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An Analysis of Famous Person Semantic Memory in Aging

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ABSTRACT

Background: In contrast to most memory systems that decline with age, semantic memory tends to remain relatively stable across the life span. However, what exactly is stable remains unclear. Is it the quantity of information available or the organization of semantic memory, i.e., the connections between semantic items? Even less is known about semantic memory for celebrities, a subsystem of semantic memory. In the present study, we studied the organization of person-specific semantic memory and its stability in aging.
Methods: We designed a word association task based on a previous study , which consisted in providing the first word that came to the mind of the participants (15 participants for each age group 20–30, 40–50 and 60–70 years old) for 144 celebrities. We developed a new taxonomy of associated responses as the responses associated with celebrities name could in principle be very varied.
Results: We found that most responses (>90%) could be grouped into five categories (subjective; superordinate general; superordinate specific; imagery and activities). The elderly group did not differ from the other two groups in term of errors or reaction time suggesting they performed the task well. However, they also provided associations that were less precise and less based on imagery. In contrast, the middle-age group provided the most precise associations.
Conclusion: These results support the idea of a durable person-specific semantic memory in aging but show changes in the type of associations that elders provide. Future work should aim at studying patients with early semantic impairment, as they could be different from the healthy elders on such semantic association task.

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Introduction

Most memory systems decline with age: working and short-term memory, verbal and visuospatial long-term memory, episodic autobiographical memory (Craik, 1994; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002; Park et al., 2002; Schaie, 2005). In contrast, semantic memory is more stable and even tends to increase across a lifespan (Hertzog, Cooper, & Fisk, 1996; Horn & Cattell, 1967; Nyberg et al., 2003; Park et al., 2002). These

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studies have examined the effect of age on semantic memory by assessing the *quantity* of information subjects have at a given moment of their lives. However, it is unclear if the *structure* of semantic memory also remains stable with age.

Burke and Peters (1986) evidenced little changes during adulthood regarding the organization of general semantic knowledge. In this study, participants were asked to tell the first word that came to their mind following a target-word. Responses were classified as paradigmatic if they belonged to the same grammatical category as the target-word and as syntagmatic if they differed. Young and older adults produced the same proportion of responses, with similar latency. Using a similar method, Hirsh and Tree (2001), showed that despite a comparable proportion of response type, younger adults produced a wider variety of responses, with less agreement and consistency than elders. Coronges, Stacy, and Valente (2007) found using network analyses of associated words that college students showed differences in concept distribution compared to seventh graders. Clustering was high and average path length similar in the two groups but the college students had greater centralization and density than the seventh graders, in accordance with Hirsh and Tree (2001). Thus, although the quantity of information contained in semantic memory appears to remain stable or even increase with age, it appears that its structure may change.

In contrast to these studies on the organization of general semantic memory, few studies have focused on how person-specific knowledge evolves with age. Studying the organization of person-specific semantic knowledge and its consistency across age is important since it was demonstrated that person-specific knowledge is dissociable from general semantic knowledge. Thompson et al. (2004), for example, published a double dissociation between two patients with opposite profiles: while one showed impaired person-specific semantic memory with preserved knowledge about objects and animals, the other exhibited the reverse pattern. Person-specific memory could furthermore follow a different semantic organization than general semantic knowledge (Lyons, Hanley, & Kay, 2002; Miceli, Daniele, Esposito, & Magarelli, 2000). Studies in brain-injured patients and in fMRI have also consistently shown that knowledge about famous people rely on overlapping but partly distinct networks, including notably the right anterior temporal lobe (Brambati, Benoit, Monetta, Belleville, & Joubert, 2010; Joubert et al., 2006). Specific models of access to identity-specific semantic information from faces or names have consequently been developed (Bruce & Young, 1986; Valentine, Brennen, & Brédart, 1996).

Haslam, Kay, Hanley, and Lyons (2004), found that 50–65-year-old participants were more accurate than 20–35-year-old in providing semantic information about people. Langlois, Fontaine, Hamel, and Joubert (2009)observe significant diminution of semantic memory for celebrities between 60 and 90 years (see also Nilsson, 2003). Furthermore, it has been suggested that knowledge about faces and names could form highly stable long-term memories (Bahrick, Bahrick, & Wittlinger, 1975) and that retrieval of proper name might be better preserved during aging than is usually thought (James, 2006; Rendell, Castel, & Craik, 2005). Thus, person-specific memory also seems to be stable with age, at least regarding the quantity of available information as assessed in most studies.

The structure of person-specific semantic memory has been studied using mostly priming paradigms (see Darling & Valentine, 2005 for a study of the structure of semantic memory using an alternative paradigm), with the IAC model from Burton, Bruce, and

Johnston (1990) accounting for many of the effects that have been observed. These studies have suggested that person-specific semantic memory could be structured by shared semantic information across famous people, co-occurrence (two persons often together) or categorical association (e.g., shared occupation) although there are debates about the preeminence of each (Wiese & Schweinberger, 2011, 2015 for extensive discussions). Interestingly, it is usually found that implicit memory, the memory assessed in priming experiments, remains stable with aging (Burke, White, & Diaz, 1987; Fleischman, 2007); including for familiar names (Komes, Schweinberger, & Wiese, 2014). However, no study has focused on the effect of age on the explicit structure of person-specific semantic memory to the best of our knowledge although it is known that aging affects how the brain processes famous people (Nielson et al., 2006).

In the present study, we studied the organization of person-specific semantic memory and its consistency during aging. We designed a word association task inspired by Burke and Peters' work, assuming that word associations are a good index of the organization of semantic memory (see Burke & Peters, 1986). However, the taxonomy usually employed to categorize semantic association responses (i.e., paradigmatic vs. syntagmatic responses, Burke & Peters, 1986; Hirsh & Tree, 2001) is too restrictive to classify person-based semantic responses. To overcome this issue and investigate the organization of person-specific semantic memory, we developed a new taxonomy of associated responses. We present this new taxonomy and determine whether any qualitative age-related changes can be found in word associations in response to famous people. The current work is thus a preliminary study that proposes a new method for the analysis of person-specific semantic memory organization.

Methods

Participants

Forty-five people aged from 21 to 69 participated in the study. There were 15 participants for each of three age decades: 20s (M = 23.7, SD = -2.3); 40s (M = 44.7, SD = 3.2); 60s (M = 64.0, SD = 2.4). Within the younger group, three participants worked, the others were students (one data missing). All middle-aged worked. Within the oldest group, three worked, all the others were retired. The number of male and female participants was equivalent across the three age decades (respectively 7, 7 and 8 females). The three groups were also equivalent in terms of years of education (respectively 15.5, 15.2 and 15.7; (X^2 (2, N = 45) = 0.17; p = 0.92). Participants were selected according to eight criteria: MMSE ≥ 28; no general anesthesia in the last two months; no history of neurological or vascular disease (head trauma, stroke, cerebral tumor, epilepsy, or neurodegenerative disease); no history of alcohol or drug abuse; no uncorrected visual or auditory defect; no general progressive and invalidating disease; being in France for at least the last 10 years; speaking and writing French fluently. The research was completed in accordance with the Helsinki Declaration. Any ethics committee was required. Participants all signed informed consent before the experiment.

