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Subjective age and verbal fluency among middle aged and older adults: A meta-analysis of five cohorts

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ABSTRACT

Objectives: This study aimed to examine the relation between subjective age and verbal fluency in five large samples of older adults to advance knowledge on the role of subjective age in a complex cognitive function that is an intermediate marker of cognitive impairment and dementia risk.
Methods: Participants ($N > 27{,}000$), aged 32 to 99 years old, predominantly white, were from the Wisconsin Longitudinal Study Graduate (WLSG) and Siblings (WLSS) samples, the Health and Retirement Study (HRS), the Midlife in the United States Study (MIDUS), and the English Longitudinal Study of Ageing (ELSA). They provided complete data on subjective age, demographic factors and verbal fluency. Estimates from each sample were combined in a meta-analysis.
Results: Across each of the five samples and in the meta-analysis, an older subjective age was related to lower performance on the verbal fluency task. This association was independent of chronological age and was not moderated by age, sex, nor education. The difference in fluency between individuals with an older and younger subjective age ranged from $d = 0.09$ to $d = 0.37$ across the five samples.
Conclusions: This study found replicable evidence for an association between an older subjective age and lower verbal fluency, extending knowledge about an intermediate marker of cognitive function.

1. Introduction

Subjective age refers to how old or young individuals feel relative to their chronological age (Kotter-Gruhn et al., 2016). An older subjective age has been related to declines in health over time, including limitations in activities of daily living and depressive symptoms (Rippon & Steptoe, 2018), higher risk of cardiovascular disease (Stephan, Sutin, Wurm, & Terracciano, 2020), and ultimately higher mortality risk (Rippon & Steptoe, 2015). Moreover, subjective age is associated consistently with cognitive function. Specifically, feeling older is related to worse memory performance in cross-sectional studies (Hughes & Lachman, 2017; Stephan, Sutin, Caudroit, & Terracciano, 2016), to worse memory assessed 10 years later (Zee & Weiss, 2019), and to a steeper decline in memory over time (Stephan et al., 2016). An older subjective age is also associated with informant reports of cognitive decline and worse cognitive function Stephan, Sutin, Luchetti, & Terracciano (2020). Consistent with these findings, feeling older than one's age is predictive of a higher risk of cognitive impairment and dementia (Qiao et al., 2021; Stephan, Sutin, Luchetti, & Terracciano, 2017). Experimental research further indicates that the induction of a younger subjective age is related to better memory performance (Shao et al., 2019).

Research on the link between subjective age and cognition has focused mainly on memory performance or cognitive impairment. Little is known about how subjective age is related to other, more complex cognitive tasks that play an important role in individual functioning. In this study, we focus on verbal fluency, a cognitive task that is routinely assessed in both research and clinical domains. Verbal fluency refers to the ability to produce many words from a single category in a short time (Lezak, 2004). Typically, participants are asked to name as many words as possible from a specific category (e.g., animals) in 60 s. Performance on verbal fluency tasks requires the activation and integration of several cognitive processes (Shao, Janse, Visser, & Meyer, 2014) that include speed, attention, self-monitoring, and inhibition. This measure is

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commonly included in neuropsychological testing in research and clinical settings (Lezak, 2004). There is evidence that chronological age is related to change in cognition (Salthouse, 2009), and verbal fluency in particular (Buczylowska & Petermann, 2016). However, to our knowledge, no study has tested whether the subjective experience of age may relate to performance on a fluency task. Furthermore, verbal fluency is recognized as a crucial cognitive marker that is predictive of age-related outcomes, including a lower risk of incident dementia (Sutin, Stephan, & Terracciano, 2019). Therefore, the examination of the link between subjective age and an intermediate marker of cognitive function such as verbal fluency could inform on processes that link subjective age to cognitive impairment and dementia. The identification of a link between subjective age and verbal fluency could also have practical implications, by helping identify individuals at risk of decline in cognitive function, which may be targeted by intervention efforts.

