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Semantic Knowledge Use in Discourse: Influence of Age

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Abstract

Semantic memory is relatively stable across the lifespan (Rönnlund, Nyberg, & Bäckman, 2005; Spaniol, Madden, & Voss, 2006); however, most research has been conducted at the single concept level. Few researchers have examined how semantic knowledge is used in discourse. The purpose of the study, then, was to determine the proportion of semantic knowledge and category domains used in discourse produced by younger and older participants. Cognitively healthy, younger ($n=30$, 20–39) and older ($n=30$; 60–89) participants told stories that were transcribed and coded for 10 domains of semantic knowledge and also *living* and *nonliving things*. Results indicated group differences for the proportion of semantic knowledge type, *sound*, and for the category type, living things. These findings extend previous research on semantic features into the realm of discourse and indicate the importance of studying semantic features and categories within discourse.

Keywords

aging; semantics; discourse; categories

INTRODUCTION

Semantic memory stores semantic knowledge, concepts, words, and categories (Lambon Ralph, 2014). Semantic knowledge refers to the general knowledge and features that make up concepts that people have acquired and abstracted from their experiences. Concepts are associated with and comprised of semantic knowledge. Concepts are also connected to words. Categories are groups of concepts that share one or more semantic features. For example, “feathers” is a type of semantic feature for the concept and word “bird,” which can be categorized under the category of “living things.” Within aging research, most researchers have examined semantic memory at the single concept level (Brosseau & Cohen, 1996; Craik & Rose, 2012; LaBarge, Edwards, & Knesevich, 1986; Maintenant, Blaye, & Paour, 2011; Spaniol et al., 2006) or examined how treatments for semantic memory improve discourse production in disordered populations (Boyle, 2004; Kiran, 2008; Kiran & Thompson, 2003; Peach & Reuter, 2010; Rider, Wright, Marshall, & Page, 2008). However, few, if any, studies have focused on how semantic knowledge or categories are used within discourse. For many disordered populations, the inability to access certain domains of

semantic knowledge will impair access to certain concepts, words, or categories (Cree & McRae, 2003; Moss & Tyler, 2000). Moreover, an inability to access certain knowledge domains or categories could fundamentally change the information integrated into a narrative. There is a lack of research into how semantic knowledge and categories are used within discourse as well as on how semantic knowledge use changes across a healthy lifespan.

Within single concept research, researchers have investigated the differences in semantic memory by examining whether semantic knowledge is intact in older adults (Rönnlund et al., 2005) and whether category membership assignment is different between younger and older adults. Semantic memory is preserved in older adults (Rönnlund et al., 2005; Spaniol et al., 2006). Rönnlund, Nyberg, and Bäckman (2005) conducted a longitudinal study on semantic memory with 829 participants between the ages of 35 and 80. The study had two sessions separated by 5 years. The semantic memory measures consisted of tests for general knowledge, vocabulary, and word fluency. The participants' scores on the semantic memory measures increased between the ages of 35 to 55, stabilized until the age of 65, and slightly declined after the age of 65. The researchers concluded that semantic representations are maintained in older adults. These results are similar to other findings that examined semantic memory (Spaniol et al., 2006) and word access (LaBarge et al., 1986). Therefore, any differences found in semantic knowledge within discourse production are most likely not the result of degraded representations within semantic memory.

The research into age-related differences in categorical representations has yielded mixed results. Some studies suggest that older and younger adults differ in terms of how they represent semantic categories (Brosseau & Cohen, 1996). However, the reverse has also been reported (Yoon et al, 2004). Yoon et al. (2004) included younger and older American and Chinese participants who produced concepts within certain categories. The participants wrote down five items that belonged to each of the 105 categories. There was a high level of agreement for concepts named between the younger and older participants (Chinese: 85% and American: 91%), except for categories that are highly susceptible to cultural change (e.g. diseases or herbal medicines). Other researchers have reported similar results (Craik & Rose, 2012).

Brosseau and Cohen (1996) had younger (mean age = 27.3 years) and older (mean age = 71.8 years) participants write down four associations for 30 categories. 21 of 30 categories had significant differences for the four most common responses between the two age groups with 63.3% of the most common associations generated being different. Though the researchers were unable to determine what contributed to the different responses, they hypothesized that broadening category boundaries or cultural differences may have contributed to the results. So while semantic knowledge is intact in older adults, conceptual membership within a category might be different between younger and older adults. Unfortunately, there has been no research into how these differences might impact discourse.

In addition to potentially representing categories differently than younger adults, older adults may also have a greater degree of difficulty in using categorization rules. Maintenant et al (2011) conducted a study on the effects of aging on categorization. The study included 61

participants between the ages of 21 to 40 years old and 60 participants between the ages 60 to 91 years old. In the task, participants chose one picture that did not belong to the group. Participants were required to either maintain categories between tasks or switch between categories with interfering pictures from the last category task. Older participants had a harder time maintaining and switching between categorical knowledge compared with younger adults. Since producing discourse requires semantic control and the ability to switch between different categories, the reduced ability of older adults to use semantic categorization rules could potentially have effects at the discourse level.

