Categorization in Context for Young and Older Adults

Abstract

This investigation explored effects of linguistic context on category structure in young and typical older adults. In a timed computer-based contextual categorization task, participants were provided with 150 stimulus sentences containing a superordinate category label. Participants were required to make a semantic decision relative to determining if a specific exemplar was the best example of the target category concept in the sentence using context. Response accuracy and reaction time results revealed that use of linguistic context for categorization was vulnerable to the aging process, as older adults were slower and less accurate for all response types except out-of-set examplars.

Individuals organize information by grouping items into categories sharing characteristics (Barsalou, 1983; 1987; Hough 2007b; Kiran & Thompson, 2003; Pennequin et al., 2006; Sachs et al., 2008; Sebastian & Kiran, 2007; Smith & Medin, 1981). Research indicates that older adults may organize concepts differently than young adults (Hough, 1989, 1993; 2007a; 2007b); however, findings are inconsistent.

Linguistic context is influential in determining word meaning in language (Dagerman et al., 2006; Roth & Shoben, 1983; Smith et al., 1974). It is unclear whether aging influences individuals' ability to utilize linguistic context (Cohen & Faulkner, 1983; Meyer et al., 1975; Wingfield et al., 1994). Cohen and Faulkner (1983) theorized that increase in older adults' ability to use context was compensation for declines in processing of sensory information. Reduced ability interpreting information from sense organs may be balanced by more intact retrieval relative to utilizing context. However, Wingfield et al. (1994) suggested that although older adults utilize linguistic context to derive meaning, memory decline may make it more difficult for them to use vital contextual cues for clarification of ambiguous words. Memory impairment may adversely affect retrieval of words dependent upon context to resolve meaning. Thus, older adults may not utilize context as effectively as younger adults (Hough, 1989, 2007a), due to difficulty with retrieving contextually-based lexical referents of categories that are less typical relative to category graded structure (Barsalou, 1982; 1983; 1987; Hough, 1989; 2007a).

Questions remain regarding whether older adults utilize linguistic context as effectively as young adults for retrieval of concepts. Reduced ability relative to utilizing context for categorization disrupts comprehension of linguistic information. Thus, the purpose of this study was to examine effect of linguistic context on category structure in young and older adults.

Method
Participants

Participants were 40 typical adults: 20-35 (i.e., younger) and 65-80 (i.e., older). All participants had attained at least a high school diploma and were native speakers of American English, had hearing acuity within normal limits (Ventry, 1992), and adequate vision/reading proficiency. All passed a category-screening test with 80% accuracy (Table 1). Participants were administered the *Peabody Picture Vocabulary Test-IV* (PPVT-IV) (Dunn & Dunn, 2007), achieving standard scores within normal limits (>85).

Materials

Twenty-seven sentences were developed based on Roth and Shoben (1983) and Hough and Jordan (1991). Fry's (1968) Readability Scale predicted stimulus readability at a 6th grade level.

For each sentence, one noun was replaced with a superordinate category label for this target word. Six exemplars were developed for the category label target word in each sentence. These exemplars varied in degree of category graded structure relative to the superordinate category. The linguistic context of the particular sentence influenced which of the six exemplars was the "best fit" relative to sentence meaning. The six exemplars were identified as true related (TR), true unrelated (TU), false related (FR), false unrelated (FU), out-of-set related (OR), and out-of-set unrelated (OU) based on previous research with college-aged students (Roth & Shoben, 1983) and aphasic adults (Hough & Jordan, 1991; Jordan, 1990) (Table 2).

Procedures

Two target sentences were practice items. For all stimuli, target sentences were presented auditorally by the examiner and visually with capitalization and quotation marks around the target word. A fixation cross appeared in the center of the screen for 5 seconds. Next, a target sentence was presented visually. The stimulus sentence remained on the screen for 10 seconds. Then, the participant was asked visually if, in context of the sentence on screen, the category term meant "XXX", this being one of the 6 exemplars for that sentence. The participant answered "YES" or "NO" using a response pad. Sentences remained on the screen for 12 seconds or until participant response. Then, another stimulus item was presented. The 12 practice stimuli were presented followed by 150 experimental stimuli (25 sentences paired one of six exemplars).

Stimuli were randomly presented on a Dell Inspiron 8500 laptop computer using SuperLab 4.0 (Cedrus Corporation, 2007). Accuracy and reaction time (RT) were measured for each stimuli.

Results

Accuracy. A two-factor mixed ANOVA yielded significant main effects for group (F(1, 38) = 6.548, p = .015), exemplar category (F(3.0, 115.8) = 141.714, $p < .001$), and significant interaction (F(3.0, 115.8) = 8.039, $p < .001$) (Figure 1). Post hoc independent t-tests revealed significant differences between groups ($p < .05$) for all but OU responses. Single degree of freedom contrasts conducted within groups yielded significant differences between all contrasts for the young group ($p < .001$), except between TR and TU. All contrasts were significant ($p < .001$) for the older group. Binary logistic regression to determine whether group or exemplar category predicting accuracy revealed main effects for group (LR = 23.0, df = 1, $p < .001$), exemplar (LR = 1497.0, df = 5, $p < .001$), and significant interaction (LR = 41.6, df = 5, $p < .001$) (Table 3).