There are several reasons to expect a relationship between subjective age and verbal fluency. First, the consistent relation between subjective age and both memory (Hughes & Lachman, 2017; Stephan et al., 2016; Zee & Weiss, 2020) and dementia risk (Stephan et al., 2017, 2018) suggests that it may be also related to other cognitive tasks, such as verbal fluency. Moreover, subjective age is related to several factors implicated in performance on verbal fluency. For example, individuals with an older subjective age are less open to experience (Canada, Stephan, Caudroit, & Jaconelli, 2013) and have a lower IQ (Stephan, Sutin, Kornadt, Caudroit, & Terracciano, 2018), which are both related to lower performance on verbal fluency tasks (Sutin, Damian, et al. 2019; Von Stumm & Deary, 2013). In addition, the pattern of social interactions associated with subjective age may impact verbal fluency. For example, feeling older is associated with more feelings of loneliness (Bodner, Ayalon, Avidor, & Palgi, 2016), which in turn are associated with lower verbal fluency (Yin, Lassale, Steptoe, & Cadar, 2019). Subjective age is also associated with health behaviors that contribute to cognition in old age. Indeed, an older subjective age is related to physical inactivity (Wienert, Kuhlmann, Fink, Hambrecht, & Lippke, 2016), which is deleterious for performance on cognitive tasks, including verbal fluency (Daly, McMinn, & Allan, 2015). The extent to which these factors explain the association between subjective age and verbal fluency could be accounted by two different, non-mutually exclusive theoretical perspectives. According to a causal model, subjective age may predict fluency through its influence on psychological, social and behavioral factors (Wurm, Diehl, Kornadt, Westerhof, & Wahl, 2017). In an alternative perspective, subjective age is conceptualized as a biopsychosocial marker of aging (Stephan, Sutin, & Terracciano, 2015). That is, an older subjective age reflects worse psychological, social, and behavioral functioning, which may manifest into lower verbal fluency.

The present study examines the relationship between subjective age and verbal fluency in five large samples of middle-aged and older adults. It was hypothesized that an older subjective age would be related to lower performance on a verbal fluency task. Additional analyses tested whether age, sex, and education moderated this relationship.

2. Method

2.1. Participants

Participants were from five samples: the Wisconsin Longitudinal Study Graduate (WLSG) and Siblings (WLSS) samples, the Health and Retirement Study (HRS), the Midlife in the United States Study (MIDUS), and the English Longitudinal Study of Aging (ELSA). These studies were selected because they were publicly available and included assessments of both subjective age and fluency. In all samples, participants provided informed consent to participate in data collection. Participants were included if they had complete data on subjective age, verbal fluency, and demographic variables. Descriptive statistics are presented in Table 1.

The WLS is a long-term study of a random sample of 10,317 men and women who graduated from Wisconsin high schools in the same year, 1957. The WLSG sample is broadly representative of white, non-Hispanic American men and women who graduated from high school. Complete data on subjective age, demographic factors, and verbal fluency were obtained in 2011 from a total of 2062 participants aged 70 to 74 years (53% women, mean age = 71.22, SD = 0.94). Selected siblings of the graduates were also included in the WLS sibling sample (WLSS). A total of 1146 participants aged 47 to 92 years (53% women, mean age = 69.10, SD = 6.74) had complete data on the variables of interest in 2011. A public use file of data is available at http://www.ssc.wisc.edu/wlsresearch/data/.

The HRS is a nationally representative longitudinal study of Americans older than 50 years. Demographic factors, subjective age, and verbal fluency data were obtained from half of the sample in 2010 and the other half in 2012. Both waves were combined, resulting in a total sample of 13,144 participants aged 50 to 99 years (59% women, mean age=67.30, SD=10.52). HRS data is publicly available at http://hrsonline.isr.umich.edu/.

The MIDUS is a sample of non-institutionalized, English-speaking adults. The present study used the second wave (2004–2009, MIDUS II). A total of 3388 participants aged 32 to 84 years (55% women, mean age=56.45, SD=12.31) had complete subjective age, verbal fluency, and demographic data. MIDUS data is publicly available at http://midus.wisc.edu/index.php.

ELSA is a representative cohort of men and women living in England aged 50 years and older. Subjective age and verbal fluency were obtained from Wave 2 (2004). Complete data were available from a total of 7335 individuals aged 50 to 89 years (55% women, mean age=65.20, SD=9.26). ELSA data are available at https://www.elsa-project.ac.uk/

2.2. Measures

2.2.1. Subjective age

In the five samples, participants were asked to report the age they felt. In line with existing research (Stephan et al., 2018), a proportional age discrepancy was computed. Specifically, chronological age was subtracted from felt age and then divided by chronological age. An older subjective age was represented by a positive value, whereas a younger subjective age was indicated by a negative value. Based upon past

Table 1
Characteristics of the samples.