Before the study, participants underwent a set of neuropsychological tests: Digit-Symbol and Information subtests of the Wechsler Adult Intelligence Scale (WAIS-III, Wechsler, 1997), p. 2000), Beck Depression Inventory (BDI, Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), State-Trait Anxiety Inventory (STAI – YA subpart, Spielberger, 1983), and the Cognitive Difficulties Scale (McNair & Kahn, 1983). These last three tests were used to verify that all participants, in particular, the oldest ones, were healthy subjects. We used the standard norms for each test. No subject was finally discarded from analyses following this procedure. Moreover, the participants were asked to complete a questionnaire of media exposure to assess the average number of hours per week they usually spent watching television, listening to the radio and reading newspapers. They were also asked to rank their interest in 6 media fields (politics, cinema, music, sport, TV broadcasts, and talk-shows) on a scale from 1 (not interested at all) to 7 (highly interested). As expected, older participants obtained lower scores in the digit-symbol subtest, but better scores in the Information subtest consistent with the idea of a stable or better semantic memory with age (Park et al., 2002). All this background information for each age group is shown in Table 1.

Stimuli

In order to select the items of the study, a list of 643 famous names (politicians, actors, singers, sportsmen and TV presenters from France and foreign countries) was established by the authors and ranked by 252 French participants aged from 16 to 76 (who were different from those who participated in the study). Each participant had to determine the people he/she knew. We selected those chosen by at least 99% of the participants. The final pool consisted of 144 famous people: 54 politicians, 39 singers, 35 actors, 8 sportsmen, and 8 TV presenters (see list in Supplementary Material).

Procedure

Participants were tested individually in a quiet room. After filling out the background tasks and questionnaires, participants were trained with two tasks requiring fast responses in order to familiarize themselves with the use of the microphone: a detection task of a red square amongst a set of green squares presented sequentially and randomly; a naming task (20 items). These data were not analyzed.

Table 1. Background information of participants of each age group. All statistical comparisons were performed with non-parametric Kruskal Wallis tests excepted gender for which a X^2 was used. Average values together with standard deviations in brackets are provided for each age group. P-values are provided in the last column. * $p < 0.05$.

	20–30	40–50	60–70	*p-value*
Age	23.7 (2.3)	44.7 (3.2)	64.0 (2.4)	*n/a*
Gender (F/M)	7/8	7/8	8/7	*0.91*
Education (years)	15.5 (1.6)	15.2 (2.1)	15.7 (2.9)	*0.92*
MMSE (max: 30)	29.2 (0.9)	29.3 (0.9)	29.0 (0.8)	*0.59*
WAIS Digit-symbol subtest (max: 133)	88.5 (9.4)	73.7 (11.2)	63.4 (10.9)	***0.00***
WAIS Information subtest (max: 28)	17.9 (3.4)	23.3 (2.8)	23.2 (3.8)	***0.00***
Depression inventory (max: 39)	1.5 (2.6)	2.2 (2.9)	3.9 (4.1)	*0.07*
State-Trait Anxiety Inventory (max: 80)	30.2 (6.9)	28.0 (6.4)	31.7 (11.3)	*0.69*
Cognitive Difficulties Scale (max: 96)	20.9 (9.4)	21.7 (11.8)	24.6 (9.6)	*0.42*
Hours/week TV	14.4 (12.3)	13.1 (11.9)	15.7 (14.4)	*0.89*
Hours/week newspaper	2.8 (3.3)	2.5 (2.3)	2.6 (2.5)	*0.98*
Hours/week radio	4.5 (2.7)	11.3 (9.5)	9.5 (11.2)	*0.11*
Average media interest (min:1; max: 7)	3.9 (1.1)	4.0 (1.0)	3.2 (0.9)	*0.08*

Then, the main task started. Participants were told that they would be presented with names of well-known people that would appear on the computer's screen. They were asked to respond as quickly as possible with "the first word (or group of words) that came to mind" (as in Burke & Peters, 1986). It was emphasized that there was no correct response and that they should remain as open as possible to the first response that came to mind. There was no time limit but the experimenter ensured that participants understood that they had to answer fast. The experiment started with a training session on 10 items that were not further analyzed. Then, the 144 stimulus words were presented in a random order using E-prime 1.1 (Schneider Eschman, & Zuccolotto, 2012). Participants had to produce their response in a microphone which recorded reaction times (RT) using a vocal key provided by the software (E-prime). The RT was indicated as a feedback on the screen so that the participants could monitor whether they were responding quickly. False positive RTs (microphone triggered before the response or by unrelated noise such as lip smacking) and false negative RTs (microphone not triggered by the response, for example, the voice of the participant not loud enough) were manually discarded from further RTs analyses (483 RTs out of 6480 responses, 5997 RTs were thus analyzed). Each oral response provided was also written down for further analysis, independently of whether the RT could be recorded or not. A total of 6480 oral responses were analyzed. After the RT was validated or discarded and the response was written down, a fixation cross appeared to indicate that the next stimulus word was about to happen. This screen lasted from 300 to 600 ms. Every 20 items, the experimenter asked the participant whether he respected the instruction to provide the first word coming to mind. This procedure is described in Figure 1.

After this task, participants saw the 144 names of celebrities again and were instructed to rank them according to their knowledge of them (from 0: not known at all, to 9: extremely well known). This procedure allowed assessing participants' familiarity with the celebrities of the test. The whole session, including neuropsychological assessment, lasted about 2 h and the association task itself lasted between 25 and 35 min.

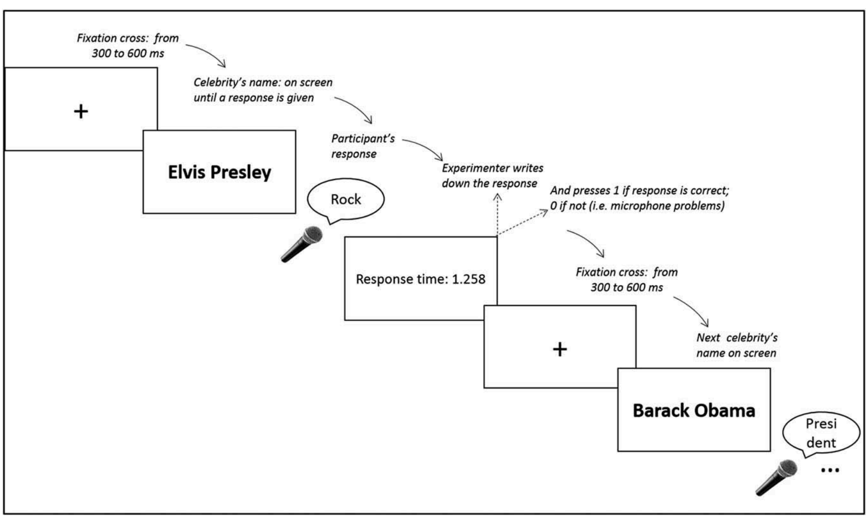

Figure 1. Experimental design for the semantic association task.

Response classification

The 6480 responses (144 items x 45 participants) were analyzed and served as a basis for elaborating a response classification nomenclature. The classification was elaborated by four of the authors (TB, AP, MJ & EJB) helped by two external collaborators. As no nomenclature exists for person-based responses classification, our purpose was to group the responses by homogenous categories in terms of semantic and linguistic properties. We identified five main categories: *Autobiographic, Subjective, Semantic, Linguistic* and *Residual* (see Figure 2 and Table 2).

Autobiographic category includes personal memories involving the participant him/herself (e.g. Alain Delon: "mommy" because the participant's mother liked the actor Alain Delon). *Subjective category* concerns participant's own opinion (e.g., Brad Pitt: "handsome"). These responses consist of a combination of semantic information about the celebrity and the participant's personal judgment. *Semantic category* includes all the public semantic information about the celebrities (e.g. Bruce Willis: "Demi Moore"). *Linguistic category* represents pure lexical labels related to the celebrity's name (e.g. Elizabeth II: "Her Majesty"). Finally, we defined a *Residual category* for wrong responses, no-responses and unclassifiable responses (e.g., Nelson Mandela: "South America").

