either directly, or interacting with age.

In contrast to depression, there was a significant direct effect of loneliness on semantic fluency, as well as significant interactions between loneliness and age for both the linear and quadratic terms. The direct effect of loneliness (b = -0.550) appears straightforward to interpret – the presence of loneliness is associated with a reduction in semantic fluency, and this reduction is greater the more severe the loneliness. However, the two significant interaction terms between loneliness and age along with the significant *direct* effects of age mean the relationship between loneliness and semantic fluency is more nuanced.

Firstly, considering the subset of the Spanish population with no loneliness, or only mild levels of loneliness, the model predicts that there will be a decline in semantic fluency with age, but that the differences will be smaller with increasing age. This is due to the fact that direct effect of age weakens for older participants (due to the positive quadratic effect, b = 0.005), and the positive linear interaction term (b = 0.063) cancels out much of the negative quadratic interaction term (b = -0.002) for high values of age and small values of loneliness. Secondly, for medium levels of loneliness the model predicts that there will be an approximately constant decline in semantic fluency with increasing age. This is due to the fact that as the direct effects of age start to weaken, the direct effects of loneliness due to age start to increase. Finally, considering the subset of the Spanish population with severe levels of loneliness, the model predicts that there will be a decline in semantic fluency due to age, but that the differences will increase as age increases. This is due to the fact that the negative

quadratic interaction term (b = -0.002) becomes increasingly influential when both the loneliness and age variables take on high values.

Discussion

The purpose of the present study was to explore the relationship between mental health symptoms and verbal fluency in elderly individuals, controlling for age, education, general cognitive functioning, gender, and social and family networks. In particular, we were interested in determining if the presence of depression and loneliness were associated with lower levels of two types of verbal fluency – phonological and semantic. We were also interested in exploring if any such relationships differed between the third and fourth ages. To achieve these goals we analysed pilot data drawn from the ELES project – a longitudinal study of aging in Spain.

The main finding of the present study is the existence of a negative relationship between loneliness and semantic fluency in the Spanish population. Mild levels of loneliness were associated with deterioration in semantic fluency during the middle age (approximately 50-70 years), however the differences in semantic fluency became smaller at older ages (70+ years). In contrast, for that part of the population with severe levels of loneliness, the differences in semantic fluency became larger as age increased. Importantly, this pattern of results was found after controlling education, cognitive function, depression and satisfaction with social and family networks, with no difference found between males and females.

The absence of a similar relationship between phonological fluency and loneliness suggests that the relationship between loneliness and semantic fluency is direct, and is not mediated by phonology. This finding is in line with previous literature which has found associations between loneliness and different cognitive abilities such as processing speed, attention, orientation, abstraction, and visual memory, and confirms the trends and relationships between loneliness and verbal fluency reported in previous studies (O'Luanaigh et al., 2012; Tzang et al., 2015). However, the present study extends the findings of these two studies in a number of important ways.

Firstly, the O'Luanaigh et al. (2012) sample consisted of patients recruited from only the patient lists of four general practitioners in the catchment area of just one hospital located in an urban area and the Tzang et al. (2015) sample consisted of just 189 males recruited from a single Veteran's home. In contrast, the participants in the present study were drawn from a sample that was designed to be representative of the entire Spanish population aged 50 years or older. Secondly, both Tzang et al. and O'Luanaigh et al. were limited to participants aged 65 years or older. By including participants aged 50 years or older, the present study was able to look for more nuanced relationships, and in particular, differences between the third and fourth ages. Thirdly, neither O'Luanaigh et al. nor Tzang et al. looked for non-linear effects of age, nor for interactions between age and loneliness – factors which were found to be significant in the present study.