Research into differences in lexical access between older and younger adults may provide information about semantic knowledge use in older adults. Specifically, problems with lexical access could suggest that older individuals might have problems accessing the different domains of semantic knowledge that make up concepts. Researchers have examined lexical access within discourse in both younger and older adults (Cooper, 1990; Marini, Boewe, Caltagirone, & Carlomagno, 2005). Cooper (1990) found that older adults had an increase in the amount of indefinite words produced. The researcher examined the discourse produced from three line drawings of 80 participants (42 females) between the ages of 20 to 78. The increase in indefinite words was attributed to cognitive slowing and word finding difficulties.

Marini and colleagues (2005) examined the microlinguistic and macrolinguistic elements within discourse transcripts of 69 healthy adults divided into five age groups (20–24, 25–39, 40–59, 60–74, 75–84). A single-picture stimulus and two six-frame sequential pictures were used to elicit discourse. There was a linear decrease in the lexical informativeness across the age groups and a sharp increase in the amount of semantic paraphasias in the oldest group. Similar to Cooper (1990), Marini et al. attributed these microlinguistic differences to slowed processing and possible word finding difficulties. While both these studies examine lexical access issues and not semantic knowledge at the conceptual level, the lexical access difficulties could suggest that older individuals might have problems accessing the different domains of semantic knowledge that make up concepts.

The purpose of the current study, then, is to determine if there is a difference in the proportion of semantic knowledge and category domains used in discourse produced by younger and older participants. This is important for two reasons: (1) the research will demonstrate how healthy younger and older adults use semantic knowledge and categories to produce narratives across the adult lifespan, and (2) any differences found can elucidate how changes in accessing semantic memory impact narrative construction. It is hypothesized that older adults will produce a smaller proportion of ideas related to *living things*, since researchers typically report more problems associated with recalling *living things* than *nonliving things* (Cree & McRae, 2003; Gainotti, 2006; Warrington & McCarthy, 1987). It was also hypothesized that older adults will produce a small proportion of ideas related to sensory knowledge compared with younger adults, since one in four older adults presents with a hearing or vision impairment (Wray & Blaum, 2001). Sensory impairments have been shown to impact conceptualization of concepts that rely on those senses for identification and/or comprehension (Barsalou, 1999; Barsalou, 2008; Zwann & Madden, 2005).

METHOD

The data presented are a subset of data from a larger study examining discourse processing across the lifespan. The database included discourse samples and cognitive measures collected from 400+ participants ranging in age from 20 to 89 years old. The discourse task included two procedural discourse tasks, two stories, three recounts, and four eventcasts for a total of four discourse types and 11 discourse tasks per participant. Procedural discourse is an account of the steps involved in an activity or routine, such as planting a flower or making a peanut butter sandwich. Stories are fictionalized, structured discourses. Recounts are verbal reiterations of past events. Eventcasts are narratives that explain a scene of activities and are typically elicited with single or sequential pictures. All participants' discourse samples were either video or audio recorded. For the cognitive measures, participants completed several measures of memory and attention. These measures included: Wechsler Memory Scale-III (WMS-III; Wechsler, 1997), Comprehensive Trail-Making Test (CTMT; Reynold, 2002); and STROOP Color and Word Test (STROOP; Golden, 2002). For this study, participant data were randomly selected from this larger data set with the parameter of age such that, 30 participants were randomly selected from the pool of participants between 20 and 39 years old and 30 were randomly selected from the pool of participants that were between 70 and 89 years old.

Participants

Sixty healthy adults participated in the study and comprised two groups – younger adults (YA; 20–39 years old) and older adults (OA; 70–89 years old). The mean age for younger adults was 28.83 years ($SD=5.71$), and the mean age for the older adults was 72.90 years ($SD=7.71$). There were 15 females in the YA group and 15 females in the OA group. The participants were matched for education with the younger adults reporting a mean of 15.13 ($SD=1.89$) years of education and the older adults reporting a mean of 15.27 ($SD=2.43$) years of education.

All study participants met the following inclusionary criteria: (a) aided or unaided visual acuity within normal limits (Beukelman & Mirenda, 1998); (b) aided or unaided hearing within functional limits as measured by CID List of Everyday Speech (Davis & Silverman, 1978); (c) no presence of depression as measured by the Geriatric Depression Scale (Sheikh & Yesavage, 1986); (d) cognitive function within normal limits as measured by the Mini Mental State Examination (Folstein, Folstein, & McHugh, 2001); (e) no self-reported history of stroke, head injury, or progressive/acquired neurogenic disorder; and (f) English as their first language. Table 1 includes both groups' demographic information.

Discourse Task

For this experiment, only participants' storytelling discourse sample for the wordless picture book, *Picnic* (McCully, 1984) was included. *Picnic* is a story about a family of mice who use a pickup truck to go on a picnic in the middle of the forest. *Picnic* was chosen for two reasons. First, it is a well-structured narrative with a wide range of activities included in the pictures that provide the participants with ample opportunity to access multiple forms of semantic knowledge. Secondly, wordless pictures books elicit a more consistent narrative

with a better range of vocabulary than sequential pictures or single pictures (Fergadiotis, Wright, & Capilouto, 2011). This is important because an individual's vocabulary influences the type and range of semantic knowledge used in discourse.