RT. Independent sample t-tests conducted on RT for correct responses revealed a significant group difference (t(19) = -6.33, $p < .001$). Independent t-tests conducted on average RT for correct responses (t(19) = -7.002, $p < .001$), and mean RT errors (t(19) = -4.826, $p < .001$) between groups were significant (Table 4).

A 2 x 6 repeated measures ANOVA conducted on RT based on exemplar category revealed significant main effects for group (F(1, 38) = 40.182, $p < .001$), response category (F(2.1, 81.6) = 26.677, $p < .001$), and significant interaction (F(2.1, 81.6) = 3.950, $p = .021$) (Figure 2). Post hoc t-tests revealed significant differences between groups for each exemplar category ($p < .001$); young adults responded faster for all categories, except OU responses. Single degree of freedom contrasts within each group revealed all comparisons were significant

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for the young group. For the older group, all contrasts were significant ($p \leq .001$) except TR and TU compared to FR and FU.

      Correlations. Pearson Product-Moment correlations conducted between PPVT-IV scores, and RT and accuracy for both groups revealed a significant positive correlation between PPVT-IV and RT for the young group ($r = .490$, $n = 20$, $p = .028$) (Figure 3). Higher PPVT-IV scores were related to slower responses. There also was a significant negative correlation between PPVT-IV and RT for the older adults ($r = -.515$, $n = 20$, $p = .020$); as PPVT-IV scores increased, participants responded faster (Figure 4).

Discussion

      On a timed semantic decision task, young adults generally responded more accurately and faster than older adults. The young adults were able to utilize contextual constraints to determine category representativeness more effectively than the older adults. This pattern was observed for accuracy and RT except for OU responses where there were no differences between groups. Regression analysis indicated that it was possible to predict a participant's accuracy on the experimental task based on age.

      As mentioned, older adults typically experience decline in working memory. In the current investigation, the older adults did not utilize linguistic context as effectively as the younger adults in retrieving contextually-based lexical referents of categories for both typical and atypical exemplars relative to category graded structure. These reduced abilities appear to contribute to subtle linguistic comprehension impairment.

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Table 1

Demographic Information: Means, Standard Deviations and Ranges for Young and Older Adults

		Young	Older
Gender		19 ♀ (1 ♂)	13 ♀ (7 ♂)
Age	*M*	25.10	72.35
	SD	4.154	4.716
	Range	22-35	65-80
Education	*M*	17.25	16.15
	SD	1.07	3.10
	Range	16-21	12-21
PPVT scores	*M*	109.3	107.6
	SD	8.548	13.268
	Range	93-132	83-134

Table 2
Six exemplar categories

| Category	Description	Example
True related	Most appropriate category exemplars associated with the superordinate label for the particular sentence context	'At noon today, the summer sky was a lovely shade of *color*.' (blue)
True unrelated	Exemplars are members of the superordinate category label indicated in the sentence but are less typical based on linguistic context.	'Jan loved the *gem* in her engagement ring.' (sapphire)
False related	Referents of the category term in isolation, but violate constraints based on linguistic context.	'Melissa looked at the ringed *planet* through the telescope.' (Uranus)
False unrelated	Members of the category in isolation but are less typical based on linguistic context.	'Lydia found her favorite wine at the *restaurant*.' (McDonald's)
Out-of-set related	Nonmembers of the superordinate category label in the sentence, but are members of a related category within the particular linguistic context.	'Mike relaxed on the *furniture*.' (bucket)
Out-of-set unrelated	Nonmembers of the superordinate category label within the sentence.	'After the game, Jon's *clothing* was wrinkled and muddy.' (tuba)
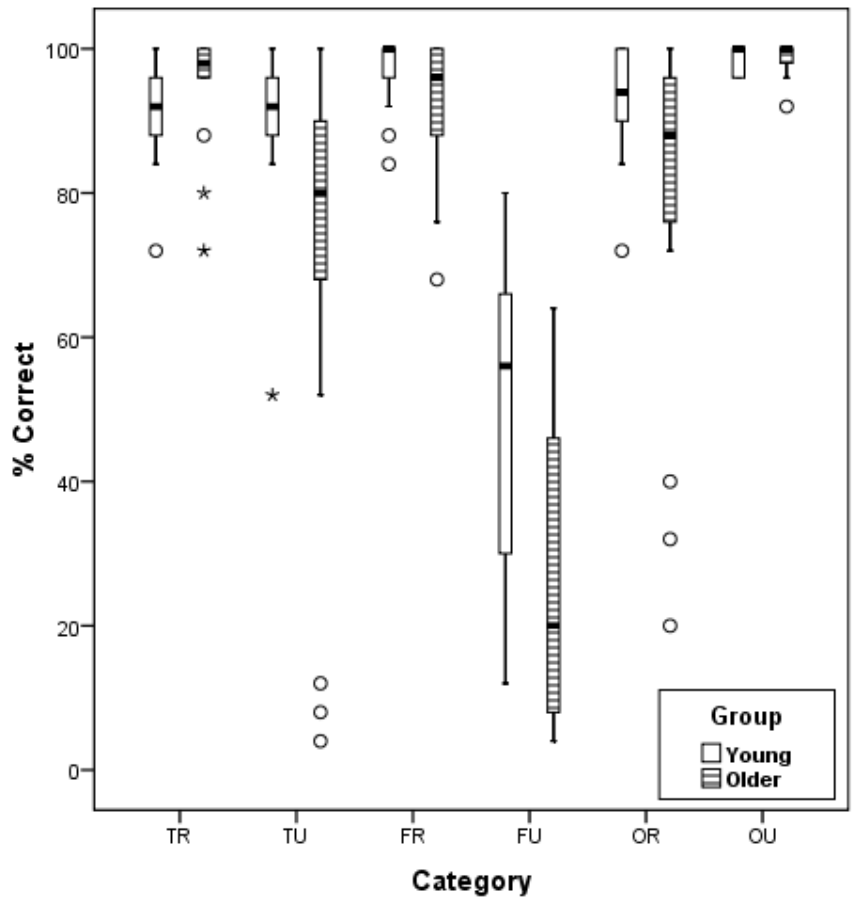
Figure 1: Task Accuracy as a Function of Exemplar Category for Young and Older Adults

