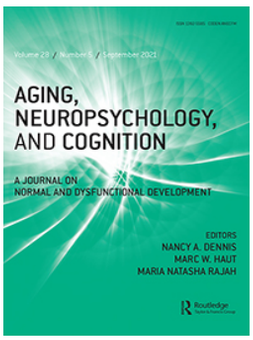

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Dillon H. Murphy & Alan D. Castel

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Age-related similarities and differences in the components of semantic fluency: analyzing the originality and organization of retrieval from long-term memory

Dillon H. Murphy and Alan D. Castel

Psychology Department, University of California Los Angeles, Los Angeles, CA, USA

ABSTRACT

The present study investigated age-related differences in retrieval from long-term memory using a semantic fluency task in which participants recalled animals during a 5-minute retrieval period. We evaluated the relative uniqueness of items and their output position within the retrieval process to further elucidate how younger and older adults access and retrieve semantic knowledge in long-term memory. Although older (n = 96, aged 56-79, M = 62.44) and younger adults (n = 98, aged 18-27, M = 23.44) scored similarly for retrieval fluency and originality, these abilities tended to decline when we analyzed age as a continuous variable, indicating some preservation in earlier adulthood, but impairment in older age. Additionally, participants tended to recall common, more easily accessible items before unique, less accessible items, and this pattern was more prominent in older adults. Thus, there are both similarities and differences in semantic fluency in older age.

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KEYWORDS
Semantic fluency; originality; aging; long-term memory; retrieval

To assess the retrieval ability of knowledge from semantic long-term memory, fluency tasks instruct participants to generate items from a given category (e.g., animals) and have often been used to evaluate differences in executive functioning and control in both cognitive and neuropsychological research. Fluency tasks are usually scored based on the number of correct items retrieved and in these tasks, given that older adults have lived longer and possess more life experience, one might expect them to generate more items than younger adults. However, compared to younger adults, older adults often show a deficit in semantic long-term memory retrieval such that younger adults retrieve more items (Rodríguez-Aranda & Martinussen, 2006; Troyer et al., 1997). This may be due to many of the memory deficits accompanying aging (cf., Hess, 2005; Park & Festini, 2017; Salthouse, 2010) but the organization of retrieval may also be an important factor.

When retrieving items in a semantic fluency task, exemplars are not usually generated in random order. Largely beginning with the work of Bousfield and Sedgewick (1944), many studies have suggested that participants use a two-stage cyclical process as they search for items in semantic long-term memory (e.g., Gruenewald & Lockhead, 1980; Herrmann & Pearle, 1981; Troyer et al., 1997; Wixted & Rohrer, 1994). In the first stage, known as switching, participants self-generate cues for categories of items. The second

CONTACT Dillon H. Murphy dmurphy8@ucla.edu

stage, known as clustering, involves the generation of successive items within a category. For example, in a fluency task with the category "animals," participants typically start by searching for a general category of animals (e.g., pets) and subsequently generate a cluster of items within that category (e.g., cat, dog, hamster, etc.). They then switch to a different category and search for items in that category and repeat the process until each category has been exhausted of items.

Both clustering and switching are important determinants of fluency performance (Unsworth et al., 2011), however, there appear to be minimal age-related differences in clustering (Troyer et al., 1997). Rather, older adults' poorer performance has been credited to less switching (Troyer et al., 1997; but see Mayr, 2002). Since switching uses the associative links between items to generate new categories of items (e.g., the retrieval of "brown bear," an animal typically found in the forest, may serve as a cue for the retrieval of "polar bear," an animal commonly found in a very different environment, as well as other animals from that environment like "penguin"), older adults' associative memory deficits (Naveh-Benjamin, 2000) may be responsible for their decreased switching and subsequent poorer performance. Furthermore, Wingfield and Kahana (2002) have demonstrated age-related differences in self-initiated retrieval such that older adults demonstrate deficits in the control processes required to generate cues to initiate a search for items, consistent with spared semantic memory but declines in episodic retrieval in older adults. Thus, older and younger adults tend to generate a similar number of successive items from a category before switching to a new category but older adults do less switching between categories and/or generating new categories than younger adults.