A possible explanation for the association between loneliness and semantic fluency, and the lack of association between loneliness and phonological fluency, could be that loneliness differentially affects the neural systems implicated in cognitive processing (Boss et al., 2015). In line with this proposal Wilson et al. (2007) suggest that socially isolated animals lose dendritic connections in zones such as the hippocampus, which are located in the temporal lobes. Neuroimaging data suggest that phonemic and semantic fluency rely on distinct cognitive resources. Importantly, semantic verbal fluency has been shown to be associated with the activation of a number of areas, including the temporal lobe the left hemisphere (Binder et al., 2009). In contrast, verbal fluency, but not semantic fluency, has been shown to be associated with extensive activation in the left frontal cortex (Zatorre et al., 1996). Thus, if loneliness affects different areas of the human brain, as it appears to do in animal brains, this could explain why loneliness affects semantic but not phonological fluency. Consequently, it is possible that lonely individuals possess a reduced neural reserve (Wilson et al. 2007) that may influence lexical-semantic access. In this sense, loneliness and

social isolation might debilitate cognitive reserve because they prevent lonely individuals from being able to compensate for age-related brain pathology (Zhong et al., 2017). Furthermore, this suggestion is in line with the finding that social contact contributes to strengthening older adults' cognitive reserve (Shankar et al., 2013).

With regards to depression, previous studies have shown that depression in elderly individuals can affect a wide range of cognitive domains (e.g., Burt et al., 1995; Hermann et al., 2007). Nevertheless, the influence of depression on verbal fluency has been less well studied (Ganguli et al., 2009), and given depression's functional relationship with other cognitive areas, this is a particularly important analysis. It is plausible that depression may influence verbal fluency due to the tendency of depressed people to ruminate and have intrusive thoughts that affect their ability to process information as well as their ability to allocate attentional resources (Bauermeister & Bunce, 2015). Thus, linguistic production would be lower in depressed elderly individuals due to the interference of these thoughts. In line with this suggestion, depression was significantly negatively correlated with both phonological and semantic fluency. Nevertheless this relationship disappeared once age, education and general cognitive function were controlled. Although other studies have reported an association between depression and verbal fluency many of these studies have pre-selected participants who had been previously diagnosed with depression (for a meta-review, see Henry & Crawford, 2005). Consequently, in studies that have compared a depressed group with a control group, the incidence of depression is effectively 50%. In contrast, based on their CESD-10 scores, just 20% of the participants in the present study could be considered as having depression. Thus, it may be the case that depression is negatively associated with verbal fluency, but such a relationship is too weak to be detected when the profile of the sample matches that of the broader community in terms of the incidence of depression.

One surprising result is that deterioration in phonological fluency was not related to age despite the fact that there was a significant, medium strength correlation between the two variables. Instead, a deterioration in phonological fluency was linked to cognitive function, which was itself correlated with age. This result suggests that deterioration in phonological fluency is associated with age related cognitive decline, but not to aging per se. This finding is in line with previous research (Crossley, D'arcy & Rawson, 1997; Meinzer et al., 2009), and these results have also been replicated in individuals with mild cognitive impairment (Murphy et al., 2006). The explanation for these results could be that different sub-portions in the left inferior frontal gyrus are activated during both tasks (for a review see Costafreda et al., 2006).

In terms of the control variables, we found that both years of education received and general cognitive functioning exert a protective influence on the language variables. Additionally age was found to exert a protective influence on semantic fluency. As age increased, semantic fluency decreased, although the effect was non-linear – the "rate of decline" was greater in the third age compared to the fourth age. These results show that variables related to cognitive reserve exert an effect in the maintenance of cognitive functioning in adulthood, and as such reflect results reported in other studies (e.g., González et al., 2013).

Finally, females showed significantly higher levels of phonological fluency after controlling for all other factors, but this advantage was not present for semantic fluency. This result is in line with previous research (Crossley et al., 1997; Weiss et al., 2006), and suggests some important underlying difference between phonemic and semantic fluency tasks. As described in the introduction, Weiss et al. (2006) suggested that women's superior performance on the phonemic fluency task was due to them adopting a more efficient strategy. If so, why is the same not true for the semantic fluency task? Although both fluency

tasks share similar processes (efficient organization of verbal retrieval and recall, self-monitoring aspects of cognition, effortful self-initiation, and inhibition of responses; Henry & Crawford, 2005), they involve different cognitive demands. Good semantic fluency relies on access to an intact semantic lexicon, and it is commonly believe that retrieving one exemplar from a specific semantic category automatically activates closely related semantic neighbours (Rohrer et al., 1999; Troyer et al, 1997). In contrast, phonemic fluency typically requires the processing of the phonemic characteristics of the word's first phoneme, and this can be prone to intrusions. Hence, it is believed that phonemic fluency tasks require a sustained level of focused attention. Potentially, women and men adopt similar strategies for the semantic fluency task but the increased requirement for focused attention in the phonemic fluency task may alter the strategy used by women, but not men. In line with this idea, Weiss et al. (2006) reported significant differences between men and women in terms of the number of clusters generated, and the size of the clusters generated in the phonemic, but not semantic fluency tasks.