We elaborated different subcategories, not knowing which one would be useful to classify participants' responses. Some of the categories were therefore subdivided into subsections as detailed in Figure 2 and Table 2. Autobiographic responses were subdivided into *autobiographical episodic (1)* memories (e.g., Michael Jackson: "Concert" (when I saw him)) versus *autobiographical semantic (2)* ones (e.g., Michael Jackson: "My sister" (is a fan)). The main category, the Semantic category, was notably subdivided into two main subsections: *Superordinate* responses concern general information, not specific to the celebrity, defining the global professional and geographical context. Those responses are classified into different levels of precision: *General domain* (4) (e.g., Michael Jackson: "Music") and *Specific domain* (the latter is also divided into two categories, i.e., *context* (5) (e.g., "Pop music") and *function (6)* (e.g., "singer")). *Subordinate* responses involve all the specific details characterizing the celebrity. Those responses are subdivided into *Imagery* (7) (terms defining the celebrity's appearance – e.g. Woody Allen: "glasses"), *Synonyms* (8) (nicknames usually used to call the celebrity – e.g. French singer Edith Piaf: "La Môme"), *Connections* (9) (names of relatives and terms related to other famous people linked to the celebrity – e.g. Lady Diana: "Prince Charles") and *Activities* (specific details characterizing

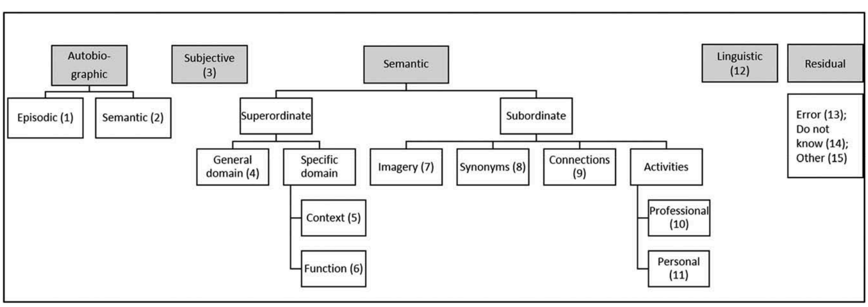

Figure 2. Response nomenclature.

Table 2. Example of response classification for two celebrities. Examples nonapplicable for those celebrities are written n.a.

Category			Description	Example 1: Bill Clinton	Example 2: Charlie Chaplin
AUTOBIOGRAPHIC (1,2)			Personal memories involving the participant him/herself		
	1	Episodic	Specific episodes experienced by the participant	Meeting (the meeting I was when I learned about the affair)	English lessons
	2	Semantic	Information regarding the participant's own semantics	My wife (finds him good looking)	My wife (is a fan)
SUBJECTIVE (3)			Participant's own opinion about the celebrity (mix between semantic information on the celebrity and participant's judgment)	Charismatic	Fun
SEMANTIC (4,5,6,7,8,9,10,11)			Public semantic information on the celebrity		
SUPERORDINATE	4	General domain	Most general information defining the professional area	Politics	Cinema
		Specific domain	More precise but still general information		
	5	Context	More precise but still general information defining the global professional or geographical context	Democrat	Silent film
	6	Function	More precise but still general information defining the global professional function	President	Humorist
SUBORDINATE	7	Imagery	Specific details characterizing the celebrity's physical aspect or characterizing the celebrity's usual paraphernalia	Hair	Mustache Stick
	8	Synonyms	Nicknames usually used to call the celebrity	n.a.	Charlot (his French nickname)
	9	Connections	Celebrity's relatives and terms related to other famous people linked to the celebrity	Hilary	n.a.
	Activities		Specific details characterizing the celebrity's acts and productions		
	10	Professional	Specific details characterizing the celebrity's professional activities	Re-elected	The Kid
	11	Personal	Specific details characterizing the celebrity's private acts	The Lewinsky scandal	n.a.
LINGUISTIC (12)			Pure lexical label related to the celebrity's name	(only for pope, queen and prince)	
RESIDUAL RESPONSES (13,14,15)			Wrong responses, no-responses and unclassifiable responses		
	13	Error	Wrong information on the celebrity	Republican	American
	14	Do not know	No response provided		
	15	Other	Unclassifiable responses	Airport	Statue

the celebrity's acts and productions). This last category was also subdivided into *Professional (10)* responses regarding the celebrity's professional productions (e.g., Michael Jackson: "Thriller") and *Personal (11)* responses including details on the celebrity's private life (e.g., Brad Pitt: "Adoption").

Three independent judges validated this classification: one of the authors (AP), one judge who only participated in the testing of participants, and one completely neutral judge (not involved in the study). These three judges classified independently the responses of 10 randomly chosen participants (total amount of responses to classify: 1440) according to the 15 categories of the defined nomenclature. The Cohen's kappas between these three judges were excellent (0.84, 0.88 & 0.89, all *ps*<0.001). These results demonstrate that the classification has a very good inter-rater agreement.

Statistical analyses

Analyses of response categories

First, we conducted a descriptive analysis to select the most representative categories. We only included categories that obtained at least 5% of the response. Second, we analyzed the effect of age on response categories. Such analysis on percentages required complex procedures. Indeed, each proportion for each category is dependent on the proportions of the other categories. To allow inter-subject analyses, we standardized the proportions for each single participant and compared the categories two-by-two, according to their hierarchy within the taxonomy (keeping the categories that obtained at least 5% of response). First, at the general level, the proportion of Subjective *vs.* Semantic responses was compared. Second, within the Semantic responses, the following comparisons were carried out: *Superordinate vs. Subordinate; Superordinate General Domain vs. Superordinate Specific Domain* and *Imagery vs. Activities*. We calculated standardized indexes for those four comparisons according to the following formula: (Category A – Category B)/(Category A + Category B). These indexes were compared between the three age groups using Kruskal-Wallis tests completed with post hoc Mann–Whitney tests adjusted for pairwise multiple comparisons (see above). To fit more precisely the relationship between age and performance, we also conducted a set of regression analyses. In order to find the best fitting curve, we performed linear and polynomial nonlinear regressions. In case several curves fitted our data, we used the coefficient of determination to identify the best predictive model.

Analyses of reaction time

For each participant, response times slower than 3 standard deviations were discarded. Response times for categories represented by less than five responses per participant were not taken into account. We conducted a repeated measures ANOVA on median reaction time for each participant in each category with age group as a between factor and response category as a within factor. We used the Tukey test for post hoc analysis.

Analysis of familiarity ranking

We conducted repeated measures ANOVA on mean familiarity rank for each participant in each category. We used the Tukey test for post hoc analysis.

Effect sizes

For significant results, the effect size was assessed using Cohen's d. Values of d are discussed according to recommendations: around 0.5 is considered a medium effect and >0.8 a large effect (Cohen, 1992). Standard deviations were weighted by sample size when n was not equal between groups (Zakzanis, 2001).

Results

Analysis on response categories

Descriptive analysis

The total number of responses for the 45 participants across the 18 categories is represented in Figure 3.

It allowed us to discriminate the most common type of responses and reduce the number of categories for further analyses. As mentioned in Methods, we discarded the categories with less than 5% of responses. Among the 15 categories, 8 were discarded (*Autobiographic Episodic* (1), *Autobiographic Semantic* (2), *Synonyms* (8), *Connections* (9), *Linguistic* (12), *Error* (13), *Do not know* (14) and *Other* (15)). Four were pooled within a more general category as summarized in Figure 3b (*Superordinate Specific Domain Context* (5) and *Function* (6) were pooled within a *Superordinate Specific Domain* category; *Professional (10)* and *Personal* (11) were pooled within an *Activities* category). In other words, remaining categories (representing altogether 91.4% of the responses) were grouped into five main categories: *Subjective* (3), *Superordinate General Domain* (4), *Superordinate Specific Domain, Imagery* and *Activities*. This classification was motivated by the content of the categories. *Subjective* category concerns personal opinions on the celebrities; *Superordinate General Domain* category includes the most general responses; *Superordinate Specific Domain* category comprises responses still general but more precise in terms of context and function; within *Subordinate* categories, *Imagery (7)* category includes all the perceptual responses based on the physical aspect of the celebrity or his/her associated accessories; and *Activities (10,11)* category concerns all the celebrity's actions produced in his/her professional or personal life.