While fluency scores concern only the quantity of items retrieved, the accessibility of retrieved items may play a role in determining fluency performance and can be operationalized via a metric known as originality. Measures of originality capture the relative uniqueness of generated items and when scoring originality via statistical infrequency (see Dumas & Dunbar, 2014; Hocevar, 1979; Silvia, 2008, 2011 for various methods), if only a few participants in the entire sample generate a particular item, that item would score highly for originality while more common items would receive lower scores. Therefore, common items receiving low originality scores may be more accessible or retrievable in semantic long-term memory than unique items receiving high originality scores.

Previous work suggests that participants who retrieve many original items also tend to retrieve more items overall (e.g., Dumas & Dunbar, 2014; Silvia, 2008), however, others have suggested that fluency and originality are highly separable constructs (Benedek et al., 2006; Hocevar, 1980). Regardless of the relationship between fluency and originality, research has failed to thoroughly examine the organization of semantic memory retrieval or age-related differences in originality. Specifically, the retrieval of less common or original items within the overall retrieval process as well as within participants' categories and clusters of items should be examined to further elucidate how younger and older adults retrieve semantic knowledge from long-term memory. The organization of retrieval may be an important determinant of performance such that the retrieval of common, easily accessible items may facilitate the retrieval of additional items, leading to greater scores. On the contrary, the retrieval of more unique items early in the retrieval period may produce fewer cues to assist in the retrieval of additional items leading to a more unique set of responses, but fewer items overall.

The current study

In the present study, we administered a semantic fluency task to better elucidate the strategies and processes needed for successful performance and why individuals differ in performance. Specifically, we were interested in how younger and older adults differ in originality and the order with which they generate items as a function of item retrieval frequency. In fluency tasks, participants typically retrieve items quickly in the beginning, but their rate of responses slows considerably as the task endures (Crowe, 1998). In light of this, researchers have used fluency tasks of varying lengths (e.g., 1 minute: Unsworth et al., 2011; 5 minutes:, Unsworth et al., 2013; 15 minutes: Rosen & Engle, 1997), however, in the 1 minute version of this task, participants may not have enough time to fully exhaust each cluster. In the present study, we gave participants 5 minutes to recall items to ensure that participants had plenty of time to maximize their output by exhausting each category and also retrieving less accessible, unique items.

Previous work has indicated that participants retrieve commonly outputted items before less common items (Bousfield & Barclay, 1950; Bousfield et al., 1956), however, previous research has not investigated age-related differences in this trend or if the relationship between output position and output frequency occurs within categories and clusters of responses. In the present study, we suspected that both younger and older adults would be systematic in their retrieval by first retrieving common, easily accessible items before unique, less accessible items and this may occur within each category, cluster, and/or holistically. For example, within a specific category (e.g., pets), participants may retrieve more easily accessible items, do some switching, then retrieve less accessible items from the same category. Additionally, within each cluster, participants may generate accessible items before less accessible ones and then switch to a different cluster and follow the same pattern. Alternatively, since the rate of item production decreases as the task endures (e.g., Gruenewald & Lockhead, 1980; Wixted & Rohrer, 1994), participants may begin by retrieving as many easily accessible items as they can in a cluster until those items assist in generating a cue for another category with which they will retrieve more easily accessible items. Then, once all categories have been exhausted of easily accessible items, participants may begin searching for less accessible, original items, generating them toward the end of their output. Regardless of whether participants retrieve common items before more unique items within each category, cluster, and/or holistically, we expected this tendency to be more pronounced in younger adults. Specifically, the associative links between common items may aid in the retrieval of additional items in younger adults, leading to better fluency scores but older adults' associative memory deficits (Naveh-Benjamin, 2000) may decrease their ability to use the associative links between items to generate additional items.