Limitations and Future Directions

The present study has a number of limitations. The first is the cross-sectional nature of the data which limits the ability to establish causality in the relationships between the variables of interest. Thus, rather than the presence of loneliness being detrimental to verbal fluency, it may be that language abilities could in fact be predictors of the onset of loneliness. For this reason the present results should be interpreted with caution, and future longitudinal studies are needed to confirm the relationship between, age, loneliness and semantic fluency.

A further limitation is that processing speed was not directly assessed in these participants, a factor other studies have found to be related to loneliness (e.g., O'Luanaigh et al, 2012). Potentially, the decline in semantic fluency seen with increased levels of loneliness,

especially as age increases, could, in part, be explained by an age related decline in processing speed. Future studies could resolve this issue by including a more direct assessment of processing than that offered by the MMSE. Similarly, physical health and disability may contribute both to social isolation and loneliness as well as cognitive impairment and thus these factors should be considered as candidates to include in future studies.

Despite these limitations, we emphasize that one of its strengths is that, due to the sampling methods, it is a representative survey of the Spanish population and, to our knowledge, is the first study that has investigated these relationships in Spanish speakers. Taking into account the relationship found between verbal fluency and loneliness, and given the benefits to cognitive functioning of intervention in cases of loneliness (Ybarra et al., 2008), future studies should examine if interventions designed to minimize loneliness in the elderly also have an effect on language skills. In the same vein, as the explanatory mechanisms for the relationships between loneliness and verbal fluency are unknown, future studies could also examine the impact of depression and loneliness on brain regions implicated in language production. It is also possible that interventions designed to improve verbal fluency abilities of the elderly may have important secondary benefits in the area of mental health symptoms.

In summary, the results reported here add to our knowledge of the impact of mental health symptoms and cognitive functioning in the elderly having demonstrated an association between loneliness and verbal fluency. Given the relationship between loneliness and semantic fluency, early detection of conditions such as loneliness, along with the implementation of intervention for individuals diagnosed with loneliness is advisable in order to avoid negative repercussions for the linguistic abilities of these individuals.

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Table 1

Summary of Correlations between Fluency Variables, Predictor Variables and Control Variables for the Participants Included in the Regression Analyses (n = 962), along with Descriptive Statistics.

	Correlations									Descriptive Statistics			
	1 PF	2 SF	3 Dep	4 Lon	5 Age	6 Educ	7 CF	8 Gen	9 SN	Mean or *Freq.*	(*SE*) or Pct	95% CI	Range
1. Phon. Fluency (PF)	–									11.5	(.24)	[11.0, 12.0]	0 – 28
2. Semantic Fluency (SF)	.55***	–								18.9	(.21)	[18.5, 19.4]	0 – 35
3. Depression (Dep)	-.15***	-.13***	–							1.9	(.08)	[1.7, 2.1]	0 – 10
4. Loneliness (Lon)	-.08*	-.08*	.40***	–						2.2	(.06)	[2.1, 2.3]	0 – 6
5. Age	-.35***	-.34***	.09*	.03	–					64.0	(.44)	[63.1, 64.8]	50 – 98
6. Education (Educ)	.48***	.36***	-.18***	-.03	-.27***	–				5.3	(.11)	[5.1, 5.6]	1 – 10
7. Cognitive Func. (CF)	.31***	.30***	-.18***	-.07*	-.28***	.26***	–			28.6	(.06)	[28.5, 28.8]	23 – 30
8. Gender [a]	-.01	-.05	.18***	-.05	.03	-.19***	-.10**	–		*503*	52.3		
9. Social Network (SN)	-.06#	-.08*	-.19***	-.42***	.12**	-.06	-.03	.11**	–	7.2	(.07)	[7.1, 7.3]	0 – 10
10. Family Network (FN)	-.07*	-.01	-.21***	-.42***	.06	-.09*	-.04	.13***	.60***	7.9	(.05)	[7.8, 8.0]	0 – 10

[a] Gender is coded such that positive correlations indicate higher scores for females on the associated variable.