Age effect

To analyze the effect of age on the proportion of response type, we defined four comparisons and calculated standardized proportions. As each proportion for each category is dependent on the proportions of the other categories, we indeed compared the categories two-by-two, according to their hierarchy within the taxonomy (see Methods). To fit more precisely the relationship between age and proportion of responses, we also conducted a set of regression analyses.

While comparing *Subjective* to *Semantic* responses, no age effect was found (X^2 (2, N = 45) = 1.75, $p = 0.42$) and no relationship was found between age and the proportion of *Subjective/Semantic* responses (Figure 4a). All the participants gave equally more semantic than subjective responses, irrespectively of their age. In contrast, a Kruskal–Wallis test performed on the relative proportions between *Superordinate* and *Subordinate* responses revealed a significant main effect of age ($H = 8$; $p < 0.05$). More precisely, a polynomial quadratic ("U shape") regression fitted best the relationship between age and the proportion of *Superordinate/Subordinate* responses ($F_{2,42} = 6.28$; $p < 0.01$; $R^2 = 0.23$; Figure 4b). Post-hoc Mann–Whitney

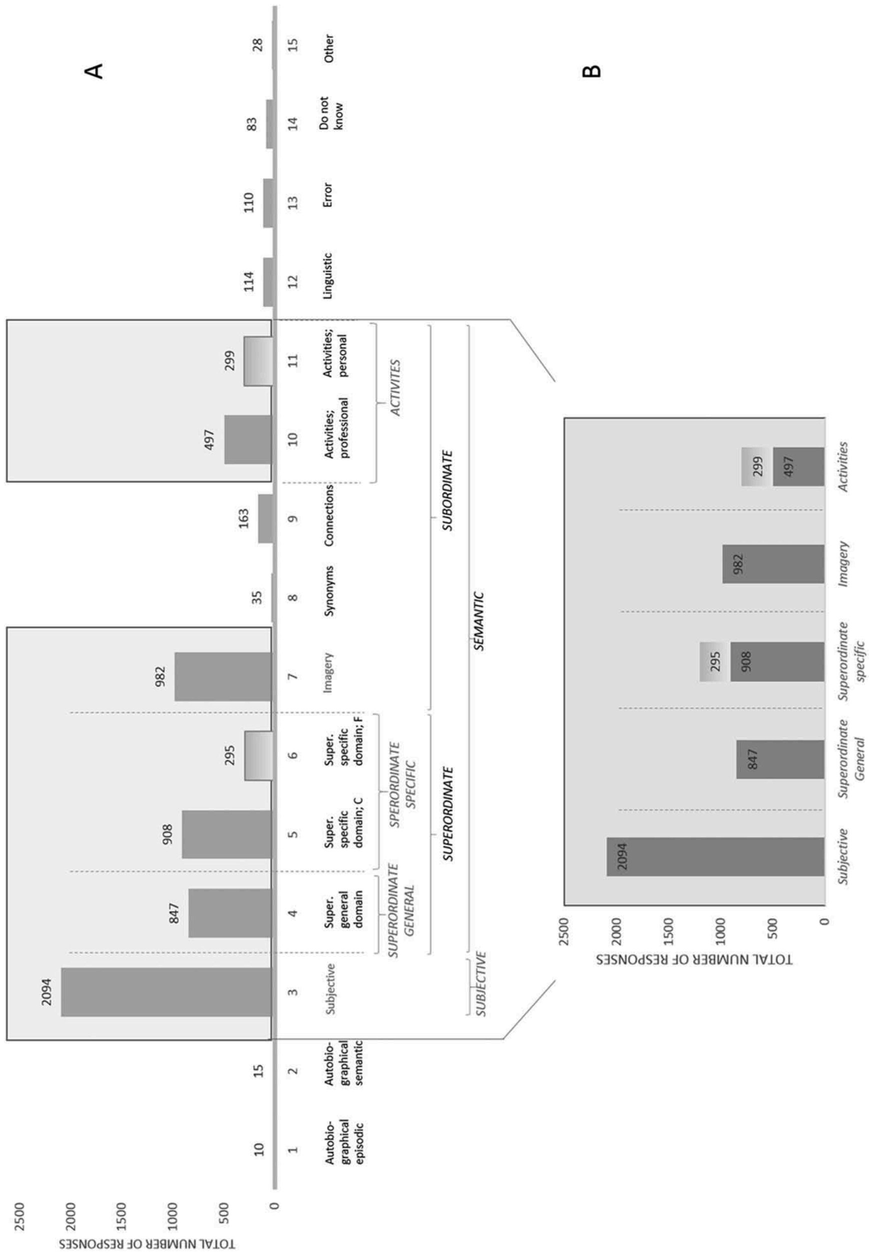

Figure 3. Total number of response for the 15 categories amongst the 45 participants. Episodic autobiographic; semantic autobiographic; subjective; superordinate general domain; superordinate-specific domain context (C); superordinate-specific domain function (F); imagery; synonym; connections; professional activities; personal activities; linguistic; error; do not know; other. (a) shows all initial categories; (b) shows the remaining categories analyzed.

U tests showed that the 60–70s group gave a significantly larger proportion of *Superordinate* responses (i.e. more imprecise) than the 20–30s ($z = -2.4$; $p < 0.05$; $d = 0.97$) and the 40–50s ($z = -2.5$; $p < 0.05$; $d = 1.1$). A significant age effect was also found on the proportion between

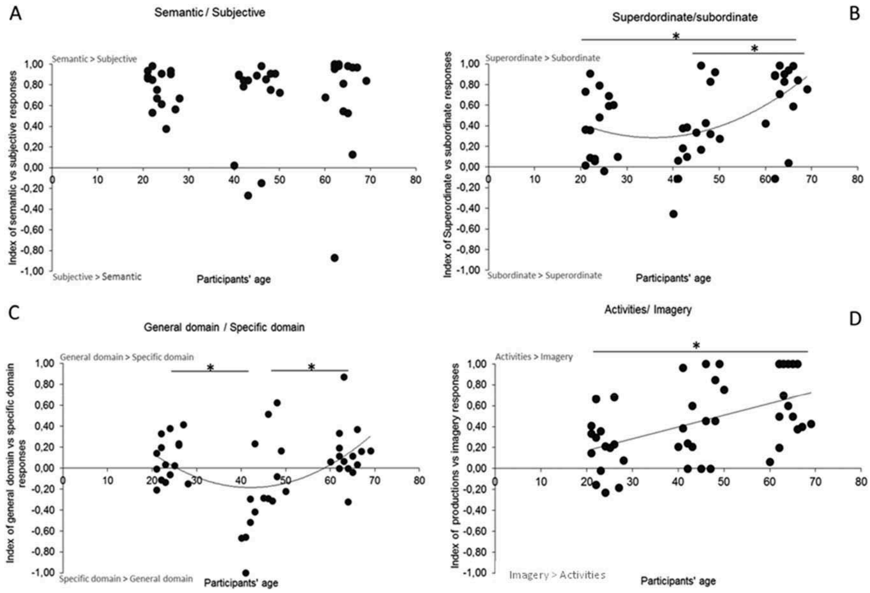

Figure 4. Response rate according to age. Each dot is a single subject. a: rate of semantic vs. subjective response; b: rate of superordinate vs. subordinate response; c: rate of superordinate general domain vs superordinate-specific domain response; d: rate of activities vs. imagery response. The curves show the regression analyses if they were significant.