In terms of originality, older adults have good semantic memory and often have greater vocabulary than younger adults (Ben-David & Erel, 2015; Kavé & Halamish, 2015). Furthermore, previous work examining connected speech has revealed that older adults generate more low-frequency words compared to younger adults (e.g., Dennis & Hess, 2016; Horton et al., 2010; Kavé et al., 2009). However, age-related differences in the frequency of retrieved items have not been examined in semantic fluency tasks and since we expect older adults to be less able to generate retrieval cues, resulting in poorer

fluency performance, we also expected older adults to retrieve fewer original items compared to younger adults.

Method

Participants

After exclusions, participants were 98 younger adults (age range: 18–27, M = 23.44, SD = 2.07) and 96 older adults (age range: 56–79, M = 62.44, SD = 4.75) recruited from Amazon's Mechanical Turk, a Web site that allows users to complete small tasks for pay. Participants received 1.50 USD for completing the experiment, which took approximately 10 minutes. All participants were required to have completed a high school degree in the United States to participate. Participants were excluded from analysis if they admitted to cheating (e.g., looking up answers) in a post-task questionnaire (they were told they would still receive credit if they cheated). This exclusion process resulted in 6 exclusions from the younger adult group and 5 exclusions from the older adult group. A sensitivity analysis indicated that for a two-group test of independent means, assuming alpha =.05, power = .80, for a two-tailed test, the smallest effects (comparisons between younger and older adults on fluency, originality, and measures of retrieval organization) the design could reliably detect is d = .40. A sensitivity analysis also indicated that for correlations (bivariate normal model), assuming alpha = .05, power = .80, for a two-tailed test, the smallest correlation we could reliably detect is r = .20.

Materials and procedure

Participants were instructed to retrieve as many exemplars from the category "animals" as possible in 5 minutes (they typed their responses into an on-screen text box and responses remained on screen after they were typed). Participants were informed that they could retrieve animals in any order that they wished but that they should keep trying to retrieve items throughout the entire 5 minute period. This category was selected because it has easily defined correct responses and clusters and has been found to be related to other fluency measures (e.g., Unsworth et al., 2011). Participants also completed a brief questionnaire regarding any search strategies that they had used during the fluency task.

Scoring

Any attempt to retrieve a type of living being, real or fake, was counted as correct. Errors were categorized as repetition (retrieving the same item more than once), semantic repetition (e.g., lion and lioness), not an exemplar (e.g., mammals), and does not exist (e.g., submissions that were not animals). Within the data coding process, participants' incorrect responses due to spelling errors or typos were counted if the intent of the response was clear (e.g., the response "chimpanzee" followed by the response "aranga-tang" was interpreted as "orangutan"). Each response was then placed into various categories for classification by a single research assistant to assess participants' clustering, switching, and organization of retrieval within categories and clusters of items. These categories included pet, farm, forest, jungle/safari, desert, aquatic, insect/bug, bird, frozen, mythical/extinct, and other. Responses were classified according to the category with which they best fit (e.g., the response "cow" would be best classified as a farm animal).[1]

The large number of categories reflects the considerable individual variation in the approach to this task.

All of the information obtained from this procedure was then used to determine how participants organized retrieval based on shared contexts between successively retrieved items in terms of originality and item output frequency. Three scores were obtained for each participant: (a) number of words generated, excluding errors and repetitions (fluency), (b) originality, and (c) average output frequency of retrieved items. Originality scores were calculated by summing the number of participants' original responses. Based on the recommendations of Milgram and Milgram (1976), items were considered original if they were generated by about 5% or less of the sample (the number of items per participant that were generated 10 times or less out of the 194 participants). Examples of items scored as common and original are shown in Table 1. Finally, output frequency for each exemplar was calculated as the number of times in the entire sample that an exemplar was generated (e.g., "cat" was generated by 187 participants while hippopotamus was generated by 70 participants) and participants were scored based on the mean output frequency of their retrieved items.

Results

The results are divided into four primary sections. The first section examined categorical differences between younger and older adults in terms of the total number of items generated, originality, and average item output frequency using independent samples *t*-tests. The second section examined younger and older adults' organization of retrieval (using within-participant correlations and one sample *t*-tests comparing these correlations to 0; see Figure 1 for correlation plots in older adults) and how participants' retrieval patterns related to performance (see Table 2 for correlations between all variables of interest). The extent to which younger and older adults differed in their organization of retrieval holistically, within each category, and within each cluster was also examined using independent samples *t*-tests. In the third section, we investigated self-report measures of participants' task strategy in relation to the output order of items of varying accessibility. In the final section, we investigated differences in fluency, originality, and measures of retrieval organization in older adults using age as a continuous variable.