#$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

Table 2

Hierarchical Multiple Regression Analyses Predicting Phonological- and Semantic-Fluency from Mental Health Symptoms (Depression and Loneliness) Controlling for Age, Education, Cognitive Functioning, Gender, Social and Family Networks

Predictor	Phonological Fluency				Semantic Fluency			
	b	(*SE*)	95% CI	*p*	*b*	(*SE*)	95% CI	*p*
Linear Age	-0.095	(0.094)	[-0.281, -0.092]	.317	-0.271	(0.084)	[-0.437, -0.105]	**.002**
Quadratic Age	0.000	(0.003)	[-0.005, -0.005]	.987	0.005	(0.002)	[-0.000, -0.009]	.066
Education	0.888	(0.079)	[-0.732, -1.104]	**< .001**	0.581	(0.079)	[-0.425, -0.736]	**< .001**
Cognitive Functioning	0.552	(0.131)	[-0.295, -0.810]	**< .001**	0.645	(0.094)	[-0.459, -0.831]	**< .001**
Gender (Female)	1.058	(0.330)	[-0.406, -1.709]	**.002**	0.257	(0.342)	[-0.418, -0.932]	.453
Social Networks	-0.071	(0.115)	[-0.298, -0.156]	.537	-0.295	(0.129)	[-0.549, -0.040]	**.023**
Family Networks	-0.183	(0.136)	[-0.452, -0.086]	.182	0.185	(0.151)	[-0.114, -0.483]	.224
Depression	-0.140	(0.167)	[-0.471, -0.190]	.403	0.043	(0.188)	[-0.328, -0.413]	.819
Depression x Linear Age	0.002	(0.023)	[-0.044, -0.047]	.947	-0.018	(0.023)	[-0.063, -0.028]	.443
Depression x Quadratic Age	0.000	(0.001)	[-0.001, -0.001]	.944	0.001	(0.001)	[-0.002, -0.001]	.398
Loneliness	-0.097	(0.293)	[-0.676, -0.482]	.742	-0.550	(0.235)	[-1.014, -0.086]	**.021**
Loneliness x Linear Age	-0.008	(0.045)	[-0.097, -0.080]	.855	0.063	(0.030)	[-0.005, -0.122]	**.035**
Loneliness x Quadratic Age	0.000	(0.001)	[-0.002, -0.003]	.953	-0.002	(0.001)	[-0.003, -0.000]	**.032**
Model R^2	31.6%				23.7%			

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Material from this point to be included as online supplementary material

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Supplementary Methodology

Sampling Procedure

The ELES questionnaire was developed using other similar longitudinal studies as a starting point, including the US Health and Retirement Study (HRS), the English Longitudinal Study of Aging (ELSA), and the Surveys of Health, Ageing, and Retirement in Europe (SHARE). One of the justifications for this approach was to ensure that the ELES data were directly comparable with similar international studies. The collection of data was carried out in three phases: telephone interviews, a face-to-face interview conducted in the homes of the participants, and a self-administered questionnaires (including a brief health assessment). The home visits were conducted by trained interviewers.

To create a sample that truly reflected the characteristics of the Spanish population, the ELES project used stratified multi-staged sampling. The first stage was clustered on province and size of community. In the second stage, households with telephones were randomly selected based on census data. In the third stage, an individual was randomly selected from each household, with further stratification by age and gender. What follows is a summary of the sample, however a detailed breakdown of the sample by region, age and gender, along with a justification of the

design, along with flowcharts of the design can be found in Teófilo, González, Díaz and Rodríguez (2011; Tables 1 and 2, p. 28). Additionally, Rojo-Pérez et al. (2012) provide further information regarding the sampling techniques while Rodríguez Laso et al. (2013) provide details of how the sample was reduced from the households initially contacted down to the final sample of individuals who took part in the telephone survey.