Superordinate responses of *General Domain* and *Specific Domain* (X^2 (2, N = 45) = 7.76; $p < 0.05$), following a "U shape" regression too ($F_{2,42} = 4.26$; $p < 0.05$; $R^2 = 0.17$; Figure 4c). The 40–50s gave a significantly larger proportion of *Specific Domain* responses than the 20–30s (z = 2.2; $p < 0.05$; d = 0.88) and the 60–70s (z = −2.5; $p < 0.05$; d = 1.1), which means that this group gave the most precise responses. The proportion between *Imagery* and *Activities* responses was also related to age (X^2 (2, N = 45) = 11.6; $p < 0.01$). A linear regression fitted best the relationship between age and the proportion of *Imagery/Activities* responses ($F_{1,43} = 15.4$; $p < 0.001$; $R^2 = 0.27$; Figure 4d). Post-hoc Mann–Whitney U tests revealed that the younger group gave significantly more *Imagery* responses than the older one (z = −3.4; $p < 0.01$; d = 1.6). As the older group seems to be less precise, we verified whether older people gave more *Error* or *Do not know* responses. No age effect was found for either (X^2 (2, N = 45) = 4.15; $p = 0.13$).

Reaction times

Analyses conducted on participants' median reaction time demonstrated a main effect of response category on response speed (F (4, 72) = 6.47; p < 0.001). Post-hoc Tukey test showed that *Superordinate General Domain* responses were faster than *Subjective* (p < 0.05; d = 0.7) and *Activities* responses (p < 0.001; d = 0.9). There was a trend concerning a main effect of age on responses time (F (2, 18) = 3.26; p = 0.06) but no interaction effect (responses category x age) was evidenced (F (8, 72) = 1.58; p = 0.1), as summarized in Figure 5.

Familiarity rankings

We counted the number of celebrities with a familiarity score superior to 2 (on a 9 points scale) in each group to verify that a similar number of celebrities were familiar in each

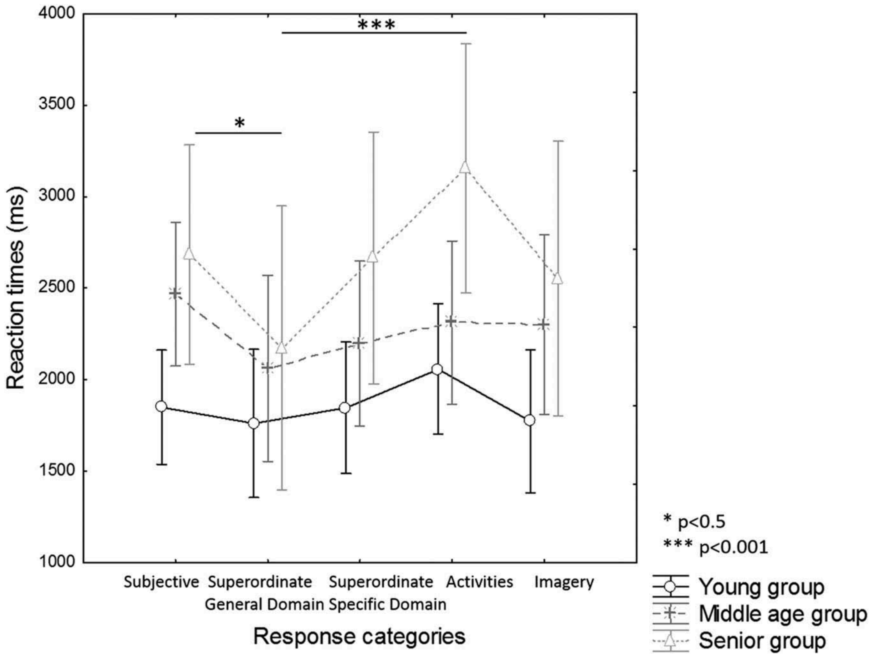

Figure 5. Reaction time according to group of age and response category.

group. Ninety-two percent of the celebrities were scored higher than 2 in the youngest group; 97.8% in the middle-age group and 94.3% in the oldest group. Before further analyzing familiarity ranking, ranks were standardized for each participant according to their average familiarity ranking. Familiarity rankings for categories represented by less than five responses per participant were discarded.

Analyses conducted on participants' average familiarity rankings demonstrated a main effect of response category related to familiarity ranking ($F(4, 72) = 6.41$; $p < 0.001$). Post-hoc Tukey test evidenced that least precise responses (*Superordinate General Domain)* were produced for items significantly less familiar than *Superordinate Specific Domain* ($p < 0.01$; $d = 0.78$) and *Activities* ($p < 0.01$; $d = 1.1$) responses: the more familiar an item was, the more precise the response was. Neither age effects ($F(4, 72) = 6.47$; $p > 0.1$) nor interactions (responses category x age) were evidenced ($F(8, 72) = 1.8$; $p = 0.09$) (Figure 6).

Discussion

In this study, we investigated if and how the structure of semantic memory for famous people changes with age. We used a highly original design where subjects had to produce as fast as they could (a reaction time feedback was provided for each answer) the first word that came to their mind following the presentation of a famous name. We were thus able to analyze the first idea associated with the name.

We show that during this semantic association task for celebrities, responses can be grouped into 5 main categories (>90% of the responses): *Subjective, Superordinate General Domain, Superordinate Specific Domain, Imagery*, and *Activities*. Among these, *Superordinate* responses are the most frequent ones. Interestingly, the *Subjective* and

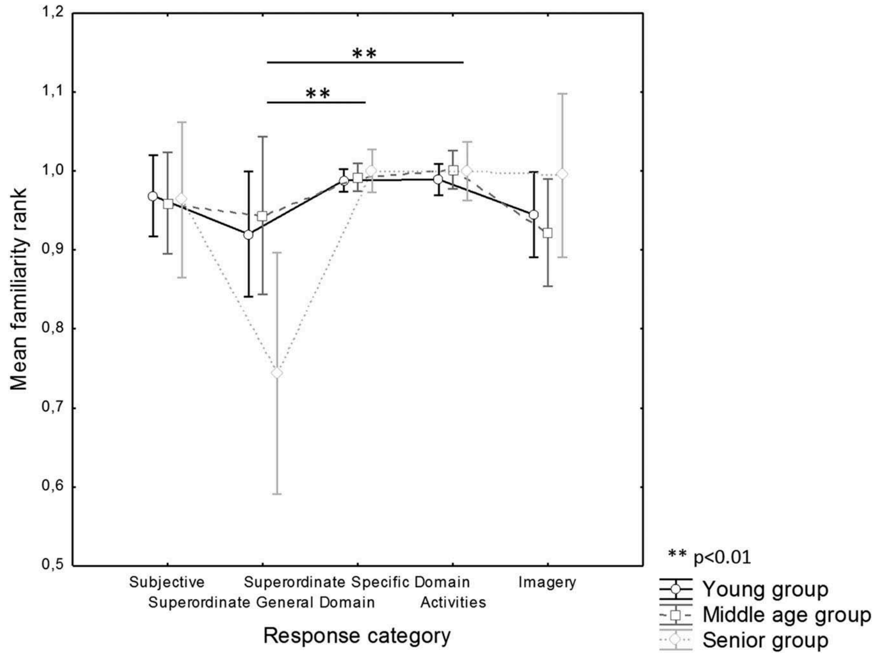

Figure 6. Mean familiarity rank according to group of age and response category.