Table 1. The top 10 most frequently generated animals (left) and examples of items outputted only once (right).

Common Items	Original Items
Cat	Botfly
Dog	Impala
Lion	Fennec fox
Tiger	Kookaburra
Elephant	Stoat
Cow	Pallas's cat
Horse	Capybara
Giraffe	Lionfish
Bear	Red-eared slider
Pig	Hagfish

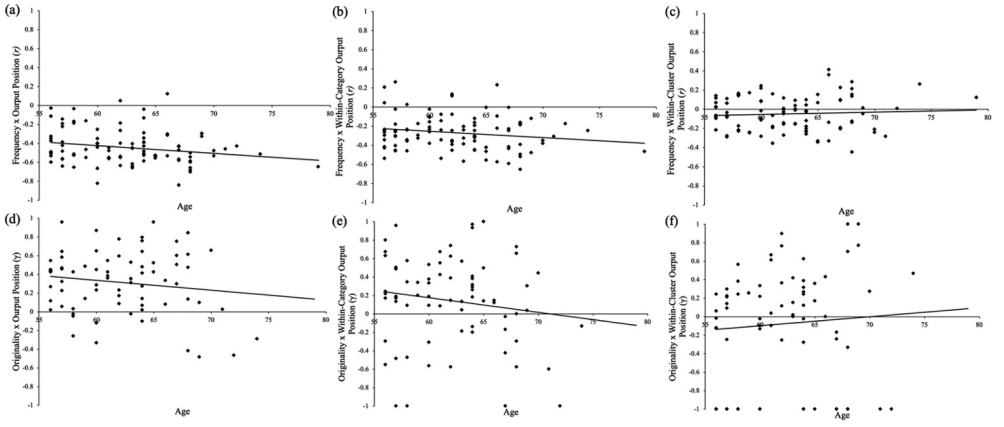

Figure 1. Pearson correlations between item frequency and output position (a), item frequency and within-category output position (b), item frequency and within-cluster output position (c), and Gamma correlations (γ) between originality and output position (d), originality and within-category output position (e), originality and within-cluster output position (f) in the older adult sample.

Table 2. Pearson correlations between variables of interest in the current study.

Measure	1	2	3	4	5	6	7	8	9
1) Fluency	–								
2) Originality	.72***	–							
3) Average Response Frequency	−.82***	−.77***	–						
4) Frequency x Output Position Pearson's *r*	.18*	.19**	−.19**	–					
5) Frequency x Within-Category Output Position Pearson's *r*	−.09	−.08	.06	.44***	–				
6) Frequency x Within-Cluster Output Position Pearson's *r*	−.26***	−.33***	.32***	−.04	.39***	–			
7) Originality x Output Position Gamma (γ)	−.15	−.12	.12	−.50***	−.24**	.06	–		
8) Originality x Within-Category Output Position Gamma (γ)	.11	.19*	−.19*	−.07	−.52***	−.32***	.34***	–	
9) Originality x Within-Cluster Output Position Gamma (γ)	.22**	.34***	−.33***	.08	−.19*	−.47***	−.09	.44***	–

Note: * = p <.05, ** = p <.01, *** = p <.001

Fluency measures

A summary of the descriptive and inferential statistics between younger and older adults is shown in Table 3. To investigate differences in fluency scores between younger and older adults, an independent samples *t*-test was conducted and Levene's test of equality of variances indicated a violation of the equal variance assumption (p < .001). Welch's *t*-test revealed no significant differences in fluency scores [t(177.94) = .72, p = .475, d = .10, BF_{10} = .198] between younger and older adults.