Variables	WLSG M/%	SD	WLSS M/%	SD	MIDUS M/%	SD	HRS M/%	SD	ELSA M/%	SD
Age (Years)	71.22	0.94	69.10	6.74	56.45	12.31	67.30	10.52	65.20	9.26
Sex (% women)	53%	–	53%	–	55%	–	59%	–	55%	–
Race (% White)	100%	–	100%	–	95%	–	78%	–	99%	–
Education	13.90	2.42	14.16	2.57	7.33	2.53	12.94	2.97	4.54	2.24
Subjective Age	−0.17	0.13	−0.17	0.13	−0.17	0.15	−0.15	0.17	−0.13	0.14
Verbal Fluency	19.89	5.98	19.78	5.91	18.92	6.12	17.50	7.22	20.43	6.36

Note. Note. HRS: $N = 13{,}744$; WLSG: $N = 2062$; WLSS: $N = 1146$; MIDUS: $N = 3388$; ELSA: $N = 7335$. See the method section for differences in measures.

research (Weiss et al., 2012), participants with scores of three standard deviations above or below the mean proportional discrepancy were excluded from the analysis in the five samples (N_{WLSG}= 32; N_{WLSS}= 13, N_{HRS}= 39, N_{MIDUS}= 46, N_{ELSA}= 133).

2.2.2. Verbal fluency

A standard measure of verbal fluency was completed by participants in the five samples. Participants were asked to name as many animals as possible in 60 s. In the WLS samples, the category participants completed was either animals or food. In the five samples, the total number of animals (or food in the WLS samples) named in 60 s was the fluency score used in the analyses. A higher score indicated a higher verbal fluency. In the WLS samples, participants were also administered a letter fluency task in which they had to generate as many words starting with either the letter "F" or "L" as possible in 60 s. As with animal fluency, more words retrieved indicated higher fluency.

2.2.3. Covariates

In all samples, age (in years), sex (coded as 1 for male), and education were included as control variables. Education was reported in years of education in the WLSG, the WLSS, and the HRS. In the MIDUS, a scale ranging from 1 (no grade school) to 12 (doctoral-level degree) was used. In ELSA, the scale ranged from 1 (no qualification) to 7 (NVQ4/NVQ5/ Degree or equivalent). Race was controlled in the MIDUS, the HRS, and ELSA.

2.3. Data analysis

In each sample, a multiple regression analysis was conducted to test the association between subjective age and verbal fluency. Verbal fluency was regressed on subjective age, controlling for age, sex, and education. Race was an additional covariate in MIDUS, HRS, and ELSA. In both WLS samples, a covariate that accounted for category (animal versus food) was included in the analyses. Comprehensive Meta-Analysis software was used to provide a summary estimate across the five samples.

An additional analysis was conducted in the WLS samples predicting letter fluency from subjective age, controlling for age, sex, education, and the letter category ("F" versus "L"). In addition, age, sex, and education were tested as moderators of the association between subjective age and fluency in each sample.

3. Results

Regression assumptions of homoscedasticity, normality and absence of multicollinearity were met in each sample. As expected, an older subjective age was related to lower performance on the verbal fluency task in all samples, controlling for demographic factors (see Table 2).

Table 2
Association between subjective age and verbal fluency in the five samples and the meta-analysis.

Sample	β
HRS[a]	−0.05***
MIDUS[a]	−0.05**
WLSG[b]	−0.06**
WLSS[b]	−0.10***
ELSA[a]	−0.05***
Meta-Analysis	
Random effect	−0.06*** (−0.078 ;−0.041)
Heterogeneity I^2	46.55

[a] Adjusted for age, sex, education, and race.
[b] Adjusted for age, sex, education and category.
** $p < .01$.
*** $p < 0.001$ Note. HRS: N = 13,744; WLSG: N = 2062; WLSS: N = 1146; MIDUS: N = 3388; ELSA: N = 7335. β = Standardized regression coefficient.

The meta-analysis confirmed the negative association, and there was little evidence of heterogeneity across the samples (Table 2). The effect size for the difference between individuals with an older subjective age and those with a younger subjective age was $d = 0.37$ in the WLSG, $d = 0.14$ in the WLSS, $d = 0.17$ in the HRS, $d = 0.09$ in the MIDUS, and $d = 0.18$ in the ELSA. The relationship between subjective age and fluency replicated with the letter fluency task in the WLSG (β= −0.08, $p<.001$), and the WLSS (β= −0.12, $p<.001$). There was no evidence that age, sex, or education moderated the link between subjective age and fluency across the five samples (all interactions in each study ns; data not shown).