Experimental Procedures

Participants were tested individually. They provided consent, completed screening measures to ensure they met inclusionary criteria, and provided educational and medical history information. Participants attended two sessions, each lasting around 2 hours. One session consisted of the discourse tasks and the other sessions included the cognitive measures. The discourse tasks and cognitive measures were presented in a random order to the participants. For the storytelling task, an examiner read a script that informed the participants that the books were wordless children's books so that a person can make up their own story. The examiner read the scripted story for *The Great Ape* (Krahn, 1978) to show the participant how to complete the task. Next, the examiner gave the participant the wordless picture book and instructed the participant to look through the book and tell a story that goes along with the pictures. Participants were given an unlimited amount of time to look through the book, and they were allowed to keep the book during the task. The cognitive measures were not examined for this study.

Transcription & Language Sample Preparation

Samples were audio or video recorded, and these recordings were then orthographically transcribed into the CHAT format that is compatible with a set of programs called Computerized Language Analysis (CLAN; MacWhinney, 2000). Next, samples were segmented into c-units. A c-unit is a communication unit and includes an independent clause with its modifiers (Loban, 1976). The following is an example of a c-unit:

Pre-c-unit segmented sample: There's a family of mice that live in a house in the forest and one day they decide to pack everyone up a large family of mice into the truck and go out for a picnic the whole family

C-unit segmented:

1. There's a family of mice that live in a house in the forest.
2. And one day they decide to pack everyone up a large family of mice into the truck and go out for a picnic the whole family (Wright & Capilouto, 2009).

Semantic Knowledge Analysis Development and Training

Cree and McRae (2003) developed a macro-scale semantic knowledge coding system that was based on distinct brain regions hypothesized to process modality-specific knowledge domains for single concepts. The researchers included nine semantic knowledge domains: (1) *color*, (2) *encyclopedic*, (3) *function*, (4) *motion*, (5) *sound*, (6) *smell*, (7) *tactile*, (8) *taste*, and (9) *visual parts and surface*. To adapt the semantic knowledge domains for analyzing discourse, the original nine semantic knowledge domains were used, along with (10) *internal state*

For the knowledge domains, seven involve sensory information and represent semantic knowledge of the senses; these include *color*, *motion*, *smell*, *sound*, *tactile*, *taste*, and *visual parts and surface*. The other knowledge types involve non-sensory/functional knowledge. *Function* represents the functional knowledge for how people use and interact with tools, objects, or other concepts. *Internal state* is the understanding that entities can have their own desires, goals, and emotions. *Encyclopedic* knowledge is a wide-ranging category for any knowledge that does not fit into the previous knowledge domains and is used when the participant provides information that is either based on facts, location, relationships, or time.

The coding system was originally used for single concepts (Cree & McRae, 2003). However, the system appears well suited to discourse for several reasons. (1) Participants could produce the features “has feather,” “lives in a tree,” “flies,” or “eats worms” for the concept *bird*. This demonstrates that phrasal length items can be reduced to one or two semantic knowledge domains. Moreover, the features of the bird could be replicated in narrative format. A participant could state, “a bird is a creature that has feathers and flies. It lives high up in trees and eats worms.” This narrative format produces similar results to simply listing features. (2) There does not appear to be any functional difference between integrating semantic knowledge from a single word or from a discourse context (van Berkum, Hagoort, & Brown, 1999). Therefore, while discourse typically involves a more complex integration of semantic knowledge, the process of integrating semantic knowledge into discourse should involve similar processes and similar knowledge domains.

For categories, *living* and *nonliving things* are the most commonly reported categories to present with deficits, as well as being the most studied categories (Cree & McRae, 2003; Moss & Tyler, 2000; Warrington & McCarthy, 1987). Therefore, nouns were coded as either *living* or *nonliving*. Numerous other categories exist. For example, Cree and McRae (2003) cite *food*, *fruits and vegetables*, *musical instruments*, and *tools* as examples of other categories. However, the other categories can fit into the categories of *living* or *nonliving things*. Moreover, breaking *living* and *nonliving things* into smaller, more distinct categories would have resulted in not enough instances of the smaller, more distinct categories to run a proper analysis. Table 2 includes examples of how certain words would be classified into one of the semantic knowledge domains.

The coders followed a multi-step training protocol prior to independently coding study participants’ transcripts. The training protocol included reviewing the definitions for each of the 10 semantic knowledge domains. Next, a transcript that was already coded was provided as an example. Finally, the coder coded a practice transcript. Results were compared to a previously coded transcript. The coder tallied the number of agreements and disagreements. For any disagreements, the coder was referred to the explanation provided on the previously scored transcript. Training was complete when agreement was greater than 90%. The training protocol is available upon request.