Next, to investigate differences in the average output frequency of retrieved items between younger and older adults, an independent samples *t*-test revealed no significant differences in the mean retrieval frequency of generated animals [t(192) = .39, p = .695, d = .06, BF_{10} = .168]. While there were no age-related differences in average item retrieval frequency, we also investigated differences in originality scores (animals retrieved by

Table 3. Descriptive statistics and results of independent samples *t*-tests (including Bayes Factor10) on differences between younger and older adults on variables of interest.

Variable	Young Mean	Young SD	Old Mean	Old SD	*p*	*Cohen's d*	BF10
Fluency	42.02	20.39	40.19	14.95	.475	.10	.198
Originality	5.53	6.64	4.41	5.33	.195	.19	.343
Average Item Frequency	72.38	20.04	71.35	16.01	.695	.06	.168
Item Frequency x Output Position Pearson's *r*	−.37	.21	−.45	.18	.011	.37	3.384
Item Frequency x Within Category Output Position Pearson's *r*	−.22	.17	−.27	.18	.046	.29	1.015
Item Frequency x Within Cluster Output Position Pearson's *r*	−.05	.22	−.05	.18	.991	.00	.156
Originality x Output Position Gamma (γ)	.29	.34	.31	.33	.685	−.07	.190
Originality x Within Category Output Position Gamma (γ)	.08	.43	.14	.48	.424	−.13	.237
Originality x Within Cluster Output Position Gamma (γ)	−.10	.57	−.08	.60	.801	−.04	.182

Note: * = p <.05, ** = p <.01, *** = p <.001

about 5% or less of participants) between younger and older adults. An independent samples *t*-test did not reveal significant differences in originality scores [$t(192) = 1.30$, $p = .195$, $d = .19$, $BF_{10} = .343$], however, fluency and originality were highly positively correlated ($r = .72$, $p < .001$), adding to the evidence that fluency and originality are related constructs (Dumas & Dunbar, 2014; Silvia, 2008).

Organization of retrieval

To determine how participants organized the retrieval of items of various accessibility, a correlation between item output position (with larger numbers indicating later output) and the corresponding item's output frequency in the present data was computed for each participant. A strong positive correlation would indicate that participants retrieved less frequently generated items before common items while a negative correlation would indicate that participants retrieved common items before more unique items. A correlation near 0 would indicate no organization of retrieval based on item retrieval frequency. These correlations ($M = -.41$, $SD = .20$) served as the dependent variable in a one sample *t*-test. Results revealed that, across ages, this correlation was different from 0 such that participants generated common items before more unique items [$t(193) = 28.61$, $p < .001$, $d = 2.05$, $BF_{10} > 100$]. Additionally, these correlations were positively associated with fluency scores ($r = .18$, $p = .012$) suggesting that the tendency to retrieve easily accessible items before less accessible ones was associated with poorer performance. However, this relationship was only significant in the older adult sample ($r = .23$, $p = .022$; younger adults: $r = .14$, $p = .180$). Furthermore, an independent samples *t*-test revealed age-related differences in the tendency to retrieve common items before more unique items such that this pattern was more prevalent in older adults than younger adults [$t(192) = 2.58$, $p = .011$, $d = .37$, $BF_{10} = 3.384$].

As mentioned earlier, we categorized each retrieved animal into one of ten categories. To investigate if participants' later retrieval of less frequent items compared to common items extended to each category of animals, we computed a correlation between within-category output position and the corresponding item's output frequency for each participant. In this analysis, each category was considered its own set of responses in terms of the output position. For example, if a participant started with the category "aquatic" and

retrieved "fish" and "dolphin" then switched to the category "pets" by retrieving "dog," then retrieved another item from the category "aquatic" like "shark," the within-category output position for shark would be third. Again, a strong positive correlation would indicate that participants retrieved less common items before frequent items while a negative correlation would indicate that participants retrieved more unique items toward the end of each category. These correlations ($M = -.25$, $SD = .18$) served as the dependent variable in a one sample *t*-test. Results revealed that, across ages, this correlation was different from 0 such that participants retrieved less frequent items toward the end of each category [$t(193) = 19.63$, $p < .001$, $d = 1.41$, $BF_{10} > 100$]. Additionally, an independent samples *t*-test revealed age-related differences in this trend such that this pattern was more prevalent in older adults than younger adults [$t(192) = 2.01$, $p = .046$, $d = .29$, $BF_{10} = 1.015$].