4. Discussion

Using five large samples of middle-aged and older adults, the present study examined the relationship between subjective age and verbal fluency. As hypothesized, an older subjective age was related to lower performance on a verbal fluency task, controlling for demographic factors. We found no evidence of moderation by demographic factors, which suggests that the association was similar across women and men and people of different ages and educational levels. This association was found consistently in the five samples that spanned different cultures and fluency measured with different categories (i.e., animal and letter). Therefore, the present study extends existing knowledge on the relationship between subjective age and cognition (Hughes & Lachman, 2018; Stephan et al., 2016) by providing new robust and replicable evidence for an association with verbal fluency. As a whole, this study provides evidence for a new factor associated with verbal fluency, in addition to recognized demographic factors, such as age and education (Mathuranath et al., 2003).

Subjective age may be related to verbal fluency through several pathways. The lower openness to experience and IQ as well as the higher loneliness of individuals with an older subjective age (Bodner et al., 2016; Canada et al., 2014; Stephan et al., 2018) may explain in part their lower verbal fluency. Furthermore, a stress-related pathway may operate in the relationship between subjective age and verbal fluency. Indeed, an older subjective age is related to higher vulnerability to stress and anxiety (Avidor, Abu Hamam; & Lahav, 2021; Shrira et al., 2018), which may interfere with performance on a verbal fluency task. Subjective age is also related to a range of behaviors and health outcomes that are associated with cognition and may have implications for fluency. For example, feeling older is related to lower physical activity (Wienert et al., 2016) and less internet use (Seifert & Wahl, 2018), which may lead to lower performance on cognitive tasks such as verbal fluency. Furthermore, an older subjective age is associated with lower sleep quality (Stephan, Sutin, Bayard, & Terracciano, 2017), which is detrimental for cognitive functioning (Scullin & Bliwise, 2015), including verbal fluency. Finally, an older subjective age is predictive of worse cardiovascular health, including a higher risk of cardiovascular disease and stroke (Stephan et al., 2020), which is again detrimental for cognition in older age and may alter verbal fluency.

The present study has theoretical implications for the understanding of the link between subjective age and cognition. Subjective age is related consistently to cognitive function, assessed using standardized performance-based test (Hughes & Lachman, 2018; Stephan et al., 2016) and informant reports (Stephan et al., 2020). In addition to objective measures, an older subjective age is also related to lower self-rated memory (Segel-Karpas & Palgi, 2019). This study shows that the link between subjective age and cognition extends to a complex and intermediate marker of cognitive function. This finding could also contribue to a better understanding of factors that link subjective age to cognitive impairment and dementia (Qiao et al., 2021; Stephan et al., 2017). Lower performance on verbal fluency tasks is predictive of a higher risk of dementia (Sutin et al., 2019). Therefore, it is likely that the higher risk of dementia associated with an older subjective age may manifest

through lower verbal fluency. In other words, lower verbal fluency may be an intermediate marker of the poorer cognitive health of individuals with an older subjective age.

From a practical perspective, this study suggests that assessment of subjective age could be helpful in building risk models for cognitive decline. In particular, individuals with an older subjective age may be targeted by interventions designed to reduce risk of cognitive impairment. Furthermore, experimental induction of a younger subjective age leads to better memory performance (Shao et al., 2019). Therefore, interventions directed toward promoting a younger subjective age may prove useful to improve cognitive health. For example, physical activity programs have been found to benefit self-perceptions of aging (Beyer, Wiest, & Wurm, 2019), and may promote a younger subjective age and ultimately better cognitive functioning.

The strengths of the present study include the use of five large samples of adults that provide evidence on the replicability of the association. However, there are also some limitations to consider. Firtst, the observational study design does not support causal interpretations. Although subjective age predicts verbal fluency, reciprocal relationships are likely to exist. Longitudinal research is needed to test for the relationships between subjective age and verbal fluency over time. Second, the five samples were predominantly white. Future research must examine this association in more diverse, heterogeneous samples. Finally, subjective age is a multidimensional construct (Kornadt et al., 2018). Therefore, future research may examine whether specific facets of subjective age are associated with verbal fluency.

In sum, the present study provides new replicable evidence that subjective age is related to verbal fluency among older adults. Specifically, an older subjective age was consistently related to lower performance on a verbal fluency task in five samples of older adults. Past research has focused mainly on memory and global cognitive status. By examining verbal fluency, this study expands knowledge on the link between subjective age and markers of cognitive health among older adults.

Author contributions

Study concept and design: Stephan,Terracciano; Acquisition, analysis, or interpretation of data: All authors; Drafting of the manuscript: Stephan; Critical revision of the manuscript for important intellectual content: All authors; Statistical analysis: Stephan, Terracciano; Study supervision: Stephan, Terracciano.

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Declaration of Competing Interest

None.

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