Semantic Knowledge Analysis Procedures

In CLAN, the transcripts were coded for semantic knowledge domains, and nouns were coded as *living* or *nonliving*. The transcripts were coded in CLAN by expanding the error tag system to be used for a new function - knowledge domains. For the coding system, only

content words were coded. No functional words (e.g. modals, auxiliaries, prepositions, pronouns, etc.) were coded. Functional words were not coded because they have limited semantic representation within semantic memory, and the coding system makes use of knowledge domains based on basic forms of semantic knowledge. Moreover, the verb *to be* was not coded in any form (e.g. *am, are, is*) because the verb acts and patterns with other functional words.

For each transcript, the coder considered the c-unit as an independent idea that contained semantic information relevant to just that c-unit. Within each c-unit, interjections and fillers were not considered semantically relevant and were ignored. The c-unit was then divided into linguistic phrases. In these phrases, the content words were either grouped together if they corresponded to one knowledge domain or separated if the words added semantic information that could correspond to different semantic knowledge domains. For example, the phrase “a white tail” contains two distinct domains of semantic knowledge, *color* (white) and *visual parts and surface* (tail). However, in the phrase “a pickup truck,” “truck” does not add any more information than “pickup,” so the phrase would be coded as a single semantic knowledge domain. Finally, the concepts were coded into one of the 10 knowledge domains. Nouns were coded as either *living* or *nonliving*.

To code each concept, the concept’s main purpose within the phrase and c-unit were determined, and the concept was coded as belonging to the semantic knowledge domain that most closely fit the concept’s main purpose within the c-unit. For example, concepts such as eats, chews, strawberries, or watermelons are typically associated with eating or *taste*. Concepts such as talking, yelling, or music would typically be related to *sound*. Concepts that talk about tool manipulation, such as hammering, driving, or playing were associated with the semantic domain *function*. Therefore, steps are as follows: (1a) divide c-unit into linguistic phrases; (1b) remove function words; (1c) group content words into concepts that correspond to the 10 semantic knowledge domains and both category types; and (1d) code the knowledge domains.

As follows is an example of these steps applied to a participant’s c-unit:

(1) The little baby is excited to eat the organic carrots

(1a) The little baby / is / excited / to eat / the organic carrots.

(1b) ~~The~~ little baby / ~~is~~ / excited / ~~to~~ eat / ~~the~~ organic carrots

(1c) ~~The~~ <little> <baby> / ~~is~~ / <excited> / ~~to~~ eat / ~~the~~ <organic carrots>

(1d) ~~The~~ <little> [* *visual part and surface*] <baby> [* *living*][* *encyclopedic*] / ~~is~~ / <excited> [* *internal*] / ~~to~~ <eat> [* *taste*] / ~~the~~ <carrots> [* *living*][* *taste*].

After the transcripts were coded, CLAN was used to generate the number of semantic knowledge domains used in each transcripts. These numbers were placed into a spreadsheet and ratios were created with the formula (semantic knowledge domain/All semantic knowledge domains). The categories of *living* and *nonliving* were also calculated and ratios

were created for the two categories. This allowed for determining the distribution of semantic knowledge domains for each participant.

Reliability

All the semantic knowledge domains were used in the coding of the discourse transcripts. The first author coded all transcripts. Six transcripts (10%) were re-coded by the first author to check intra-rater agreement. Six transcripts (10%) were re-coded by a trained coder to determine inter-rater agreement. Cohen's Kappa was performed to determine if the agreement between the raters' judgment on semantic knowledge and category domains was reliable. For intra-rater reliability, there was excellent agreement between the two raters' judgments, $\kappa = .882$, $p < .001$, according to McHugh (2012). For Inter-rater reliability, there was also excellent agreement between the two raters, $\kappa = .882$, $p < .001$.

RESULTS

To prepare the data, the guidelines from Tabachnick and Fidell (2012) were used. All variables were examined within group for outliers (univariate and multivariate), normality, homogeneity of variance and covariance, and multicollinearity. For outliers, standardized z-scores (univariate) and Mahalanobis distances (multivariate) were calculated for the variables within group. Z-scores less than -2.3 or greater than 2.3 were considered outliers and were corrected by making the outlier variable one percentage point smaller or larger than the next variable to fit within the normal distribution. For example, if the outlier variable was 10% and the next variable to fit into the normal distribution was 5%, the outlier variable would be changed to 6% or one percentage point larger than the next variable to fit within a normal distribution. For all 10 semantic knowledge domains, Mahalanobis distances were calculated for each participant. There were no outliers on the multivariate level. Normality was calculated by dividing skewness values by the standard error for skewness for each variable. This creates a z-score where less than -3.3 or greater than 3.3 are considered non-normal. All variables were normal. All variables had equal covariance as indicated by Box's Test, but *smell* and *taste* had to be transformed, $x = \sqrt{x}$, for all variables to have equal variances as indicated by Levene's Test. To check for multicollinearity, a bivariate Pearson correlation was run on all variables. Variables with a correlation greater than .90 are considered multicollinear (Tabachnick & Fidell, 2012). *Living things* and *nonliving things* had a correlation $>.90$, so *nonliving things* was removed from the analysis.