To investigate if participants' later retrieval of less common items also extended to each cluster of animals, we computed correlations at the participant level between within-cluster output position and item response frequency. Similar to within-category output position, in this analysis, each cluster was considered its own set of responses in terms of output position which reset with each switch to a different category. A strong positive correlation would indicate that participants retrieved less common items before frequent items while a negative correlation would indicate that participants retrieved more unique items toward the end of each cluster. These correlations ($M = -.05$, $SD = .20$) served as the dependent variable in a one sample *t*-test. Results revealed that, across ages, this correlation was different from 0 such that participants generally retrieved less common items before frequent items within each cluster of responses [$t(193) = 3.44$, $p < .001$, $d = .25$, $BF_{10} = 23.136$]. However, an independent samples *t*-test did not reveal differences in this trend between younger and older adults [$t(192) = .01$, $p = .991$, $d < .01$, $BF_{10} = .156$].

Similar to examining the output position of items of various retrieval frequencies, we also examined at what point during retrieval original items were typically generated by computing a gamma correlation at the participant level between each item's overall output position (as well as within-category and within-cluster) and whether an item was original. Here, a strong positive correlation would indicate that participants retrieved original items toward the end of their retrieval while a negative correlation would indicate that participants retrieved original items before common items and a correlation near 0 would indicate no organization of retrieval based on item originality. These correlations ($M = .30$, $SD = .33$) served as the dependent variable in a one sample *t*-test. Results revealed that, across ages, this correlation was different from 0 such that participants generally retrieved original items toward the end of their output [$t(148)^2 = 11.02$, $p < .001$, $d = .90$, $BF_{10} > 100$]. However, an independent samples *t*-test revealed no differences in this trend between younger and older adults [$t(147) = .41$, $p = .685$, $d = .07$, $BF_{10} = .190$].

Next, we computed gamma correlations at the participant level between within-category output position and whether an item was original. These correlations ($M = .11$, $SD = .46$) served as the dependent variable in a one sample *t*-test. Results revealed that, across ages, this correlation was different from 0 such that participants typically retrieved original responses after retrieving common responses within each category [$t(148) = 2.94$, $p = .004$, $d = .24$, $BF_{10} = 5.682$]. However, an independent samples *t*-test again did not reveal differences in this trend between younger and older adults [$t(147) = .80$, $p = .424$,

$d = .13$, $BF_{10} = .237$]. Similarly, to investigate if participants' later retrieval of original items extended to each cluster of animals, we computed gamma correlations at the participant level between within-cluster output position and whether an item was original. These correlations ($M = -.09$, $SD = .58$) served as the dependent variable in a one sample *t*-test. Results revealed that, across ages, this correlation was not different from 0 such that there was no relationship between the retrieval of original items and their output position [$t(148) = 1.86$, $p = .065$, $d = .15$, $BF_{10} = .486$]. Additionally, an independent samples *t*-test did not reveal differences in this trend between younger and older adults [$t(147) = .25$, $p = .801$, $d = .04$, $BF_{10} = .182$].

Self-report measures

On a post-task questionnaire, 82.3% of younger adults and 78.9% of older adults reported starting with easier items before retrieving harder ones. Additionally, only 9.4% of younger adults and 0.0% of older adults reported starting with harder items before retrieving easier ones. In sum, participants' self-report measures and analysis of their organization of retrieval indicated that common and original items differed in terms of when they were generated during the retrieval period such that less common and original items tended to be retrieved later than frequently outputted items (and participants were aware of this strategy).