Imagery categories probably would not have been anticipated without the methodology we used, and indicate that semantic memory for a person may be more complex than usually thought. Age had an effect on the type of response since elders gave less precise responses (more superordinate compared to subordinate responses) and more imagery responses compared to *Activities* responses. Among the three groups, response time was highly related to category: more precise responses lead to longer response times. Similarly, most precise responses were linked to the highest family ranking. However, no interaction with the age of these two factors was found.

Interest of the current taxonomy

An original experimental design and taxonomy of responses were created for the current study. Both seem reliable and provide perspectives. As the instruction is not demanding, many responses could be collected. Furthermore, there were few responses that could be considered as errors, indicating that subjects of all age could perform the task easily.

Most studies based on associative tasks used a paradigmatic/syntagmatic classification to analyze responses, while, in the current study, the type of semantic response was taken into account. In other words, we did not focus on the exact answer given (i.e., performance) but on its semantic relationship with the cue name. Using this method, and because in our study subjects were perfectly matched for the number of years of education, we avoid a bias cited by many authors related to the fact that responses vary because of lexical, cultural and life experience differences (Hirsh & Tree, 2001; Nelson, McEvoy, & Schreiber, 2004).

This lead to the conception of a person-based nomenclature based on 6480 responses. Since this type of work has never been carried out before, categories of responses were created a posteriori, according to participants' responses. Many categories (15 at first) were created to cover every kind of possible response. The usefulness of this first taxonomy seems clear as shown by a good inter-rater Cohen's kappa. However, more than 90% of the responses could be classified in just five different categories after reduction (categories with less than 5% of responses were discarded or pooled), on which we then focused in this study. Importantly, such results mean that the taxonomy and classification may be even simpler in future work.

Unsurprisingly given the nature of the cue, most associations were semantic. However, the number of *Subjective* responses (>30%) seems to suggest that memory for famous people is not only about semantic facts, but also about opinions and feelings. Semantic memory is usually thought to be culturally shared. However, this finding suggests that there are also idiosyncratic components closely related to personal knowledge, a bit like autobiographical memory also encompasses a personal semantic component which is not shared with others (Renoult, Davidson, Palombo, Moscovitch, & Levine, 2012). This also appears in line with previous work proposing that autobiographical significance could be an organizing principle of both episodic and semantic memory, including for famous people (Westmacott, Black, Freedman, & Moscovitch, 2004; Westmacott & Moscovitch, 2003).

Likewise, the number of *Imagery* responses (15%) suggests that in some instances characteristic visual features can be strongly connected to famous people. Although this can be taken as a fact, it differs largely from the propositional information that semantic memory is usually reduced to. This opens the way for other studies focusing on the consistency of these *Subjective* and *Imagery* responses across subjects in order to assess how widely these are shared.

It is noteworthy that the use of syntagmatic versus paradigmatic categories, similarly to those Burke & Peters had used, would not have been efficient in our study. First, only a few responses would have been considered as syntagmatic (*Connections* and *Linguistic* responses, which represented about 4% of all responses). Second, as previously mentioned, some categories would not have been analyzed (e.g., *Imagery*). It, therefore, brings support for the creation of a new taxonomy. Moreover, the effect sizes we report, because many were considered as large, may be considered as a further support in favor of our analyses.

Importantly for the validity of the current taxonomy, we aimed at controlling that all participants knew the celebrities equivalently. To achieve this (as was reported in the Methods section), we run a preliminary study on 252 participants of different ages using a list of 643 famous names and chose for the current study the names known by at least 99% of the 252 participants. All participants of the current study also underwent a questionnaire of media exposure, and no difference was observed between groups. Furthermore, all three groups also had a similar number of years of education. Importantly, there was no difference in the number of "don't know" or "errors" responses across the three groups. In addition, the number of celebrities with a familiarity ranking superior to 2 (on a 9 points scale) in each group was similar. A major effect of a difference of familiarity with the celebrities thus appears unlikely in this study.

Age effect on semantic memory for famous people

No age effect was found regarding "*Errors*" and "*Do not know*" responses, which means that elders were not less efficient. Similarly, there was only a marginal trend for elders to be slower than younger age groups. Elders are thus able to provide plausible responses as well as, and at a similar speed, than other younger age group.

Similarly, the three groups had a similar behavior regarding RT: the more semantically precise a response was, the slower it was. Current results appear consistent with previous literature. Using common words, Burke and Peters (1986) found longer reaction time with aging but a similar pattern within each group: high associations frequency were correlated with faster responses time, presumably because they involved less effortful processes. We may suppose that more specific information (i.e. *Activities* responses) require more retrieval effort than general information and thus take more time. In contrast, as instructions in our study were to answer as quickly as possible, it may explain the high proportion of *Superordinate* responses, which may be activated more rapidly. With this regard, *Subjective* reaction times seem quite surprising. Indeed, we may presume they involved intuitive and rapid reaction times, while there were the second longest responses (after *Activities* responses). It may, therefore, be speculated that participants gave *Subjective* responses when they did not find any other type of response in the context of time pressure.

Likewise, all groups followed a similar pattern regarding familiarity. Results indicated that the more familiar an item was, the more precise the response was. Participants may have favored more precise responses only when they were familiar with the item (i.e., when they were confident in giving an accurate and precise response reasonably fast), while they stayed more general in other cases. This has not been taken into account in the previous literature but seems preserved with age.

Thus, elders appear sensitive to similar factors than younger subjects (access to more precise categories and less familiar items requires longer time). This finding seems to corroborate the idea that use of person-specific semantic memory does not change much with age. However, do elders provide the same type of responses?

Comparisons demonstrated that elders were less precise and gave more *Superordinate General Domain* responses (*Superordinate/Subordinate* comparison) than the younger and middle-age group. This result was confirmed in a further analysis in which the elders were again less precise (*General Domain/Specific Domain* comparison) than the middle age group (but not different from the younger group). Furthermore, *Imagery* responses followed a linear regression: it was favored by the younger but less by elders. Indeed, no elders gave more *Imagery* than *Activities* responses, and some elders did not give any *Imagery* response at all during the task (Figure 4). It thus clearly appears that the elderly, although having a performance similar to the other groups, in fact, produce more general, or less detailed, responses. This could be due to either a change in the organization of the semantic structure or to difficulties accessing detailed semantic knowledge given the fact that we used a speeded task. However, the use of a speeded task may also help mimicking what occurs during social interaction when the time available to find relevant semantic information is usually short when conversations go on. The oldest group also differed from the youngest in that they relied less on imagery than the younger group. This again could be due to difficulties accessing on-line to visual representation, whereas verbal associations might be easier to retrieve, or associated more strongly, to target names of celebrities. Such results are probably linked to the task we used and differ from previous studies showing significant decline over the age of 75 (Nilsson, 2003) or 80 (Langlois et al., 2009). Indeed, using a word-association task and assessing knowledge for celebrities may evidence more changes due to aging.

Haslam et al. (2004) used a series of questions to probe knowledge about celebrities. They found that older participants (50–65 years old) produced more accurate semantic information than younger ones (20–35 years old). However, as the authors acknowledge themselves, this was probably due to higher familiarity of the older participant with the test material. This study, as many others, thus mainly assessed *quantitative* aspects of the semantic memory for celebrities in both young and old participants. In our study, we find that elders easily produce semantic knowledge associated with a famous name, similarly to what was predicted by the Haslam study. However, the taxonomy that we propose allows for a more *qualitative* assessment of the responses and provides clues about the structure of semantic memory in our participants that was not offered by previous experimental paradigms and analyses.