First, a sample of 26440 households was randomly selected from the telephone directory (after initial stratification by region and randomly selecting clusters of address). Sampled households were then screened by telephone for the presence of an age-eligible person – 13242 households had at least one person 50 years or older in residence and 6026 households agreed to receive information regarding the project via post. From this group, 2676 individuals declined to participate further and an additional 277 failed to return the survey, did not answer the phone, or repeatedly postponed their participation. A further 1326 individuals were not recruited despite expressing an interest in taking part as there was an excess of participants in their particular demographic category. Consequently, 1747 individuals took part in subsequent telephone interviews and each gave informed consent to participate in the study. Of this group, 216 individuals did not agree to a subsequent home visit from a community health nurse. During this initial home visit the community nurses administered the Mini-Mental State Examination (MMSE) to 1531 individuals. If the scores of specific parts of the MMSE reached preset thresholds (Orientation > 5, Attention and Calculation > 2, Reading = 1, Writing = 1), the participant was provided with a self-administered questionnaire to complete. Additionally, for participants who scored below 24 on the MMSE it was suggested that a proxy responder be present for the subsequent home visit – the use of proxy responders being a common practice in this type of research (Hardy, Allore & Studenski, 2009). In this second home visit tasks requiring the use of a

computer or the interaction between the participant and evaluator, including the verbal fluency tasks reported in the present study, were administered to 1400 individuals. Amongst these participants, a number required the use of proxy responders. Given that we were interested in analyzing verbal fluency, this effectively reduced the sample even further.

Materials

The complete questionnaire administered to participants is available (in Spanish) on the ELES website (http://proyectoeles.es/) and comprised the following dimensions: (1) sociodemographic characteristics; (2) physical health; (3) psychosocial aspects; (4) financial resources, work and retirement; and (5) social and family networks, social participation and transfer of care (exchanges of instrumental support – help with domestic chores, shopping, etc. – between the elderly and their social network), although only a small subset of these data were used in the present study.

Questionnaire Items.

The specific sections from the ELES questionnaire used in the present study were: semantic fluency, item p56; phonological fluency, item p57; depression, section p86; loneliness, section p144; item, p173; social networks, items p157 and p159; family networks, items p142 and p143.

Reliability.

Depression. The short form of the Center for Epidemiologic Studies Depression Scale (CESD-10; Andresen, Malmgren, Carter, & Patrick, 1994) was used to evaluate depression. This instrument is designed to detect cases of depression based on the appearance of symptoms during the previous 7 days. Cronbach's alpha has been reported as .86 (Miller, Anton, & Townson, 2008).

Loneliness. The shortened version of the de Jong Gierveld loneliness scale (de Jong Gierveld & van Tilburg, 2006) was used to evaluate loneliness. The items assess whether the participant believes that they experience situations in which the number of relationships is fewer than desired (e.g., There are many people I can completely trust), and possible answers are "yes", "more or less", and "no". As per the manual for this instrument, all responses were scored as either 0 (no evidence of loneliness) or 1 (evidence of loneliness) with the neutral response ("more or less") always counting as evidence of loneliness. Cronbach's alpha has been reported to exceed .70, and this includes samples containing participants aged 65 years and over (de Jong Gierveld & van Tilburg, 2006).

Verbal Fluency. The Multilingual Aphasia Examination of Benton and Hamsher (1989) was used to evaluate verbal fluency. Cronbach's alpha for these tasks has been reported to exceed .80 (Ruff, Light, Parker & Levin, 1996).

Cognitive Functioning. The Spanish version of the Mini-Mental State Examination (MMSE) was used (Lobo, Sanz, Marcos & Grupo de Trabajo ZARADEMP, 2001). This instrument is a screening test designed to rapidly measure cognitive impairment and includes items related to orientation, attention and calculation, recall, naming, repetition, comprehension, language and drawing. Tombaugh and McIntyre (1992) reported test-retest reliability ranged from between 0.80 and 0.95 while internal consistency was somewhat lower.

Analysis.

One of the stated goals of this study is to explore possible differences between the third and fourth age on the variables of interest. One way to achieve this would have been to split the sample into two groups with an arbitrary cut off point for age separating the two. However, this is undesirable for both methodological and statistical

reasons. In the first instance, it is not clear when transition from the third to the fourth age occurs (Shmotkin et al., 2014) as the difference between the third and fourth age lies mainly in the fact that individuals who are categorized as belonging to the fourth age are frail and dependent, thus making it problematic to choose a single, rigid cut-off age to separate the two categories. Additionally, to perform such a dichotomous split has a number of statistical disadvantages, including a loss of statistical power (Cohen, 1983). Thus, to explore possible differences between the third and fourth age we added a quadratic term for age to the regression models, thus allowing us to detect non-linear effects.

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