Age effects

To further investigate age-related effects, we also analyzed age as a continuous variable. Although we did not observe categorical differences between younger and older adults, in the older adult sample, age was negatively correlated with fluency ($r = -.31$, $p = .002$) and marginally negatively correlated with originality ($r = -.20$, $p = .056$), suggestive of age effects as seen in Figure 2. Thus, older adults demonstrated poorer fluency performance (consistent with prior work, Troyer et al., 1997) as well as poorer originality with increased age. Furthermore, older adults' age was positively correlated with average item frequency ($r = .23$, $p = .023$), indicating that older participants' retrieval tended to consist of more commonly outputted items with increased age. Collectively, despite these age-related effects, young older adults seem to perform similarly to younger adults while the old-older adults show declines indicating that fluency and originality are preserved in early older age.

Discussion

Semantic fluency tasks are a common way to assess retrieval from long-term memory. When retrieving items during fluency tasks, research has already indicated the importance of clustering and switching (e.g., Gruenewald & Lockhead, 1980; Troyer et al., 1997; Unsworth et al., 2011) in the two-stage cyclical search process (Gruenewald & Lockhead, 1980; Herrmann & Pearle, 1981; Troyer et al., 1997; Wixted & Rohrer, 1994). However, little research has examined how participants of different ages differ in the originality of their retrieval and the order with which they retrieve items of varying accessibility holistically, within each category, and within each cluster. Examining the originality and output frequency of participants' responses as well as where in their output each item occurs may predict differences

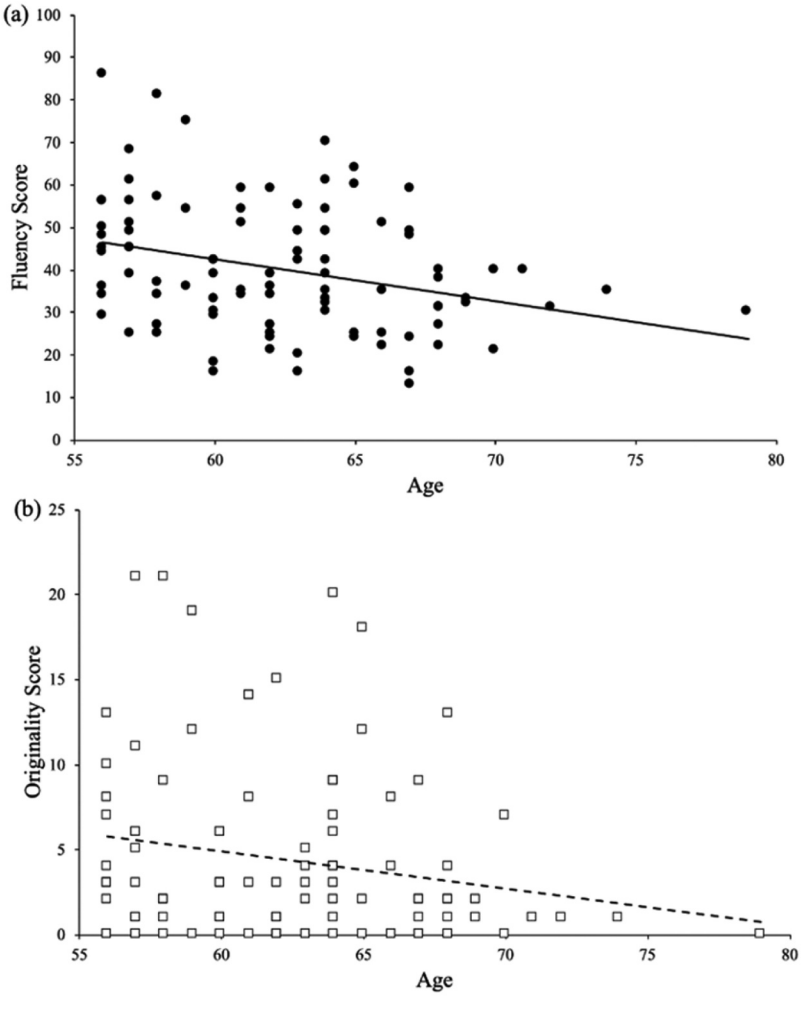

Figure 2. Fluency (a) and originality (b) scores of older adult participants with regression lines.

in performance. For example, generating common, easily assessable exemplars may facilitate the retrieval of additional items, leading to better fluency scores. However, older adults' associative memory deficits and poorer switching ability may decrease their ability to use the associative links between items to generate additional items, leading to poorer fluency performance.