The current taxonomy showed that the group that provides the most detailed responses is the middle-age group. This could be related to a bias in the selection of the celebrities we used. Although we tried to avoid this (see Methods or similar difficulties in Haslam et al., 2004), the number of faces judged familiar (rating>2) was a bit higher in the middle-age group. However, this can also be related to an optimum age when the level of semantic information about celebrities is high and access to details within this store is easy.

As we focused on the first response that came to mind in this protocol, we focused on the first *available* information. This is important to remember since this first available information might only partially be related to the structure of stored information subjects might have. The study of stored information might provide different results about the evolution of the structure of person-specific semantic memory across age than those reported in this study.

Perspectives

It would be crucial to replicate these analyses on a larger sample to reinforce current conclusions, possibly using a reduced number of stimuli to shortened future studies. It would also be important to include an older group of participants, to see if they would differ from middle-aged and young-old adults. Indeed, it seems necessary to compare participants of the same age as other studies (>70), to verify if the structure of semantic memory continues to evolve with age.

As many studies have analyzed access to names and semantic information from voices or faces (Barsics, 2014 for a review), it would also be interesting to carry out the same association task using different inputs (famous faces, for example), to see if the access to the first information varies according to the modality. Along these same lines, several studies have emphasized that proper names may have lexical characteristics that could impact recognition and recall (Brandt, Gardiner, & Macrae, 2006; Hanley & Chapman, 2008). It would be interesting to assess if similar effects of lexical characteristics are also observed in speeded paradigms such as the one used in this study.

Moreover, a full understanding of the structure of semantic memory and its evolution with age would probably require to ask participants to provide as much information as they can about a celebrity, without time pressure, and then analyze their production. This was not the purpose of this study, which aimed first at assessing a simple and quick test based on a stimulus and a response. It would be a further step to understand the organization of semantic information during aging.

Finally, person-based semantic memory is commonly impaired in Alzheimer's disease (e.g., Delazer, Semenza, Reiner, Hofer, & Benke, 2003; Joubert et al., 2008; Predovan et al., 2014) and in patients at the prodromal stage of Alzheimer's disease (Barbeau et al., 2012; Dudas, Clague, Thompson, Graham, & Hodges, 2005). Better understanding its organization could help to understand why and how person-specific memory is particularly fragile early in neurodegenerative diseases (Amieva et al., 2008). Our paradigm could be used in this framework. First, as elders were not slower, we may assume that response time could be a measure to discriminate normal from pathological aging. Second, we may suppose that patients' early semantic impairment changes their semantic network structure, leading to a pattern of responses different from healthy elders, maybe in the sense of more irrelevant responses or responses so general that they could be clearly dissociated from the production of healthy elders.

Conclusion

We developed an original word association paradigm as well as a new taxonomy to study person-specific semantic memory. Results appear promising but should be replicated on a larger group. They show that although elders performed quite similarly to a younger and middle age group, their responses were less precise. Future work should aim at identifying the origin of this change.

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References

Amieva, H., Le Goff, M., Millet, X., Orgogozo, J. M., Pérès, K., Barberger-Gateau, P., … Dartigues, J. F. (2008). Prodromal Alzheimer's disease: Successive emergence of the clinical symptoms. *Annals of Neurology*, *64*(5), 492–498. doi:10.1002/ana.21509

Bahrick, H. P., Bahrick, P. O., & Wittlinger, R. P. (1975). Fifty years of memory for names and faces: A cross-sectional approach. *Journal of Experimental Psychology: General*, *104*(1), 54–75. doi:10.1037/0096-3445.104.1.54

Barbeau, E. J., Didic, M., Joubert, S., Guedj, E., Koric, L., Felician, O., … Ceccaldi, M. (2012). Extent and neural basis of semantic memory impairment in mild cognitive impairment. *Journal of Alzheimer's Disease*, *28*(4), 823–837. doi:10.3233/JAD-2011-110989

Barsics, C. (2014). Person recognition is easier from faces than from voices. *Psychologica Belgica*, *54*(3), 244–254. doi:10.5334/pb.ap

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry*, *4*, 561–571. doi:10.1001/archpsyc.1961.01710120031004
Brambati, S. M., Benoit, S., Monetta, L., Belleville, S., & Joubert, S. (2010). The role of the left anterior temporal lobe in the semantic processing of famous faces. *NeuroImage*, *53*(2), 674–681. doi:10.1016/j.neuroimage.2010.06.045
Brandt, K. R., Gardiner, J. M., & Macrae, C. N. (2006). The distinctiveness effect in forenames: The role of subjective experiences and recognition memory. *British Journal of Psychology*, *97*(2), 269–280. doi:10.1348/000712605X73685
Bruce, V., & Young, A. (1986). Understanding face recognition. *British Journal of Psychology*, *77*(Pt 3), 305–327.
Burke, D. M., & Peters, L. (1986). Word associations in old age: Evidence for consistency in semantic encoding during adulthood. *Psychology and Aging*, *1*(4), 283–292. doi:10.1037/0882-7974.1.4.283
Burke, D. M., White, H., & Diaz, D. L. (1987). Semantic priming in young and older adults: Evidence for age constancy in automatic and attentional processes. *Journal of Experimental Psychology. Human Perception and Performance*, *13*(1), 79–88. doi:10.1037/0096-1523.13.1.79
Burton, A. M., Bruce, V., & Johnston, R. A. (1990). Understanding face recognition with an interactive activation model. *British Journal of Psychology (London, England : 1953)*, *81*(3), 361–380. doi:10.1111/bjop.1990.81.issue-3
Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*(1), 155–159. doi:10.1037/0033-2909.112.1.155
Coronges, K. A., Stacy, A. W., & Valente, T. (2007). Structural comparison of cognitive associative networks in two populations. *Journal of Applied Social Psychology*, *37*(9), 2097–2129. doi:10.1111/jasp.2007.37.issue-9
Craik, F. I. M. (1994). Memory changes in normal aging. *Current Directions in Psychological Science*, *3*(5), 155–158. doi:10.1111/1467-8721.ep10770653
Darling, S., & Valentine, T. (2005). The categorical structure of semantic memory for famous people: A new approach using release from proactive interference. *Cognition*, *96*(1), 35–65. doi:10.1016/j.cognition.2004.03.007
Delazer, M., Semenza, C., Reiner, M., Hofer, R., & Benke, T. (2003). Anomia for people names in DAT - Evidence for semantic and post-semantic impairments. *Neuropsychologia*, *41*(12), 1593–1598. doi:10.1016/S0028-3932(03)00116-7
Dudas, R. B., Clague, F., Thompson, S. A., Graham, K. S., & Hodges, J. R. (2005). Episodic and semantic memory in mild cognitive impairment. *Neuropsychologia*, *43*(9), 1266–1276. doi:10.1016/j.neuropsychologia.2004.12.005
Fleischman, D. A. (2007). Special issue: Original article repetition priming in Aging and Alzheimer ' S disease : An integrative review and future directions. *Cortex*, *43*(7), 889–897. doi:10.1016/S0010-9452(08)70688-9
Hanley, J. R., & Chapman, E. (2008). Partial knowledge in a tip-of-the-tongue state about two- and three-word proper names. *Psychonomic Bulletin and Review*, *15*(1), 156–160.
Haslam, C., Kay, J., Hanley, J. R., & Lyons, F. (2004). Biographical knowledge : Modality-specific or modality- neutral? *Cortex*, *40*(2), 451–466.
Hertzog, C., Cooper, B. P., & Fisk, A. D. (1996). Aging and individual differences in the development of skilled memory search performance. *Psychology and Aging*, *11*(3), 497–520. doi:10.1037/0882-7974.11.3.497
Hirsh, K. W., & Tree, J. J. (2001). Word association norms for two cohorts of British adults. *Journal of Neurolinguistics*, *14*(1), 1–44. doi:10.1016/S0911-6044(00)00002-6
Horn, J. L., & Cattell, R. B. (1967). Age differences in fluid and crystallized intelligence. *Acta Psychologica*, *26*(2), 107–129. doi:10.1016/0001-6918(67)90011-X
James, L. E. (2006). Specific effects of aging on proper name retrieval: Now you see them, now you don't. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *61*(3), P180–P183. doi:10.1093/geronb/61.3.P180