Preliminary analyses were conducted to determine if there was a difference in vocabulary diversity between the younger and older groups. *Vocd* was used as a measure of vocabulary diversity. A *vocd* analysis takes 35 random samples without replacement, and the average Type-Token Ratio (TTR) is calculated for each participant's discourse sample. This is repeated 100 times, and the average TTR is estimated and plotted. This process is repeated again for subsamples containing 36 to 50 tokens, which are also plotted. Finally, *vocd* is estimated by producing a theoretical curve that maximizes the fit to the TTR curve using the least squares approach. Since *vocd* is a product of sampling, the process is run three times and the average of these values is taken (Fergadiotis & Wright, 2011). A paired sample t-test was conducted and results indicated no significant differences between *vocd* scores for

younger and older participants, $t(29)=1.154$, $p=.253$. Therefore, vocabulary differences were not considered in the remaining analyses.

To address the first aim of the study of whether semantic knowledge in discourse differed between the two groups, a multivariate analysis of variance (MANOVA) was conducted with the fixed factor as group and the 10 semantic knowledge domains as the dependent variables. The results indicated that the group main effect was significant, $F(10, 49)=3.109$, $p=.004$ (see Table 3). The tests of between-subjects effects for the 10 semantic knowledge domains were examined. The 10 dependent variables increased the likelihood of a type I error, so a Bonferroni correction was applied to the alpha level ($\alpha=.05/10=.005$). The tests of between-subjects effects found that only the semantic knowledge type, *sound*, significantly differed between groups, $F(1, 58)=9.776$, $p=.003$, with the younger adults producing more words associated with *sound*.

To determine if the younger and older groups differed in category type used, an ANOVA was conducted for *living things* with group as the fixed factor and living things as the dependent variable. The number of pronouns produced by each participant was used as a covariate. The results indicated significant main effects for group for *living things*, $F(1, 57) = 12.531$, $p=.002$, with older adults producing proportionally fewer items associated with *living things*. There was not a significant difference between pronoun usage between the two groups, $F(1, 57) = .520$, $p = .474$. The mean counts for semantic knowledge and category types can be found in Table 4.

DISCUSSION

The purpose of this study was to determine how semantic knowledge and category types are used in discourse produced by younger and older adults. There was a significant difference between the semantic knowledge domains and category types used by younger and older participants. For semantic knowledge domains, *sound* was significantly different between younger and older adults, with older adults producing a smaller proportion of *sound* features than younger adults. For category type, *living thing* was significantly different for both groups, with older adults producing a smaller proportion of *living things* than younger adults.

The differences found between semantic knowledge domains and category types used during discourse by younger and older participants supports previous research that found semantic differences in older adults' discourse samples, with older adults producing more semantic paraphasias (LaBarge et al., 1986; Marini et al., 2005) and more indefinite, ambiguous words (LaBarge et al., 1986). The current results extend these findings to differences in semantic information accessed and produced at the conceptual level and to specific categories of concepts within discourse. The results are also indirectly supported by single concept research that demonstrated younger and older adults have differences in their category make up (Brosseau & Cohen, 1996). These differences in category make up could lead to some of the differences seen in the discourse of younger and older adults.

Since semantic memory is preserved in older adults (Rönnlund et al., 2005; Spaniol et al., 2006), the results might arise from two sources: (1) older adults have a different goal for discourse than younger adults, and/or (2) older adults have reduced access to certain forms of semantic knowledge and category types due to declining processing efficiency. As for the former, older adults may have produced more details within their narratives compared with younger adults. Marini et al. (2005) has found that older adults typically include more details in their discourse samples. If the older adults produced more detailed information in their narratives, it is possible that the proportion of certain semantic knowledge domains and category types could lower in relation to the generation of semantic knowledge and category types well suited for elaboration. For example, there are usually only a small proportion of living things required for telling most stories. However, there are typically many more *nonliving* concepts in stories than living concepts. So if older adults produced more details, they could produce a similar number of living things but still produce a smaller proportion of living things compared with *nonliving things*.

Older adults might have reduced access to certain forms of semantic knowledge and category types within discourse due to declining processing efficiency. Maintenant et al. (2011) demonstrated that older adults have a harder time switching between categories within a single concept design. Within discourse, concepts are accessed and stored within working memory, so they can be integrated into the narrative (Kintsch & van Dijk, 1978). If older adults have trouble switching between categories at the single concept level, it is possible that while maintaining certain concepts within working memory during discourse production, it is difficult for older adults to fully activate and access concepts outside the original concept's category. This would suggest that older adults might produce more *nonliving things* because it is difficult for them to switch between the two categories.