In the present study, we did not observe differences between younger and older adults, contradictory to some previous work (e.g., Troyer et al., 1997). This may be due to the large allotted retrieval time (5 minutes as opposed to 1) such that both younger and older adults had sufficient time to exhaust their retrieval of common items and afforded them time to retrieve original items as well. However, the design of the present study allowed for an examination of participants' retrieval strategies and better elucidated how younger and older adults differ in qualitative aspects of retrieved items.

We also may have not observed differences between younger and older adults due to our older adult participants having a lower mean age (by around 10 years) than that of

Troyer and colleagues. However, in the older adult sample, fluency (see Figure 2(a)) and originality (see Figure 2(b)) generally declined with age. Thus, despite the mean age of our older adults being younger than often observed in the literature, our sample can still detect age effects using age as a continuous variable, and the present data demonstrate some preservation of fluency and originality early in older age, but then a decline in older age, consistent with Troyer et al. (1997).

While an older adult sample with an older mean age may be needed to observe differences in fluency and originality between younger and older adults, we were also interested in the qualitative aspects of each of the items participants retrieved. Specifically, we investigated age-related differences in the average output frequency of generated items and whether older adults' retrieval was generally more unique than younger adults. However, results revealed that older and younger adults did not differ in the number of original items generated or the average retrieval frequency of items but in the older adult sample, participants' retrieval tended to contain fewer original items and more commonly generated items. Thus, with increased age, older adults prioritize retrieving easily accessible items compared to less accessible items.

In addition to the originality and item output frequency of retrieved items, the organization of participants' responses may be an important component to semantic fluency performance. We were interested in the organization of retrieval and whether participants generated common items before unique items or vice versa. To investigate this issue, we evaluated the correlation between each participant's response's retrieval frequency in the present data and the item's output position overall, within each category, and within each cluster. Similarly, we also evaluated the output position of original items overall, within each category of items, and each cluster. Results revealed that participants began retrieval with more frequently retrieved items and retrieved less common items later in the retrieval period, toward the end of each category, and the end of each cluster. Additionally, common and original items differed in terms of when they were generated during the retrieval period such that original items tended to be retrieved later than common items overall and within each category but not within each cluster. Thus, participants generally organized their retrieval according to item accessibility and typically retrieved their original responses toward the end of their output.

While the present work revealed much about age-related effects when retrieving animals, future research could investigate these effects using a broader range of categories (e.g., types of fruits and vegetables, items to buy at the supermarket, etc.) or a 1 minute version of this task. Additional categories could provide more domain-general evidence for the retrieval of easier, more commonly generated items before harder, less commonly generated items, how the retrieval frequency of items relates to performance, and if age differences exist when retrieval time is more limited. Future work could also include metacognitive predictions of performance to determine if older adults are aware of their fluency and originality abilities (see Kavé & Halamish, 2015) and if older adults are more metacognitively calibrated in their predictions. Moreover, although the present research revealed informative age-related differences in terms of examining when declines may begin to occur in older age, it would be informative to also examine a middle-aged group to see if a there linear decline in fluency and originality throughout the lifespan.

In sum, the results of the present study indicate that fluency and originality tend to decline with age. Additionally, participants generally retrieve easily accessible items (e.g., dog, cat, lion) before retrieving more difficult, less accessible items (e.g., blue-tongued skink, rock hyrax, slow loris). Similarly, research has shown that when self-regulating study time, both younger and older adults study easier items before harder items (e.g., Price et al., 2010). Thus, whether in the encoding or retrieval aspect of semantic long-term memory, people seem to proceed in an easy to difficult order.

Notes

1. While some animals may fit into multiple categories (e.g., snake), these exemplars were consistently placed in the category/environment with which they best fit/are most abundant.
2. Note that 45 participants (24 younger adults, 25 older adults) did not retrieve an original item making it impossible to compute correlations for these participants.

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ORCID

Dillon H. Murphy http://orcid.org/0000-0002-5604-3494

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