Joubert, S., Felician, O., Barbeau, E., Ranjeva, J. P., Christophe, M., Didic, M., … Ceccaldi, M. (2006). The right temporal lobe variant of frontotemporal dementia: Cognitive and neuroanatomical profile of three patients. *Journal of Neurology*, *253*(11), 1447–1458. doi:10.1007/s00415-006-0232-x

Joubert, S., Felician, O., Barbeau, E. J., Didic, M., Poncet, M., & Ceccaldi, M. (2008). Patterns of semantic memory impairment in mild cognitive impairment. *Behavioural Neurology*, *19*(1–2), 35–40. doi:10.1155/2008/859657

Komes, J., Schweinberger, S. R., & Wiese, H. (2014). Fluency affects source memory for familiar names in younger and older adults: Evidence from event-related brain potentials. *NeuroImage*, *92*, 90–105. doi:10.1016/j.neuroimage.2014.02.009

Langlois, R., Fontaine, F., Hamel, C., & Joubert, S. (2009). The impact of aging on the ability to recognize famous faces and provide biographical knowledge of famous people. *Canadian Journal on Aging = La Revue Canadienne Du Vieillissement*, *28*(4), 337–345. doi:10.1017/S0714980809990183

Levine, B., Svoboda, E., Hay, J. F., Winocur, G., & Moscovitch, M. (2002). Aging and autobiographical memory: Dissociating episodic from semantic retrieval. *Psychology and Aging*, *17*(4), 677–689. doi:10.1037/0882-7974.17.4.677

Lyons, F., Hanley, J. R., & Kay, J. (2002). Anomia for common names and geographical names with preserved retrieval of names of people: A semantic memory disorder. *Cortex; A Journal Devoted to the Study of the Nervous System and Behavior*, *38*(1), 23–35. doi:10.1016/S0010-9452(08)70636-1

McNair, D. M., & Kahn, R. J. (1983). Self-assessment of cognitive deficits. In T. Crook, S. Ferris, & R. Bartus (Eds.), *Assessment in geriatric psychopharmacology,* pp: 1569–1573. New Canaan (CT): Mark Powley Associates.

Miceli, G., Daniele, A., Esposito, T., & Magarelli, M. (2000). Selective deficit for people's names following left temporal damage : An impairment of domain - specific conceptual knowledge. *Cognitive Neuropsychology*, *17*(6), 489–516. doi:10.1080/026432900501106299

Nelson, D. L., McEvoy, C. L., & Schreiber, T. A. (2004). The University of South Florida free association, rhyme, and word fragment norms. *Behavior Research Methods, Instruments, & Computers : A Journal of the Psychonomic Society, Inc*, *36*(3), 402–407. doi:10.3758/BF03195588

Nielson, K. A., Douville, K. L., Seidenberg, M., Woodard, J. L., Miller, S. K., Franczak, M., … Rao, S. M. (2006). Age-related functional recruitment for famous name recognition: An event-related fMRI study. *Neurobiology of Aging*, *27*(10), 1494–1504. doi:10.1016/j.neurobiolaging.2005.08.022

Nilsson, L.-G. (2003). Memory function in normal aging. *Acta Neurologica Scandinavica*, *107*(179), 7–13. doi:10.1034/j.1600-0404.107.s179.5.x

Nyberg, L., Maitland, S. B., Rönnlund, M., Bäckman, L., Dixon, R. A., Wahlin, A., & Nilsson, L.-G. (2003). Selective adult age differences in an age-invariant multifactor model of declarative memory. *Psychology and Aging*, *18*(1), 149–160. doi:10.1037/0882-7974.18.1.149

Park, D. C., Lautenschlager, G., Hedden, T., Davidson, N. S., Smith, A. D., & Smith, P. K. (2002). Models of visuospatial and verbal memory across the adult life span. *Psychology and Aging*, *17*(2), 299–320. doi:10.1037/0882-7974.17.2.299

Predovan, D., Gandini, D., Montembeault, M., Rouleau, I., Bherer, L., Joubert, S., & Brambati, S. M. (2014). Loss of person-specific knowledge in Alzheimer's disease: Evidence from priming. *Neurocase*, *20*(3), 263–268. doi:10.1080/13554794.2013.770876

Rendell, P. G., Castel, A. D., & Craik, F. I. M. (2005). Memory for proper names in old age: A disproportionate impairment? *The Quarterly Journal of Experimental Psychology. A, Human Experimental Psychology*, *58*(1), 54–71. doi:10.1080/02724980443000188

Renoult, L., Davidson, P. S. R., Palombo, D. J., Moscovitch, M., & Levine, B. (2012). Personal semantics: At the crossroads of semantic and episodic memory. *Trends in Cognitive Sciences*, *16*(11), 550–558. doi:10.1016/j.tics.2012.09.003

Schaie, K. W. (2005). What can we learn from longitudinal studies of adult development? *Research in Human Development*, *2*(3), 133–158. doi:10.1207/s15427617rhd0203_4

Schneider, W., Eschman, A., & Zuccolotto, A. (2012). E-prime user's guide. Pittsburgh: Psychology Software Tools, Inc.

Spielberger, C. D. (1983). *State Trait Anxiety Inventory for adults* (rev ed.). Palo Alto (CA): Consulting Psychologists Press.

Thompson, S. A., Graham, K. S., Williams, G., Patterson, K., Kapur, N., & Hodges, J. R. (2004). Dissociating person-specific from general semantic knowledge: Roles of the left and right temporal lobes. *Neuropsychologia*, *42*(3), 359–370. doi:10.1016/j.neuropsychologia.2003.08.004

Valentine, T., Brennen, T., & Brédart, S. (1996). *The cognitive psychology of proper names*. London, England: Routledge.

Wechsler, D. (1997). *WAIS-III: administration and scoring manual*. San Antonio, Texas: Harcourt Brace & Company.

Westmacott, R., Black, S. E., Freedman, M., & Moscovitch, M. (2004). The contribution of autobiographical significance to semantic memory: Evidence from Alzheimer's disease, semantic dementia, and amnesia. *Neuropsychologia*, *42*(1), 25–48. doi:10.1016/S0028-3932(03)00147-7

Westmacott, R., & Moscovitch, M. (2003). The contribution of autobiographical significance to semantic memory. *Memory & Cognition*, *31*(5), 761–774. doi:10.3758/BF03196114

Wiese, H., & Schweinberger, S. R. (2011). Accessing semantic person knowledge: Temporal dynamics of nonstrategic categorical and associative priming. *Journal of Cognitive Neuroscience*, *23*(2), 447–459. doi:10.1162/jocn.2010.21432

Wiese, H., & Schweinberger, S. R. (2015). Getting connected: Both associative and semantic links structure semantic memory for newly learned persons. *The Quarterly Journal of Experimental Psychology*, *68*(11), 2131–2148. doi:10.1080/17470218.2015.1008526

Zakzanis, K. K. (2001). Statistics to tell the truth, the whole truth, and nothing but the truth : Formulae, illustrative numerical examples, and heuristic interpretation of effect size analyses for neuropsychological researchers. *Archives of Clinical Neuropsychology*, *16*, 653–667. doi:10.1093/arclin/16.7.653