It is possible that older adults accessed, processed, and produced items associated with *sound* less often than younger adults because of the greater incidence of hearing loss in this population. According to the theory of embodied cognition, cognition is grounded in sensory-motor experiences and that interactions with the world leave traces of experience that are partially activated during conceptualization (Barsalou, 1999; Barsalou, 2008; Zwann & Madden, 2005). For example, when you imagine a guitar being played, your brain partially activates and retrieves memory traces of guitars being played. Many older adults experience hearing loss (Wray & Blaum, 2001), which can impact their ability to remember words (McCoy et al., 2005). Possibly then, hearing loss can impact auditory memory, and some researchers would argue that a reduction in auditory activation might result in fewer items associated with *sound* being produced (Barsalou, 1999; Barsalou, 2008). Many older adults experience hearing loss (Wray & Baum) which could potentially impact an older adult's use of semantic knowledge in two ways. First, they may have a reduced ability to remember words in general (McCoy et al, 2005). Second, their impaired sensory experience may result in less activation of semantic knowledge associated with the concept of *sound*. Since the current study only tested for conversational hearing, it does not provide data to determine whether hearing loss impacts semantic knowledge access of the sensory feature *sound*. However, this possibility should be considered in future investigations.

For the decline in the proportion of *living things*, Cree and McRae (2003) found that categorical deficits can be explained by impairments in specific sensory-motor modalities that make up these categories. For example, Cree and McRae found that *musical instruments* can be impaired along with *living things*. The feature makeup of the category, *musical instruments*, is more like the category of *living things*; thus, when a category deficit for *living things* arise, *musical instruments* are more likely to be disrupted than when a *nonliving* deficit arises. Further evidence comes from research demonstrating that when people simply think about *living things* or *nonliving things*, the brain activated areas associated with perception of these concepts are also activated (Gainotti, 2006; Martin, 2001, 2007).

The proportion of *living things* significantly differed between the younger and older participants. It is possible that older adults produced fewer items associated with *living things* because of declining sensory experiences (Wray & Blaum, 2001). However, most current theories suggest that *living things* rely more heavily on visual features than *sound* features (Barsalou, 2008; Cree & McRae, 2003; Warrington & McCarthy, 1978). Therefore, while the older adults produced fewer items associated with *sound*, they produced a normal proportion of items associated with *color, motion, visual parts and surface, taste, and tactile*. So it cannot be claimed that the older adults were impaired in producing most forms of semantic knowledge associated with sensory features. It should also be noted that embodied cognition does not claim that sensory-motor experiences are the only relevant aspect to cognition. Sensory-motor states are closely related to cognition, but they are not necessary for it.

It might also be possible that *living things* are harder to process than *nonliving things* (Rogers et al., 2004; Warrington & McCarthy, 1987). Roger et al. (2004) suggested that *living* and *nonliving things* are not processed differently because of feature make up, but instead, *living things* share a greater number of properties with their semantic neighbors and are packed more densely into a neighborhood than *nonliving things*. These aspects might make it more difficult for older adults to choose between *living things* than *nonliving things*. However, this is speculative because the current study did not consider neighborhood density or sharing of semantic properties.

Conclusions

As an initial study investigating semantic knowledge and categories used in healthy discourse, the results of the current study extend previous research. Younger and older adults do use semantic knowledge (*sound*) and categories (*living things*) differently in discourse. Further, our results support Marini et al.'s (2005) finding of semantic changes in discourse produced by older participants. Collectively, these findings may be due to reduced processing efficiency caused by declining sensory-motor experiences or their changing goals related to storytelling.

The results of the study are informative and extend current research by adding evidence to the utility of investigating semantic features and semantic categories in discourse. However, this study was exploratory and had a few limitations. First, the semantic knowledge domains

and category types used were broad and developed from research investigating single concepts. Future studies with different semantic knowledge domains or different categories should further highlight the differences and similarities between younger and older adults. Second, the discourse elicitation task did not allow sufficient control to understand the mechanisms that might cause breakdowns between semantic knowledge and discourse output. Future experimental studies could examine what role sensory impairment plays in semantic knowledge access or explore the roles that episodic memory and executive function have in maintaining semantic knowledge. Future studies could also examine how differences in style and discourse focus in younger and older adults might impact semantic knowledge and category types. The experiment did take into account lexical diversity but did not take into account other aspects of vocabulary that might impact processing load, such as breadth and sophistication of vocabulary used, nor did this study consider other discourse properties that might be influenced by semantic knowledge. Future research should consider how semantic knowledge use relates to word concreteness, neighborhood density, semantic properties shared across words, or macro-linguistic discourse processes.

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References

- Barsalou L (1999). Perceptual symbol systems. *Behavioral and Brain Sciences*, 22, 577–660. [PubMed: 11301525]
- Barsalou L (2008). Grounded cognition. *Annual Review of Psychology*, 59, 617–645.
- Beukelman DR, & Mirenda P (1998). *Augmentative and alternative communication: Management of severe communication disorders in children and adults* (2nd ed.). Baltimore, MD: Brookes Publishing.
- Boyle M (2004). Semantic feature analysis treatment for anomia in two fluent aphasia syndromes. *American Journal of Speech-Language Pathology*, 13, 236–249. doi:1058-0380/04/1309-0236 [PubMed: 15339233]
- Brosseau J, & Cohen H (1996). The representation of semantic categories in aging. *Experimental Aging Research*, 22(4), 381–391. doi:10.1080/03610739608254018 [PubMed: 8968709]
- Cooper PV (1990). Discourse production and normal aging: Performance on oral picture description tasks. *Journal of Gerontology*, 45(5), 210–214.
- Craik FIM, & Rose NS (2012). Memory encoding and aging: A neurocognitive perspective. *Neuroscience & Biobehavioral Reviews*, 36(7), 1729–1739. doi:10.1016/j.neubiorev.2011.11.007 [PubMed: 22155274]
- Cree GS, & McRae K (2003). Analyzing the factors underlying the structure and computation of the meaning of chipmunk, cherry, chisel, cheese, and cello (and many other such concrete nouns). *Journal of Experimental Psychology: General*, 132(2), 163–201. doi:10.1037/0096-3445.132.2.163 [PubMed: 12825636]
- Davis H, & Silverman S (1978). *Hearing and deafness*. New York, NY: Rinehart & Winston.
- Fergadiotis G, Wright HH, & Capilouto GJ (2011). Productive vocabulary across discourse types. *Aphasiology*, 25(10), 1261–1278. doi:10.1080/02687038.2011.606974 [PubMed: 22904592]
- Folstein MF, Folstein SE, & McHugh PR (2001). Mini mental state examination. Lutz, FL: Psychological Assessment Resources, Inc.
- Gainotti G (2006). Anatomical functional and cognitive determinants of semantic memory disorders. *Neuroscience Biobehavioral Review*, 30, 577–594.

- Golden C (2002). Stroop color and word test. Austin, TX: Pro-Ed.
- Kintsch W, & van Dijk TA (1978). Toward a model of text comprehension and production. *Psychological Review*, 85(5), 363–394. doi:10.1037/0033-295X.85.5.363
- Kiran S (2008). Typicality of inanimate category exemplars in aphasia treatment: Further evidence for semantic complexity. *Journal of Speech, Language, and Hearing Research*, 51, 1550–1568.
- Kiran S, & Thompson CK (2003). The role of semantic complexity in treatment of naming deficits: Training semantic categories in fluent aphasia by controlling exemplar typicality. *Journal of Speech, Language, and Hearing Research*, 46(3), 608–622. doi:1092-4388/03/4603-0608
- Krahn F (1978). *The great ape*. New York, NY: Viking Press.
- LaBarge E, Edwards D, & Knesevich JW (1986). Performance of normal elderly on the boston naming test. *Brain and Language*, 27(2), 380–384. doi:[http://dx.doi.org.jproxy.lib.ecu.edu/10.1016/0093-934X\(86\)90026-X](http://dx.doi.org.jproxy.lib.ecu.edu/10.1016/0093-934X(86)90026-X) [PubMed: 3955345]
- Lambon Ralph MA (2014). Neurocognitive insights on conceptual knowledge and its breakdown. *Phil. Trans. R. Soc. B*, 369 doi:10.1098/rstb.2012.0392
- Loban W (1976). *Language development: Kindergarten through grade twelve*. Urbana, IL: National Council of Teachers of English.
- MacWhinney B (2000). *The CHILDES project: Tools for analyzing talk* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Maintenant C, Blaye A, & Paour J (2011). Semantic categorical flexibility and aging: Effect of semantic relations on maintenance and switching. *Psychology and Aging*, 26(2), 461–466. doi:10.1037/a0021686 [PubMed: 21443346]
- Marini A, Boewe A, Caltagirone C, & Carlomagno S (2005). Age-related differences in the production of textual descriptions. *Journal of Psycholinguistic Research*, 34(5), 439–463. doi:10.1007/s10936-005-6203-z [PubMed: 16177935]
- Martin A (2001). Functional neuroimaging of semantic memory In Cabeza R & Kingstone A (pp. 153–186), *Handbook of Functional Neuroimaging of Cognition*. Cambridge, MA: MIT Press.
- Martin A (2007). The representation of object concepts in the brain. *Annual Review of Psychology*, 58, 25–45.
- McCoy SL, Tun PA, Cox LC, Colangelo M, Stewart RA, & Wingfield A (2005). Hearing loss and perceptual effort: Downstream effects on older adults' memory for speech. *The Quarterly Journal of Experimental Psychology Section A: Human Experimental Psychology*, 58(1), 22–33. doi:10.1080/02724980443000151 [PubMed: 15881289]
- McCully EA (1984). *Picnic*. New York, NY: Harper Collins.
- McHugh ML (2012). Interrater reliability: The kappa statistic. *Biochemia Medica*, 22(3), 276–282. [PubMed: 23092060]
- Moss HE, & Tyler LK (2000). A progressive category-specific semantic deficit for non-living things. *Neuropsychologia*, 38, 60–82.
- Peach RK, & Reuter KA (2010). A discourse-based approach to semantic feature analysis for the treatment of aphasic word retrieval failures. *Aphasiology*, 24(9), 971–990. doi:10.1080/02687030903058629
- Reynolds CRR (2002). *Comprehensive Trail Making Test*. Austin, TX: PRO-ED.
- Rider JD, Wright HH, Marshall RC, & Page JL (2008). Using semantic feature analysis to improve contextual discourse in adults with aphasia. *American Journal of Speech-Language Pathology*, 17, 161–172. [PubMed: 18448603]
- Rogers TT, Garrard P, McClelland JL, Ralph Lambon MA, Bozeat S, Hodges JR, & Patterson K (2004). Structure and deterioration of semantic memory: A neuropsychological and computational investigation. *Psychological Review*, 111(1), 205–235. [PubMed: 14756594]
- Rönnlund M, Nyberg L, & Bäckman L (2005). Stability, growth, and decline in adult life span development of declarative memory: Cross-sectional and longitudinal data from a population-based study. *Psychology and Aging*, 20(1), 3–18. doi:10.1037/0882-7974.20.1.3 [PubMed: 15769210]
- Sheikh JI, & Yesavage JA (1986). *Geriatric depression scale (GDS): Recent evidence and development of a shorter version*. New York, NY: Haworth Press.

- Spaniol J, Madden DJ, & Voss A (2006). A diffusion model analysis of adult age differences in episodic and semantic long-term memory retrieval. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 32(1), 101–117. doi:10.1037/0278-7393.32.1.101
- Tabachnick BG, & Fidell LS (2012). *Using multivariate statistics* (6th ed.). Needham Heights, MA: Pearson Education Company.
- Van Berkum, Jos JA, Hagoort P, & Brown CM (1999). Semantic integration in sentences and discourse: Evidence from the N400. *Journal of Cognitive Neuroscience*, 11(6), 657–671. doi: 10.1162/089892999563724 [PubMed: 10601747]
- Warrington EK, & McCarthy RA (1987). Categories of knowledge: Further fractionations and an attempted integration. *Brain*, 110, 1273–1296. [PubMed: 3676701]
- Wechsler D (1997). *Wechsler memory scale* (3rd ed.). San Antonio, TX: Psychological Corporation.
- Wray LA & Blaum CS (2001). Explaining the role of sex on disability: A population-based study. *The Gerontologist*, 41, 499–510. [PubMed: 11490048]
- Wright HH, & Capilouto GJ (2009). Manipulating task instruction to change narrative discourse performance. *Aphasiology*, 23, 1295–1308.
- Yoon C, Feinberg F, Hu P, Gutchess AH, Hedden T, Chen HM, Park DC (2004). Category norms as a function of culture and age: Comparisons of item responses to 105 categories by American and Chinese adults. *Psychology and Aging*, 19(3), 379–393. [PubMed: 15382989]
- Zwaan RA & Madden CJ (2005). Embodied sentences comprehension In Pecher D & Zwaan RA (Eds.), *Grounding cognition: The role of perception and action in memory, language, and thinking* (pp. 224–245). Cambridge, NY: Cambridge University Press.

Table 1

Group Demographic Information

	Age		Years of Education		Depression Scale	
	M	SD	M	SD	M	SD
Young Group	28.83	5.71	15.13	1.89	1.40	1.75
Older Group	72.90	7.71	15.27	2.43	1.20	1.32

Table 2

Examples of Semantic Knowledge Types

Semantic Knowledge Type	Words
Color	red, blue, green
Visual Parts and Surface	short, small, bumpy
Motion	run, walked, fell, quickly
Smell	flower, smell
Sound	hear, said, shout, banjo, music
Tactile	grabbed, have
Taste	picnic, watermelon, ate, lunch
Function	drive, turned on, played
Encyclopedic	spot,
Internal	think, cry, sad, worry, doubt

Table 3

Semantic Knowledge and Category Type Means and Standard Deviations

	Younger Group		Older Group	
	M	SD	M	SD
Living Things *	.44	.086	.35	.096
Visual Parts and Surface	.18	.047	.20	.037
Motion	.12	.026	.11	.030
Color	.011	.011	.0103	.0106
Sound *	.029	.013	.019	.0108
Smell	.0047	.0043	.0069	.0057
Tactile	.047	.014	.055	.019
Taste	.025	.0032	.027	.004
Function	.074	2.18	.090	.025
Encyclopedic	.31	.040	.28	.034
Internal	.14	.029	.12	.038

Note: Numbers are proportions

*
p < .005

Table 4

Mean Counts for Semantic Knowledge and Category Types Produced

	Younger Group		Older Group	
	M	SD	M	SD
Living Things	33.90	14.76	31.77	19.63
Nonliving Things	39.90	11.04	53.93	27.04
Total Categories	73.40	22.12	85.27	43.86
Visual Parts and Surface	32.57	12.90	40.10	24.76
Motion	20.93	5.74	21.33	9.61
Color	1.80	1.88	2.33	2.79
Sound	5.00	2.36	4.07	3.65
Smell	.77	.858	1.57	1.61
Tactile	8.33	2.78	10.73	6.20
Taste	11.23	3.63	14.07	6.90
Function	12.43	3.44	17.50	10.77
Encyclopedic	54.83	17.65	54.67	26.54
Internal	26.63	11.47	23.43	13.66
Total Knowledge Types	174.53	46.56	189.80	93.66