Table 3

Accuracy (Proportion Correct) of Exemplar Categories by Group

Category	Young Accuracy	Older Accuracy
TR	.9220	.9560
TU	.8940	.7040
FR	.9700	.9180
FU	.5000	.2680
OR	.9340	.8080
OU	.9880	.9880

Table 4

Accurate and Error Response Times for Young and Older Adults in Milliseconds

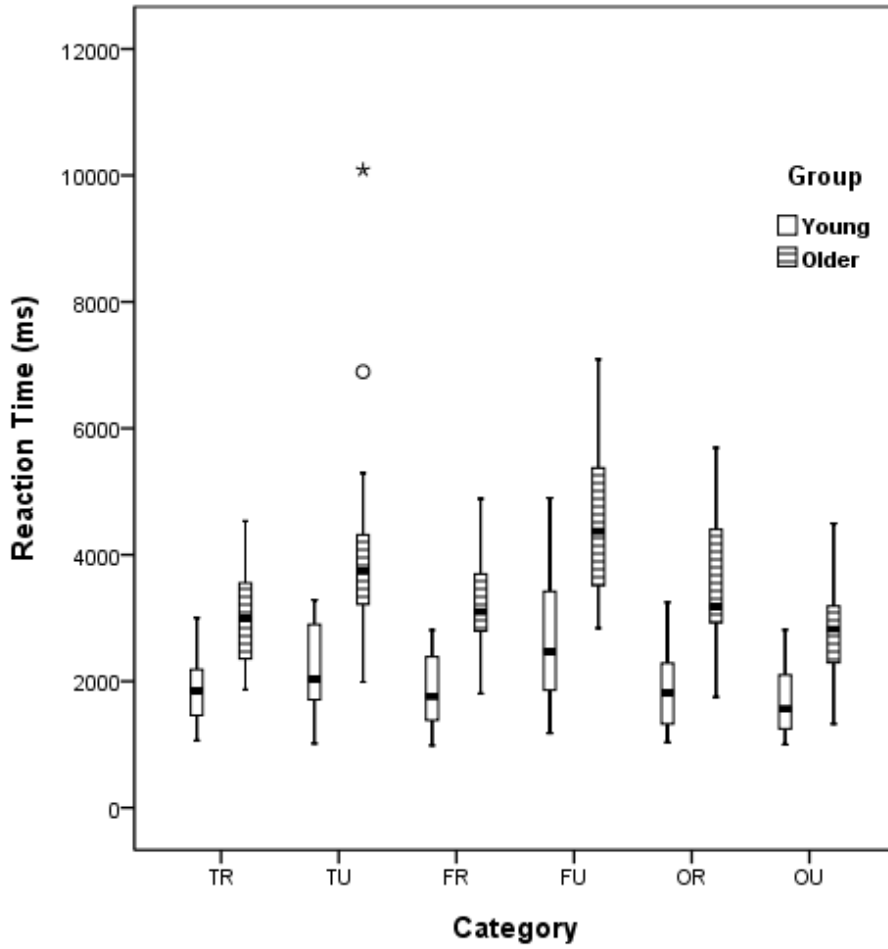| | Accurate responses | | Error responses | |
	M	*SD*	*M*	*SD*
Young	2040.145	679.214	3292.551	1433.628
Older	3581.083	848.842	5264.960	1233.933

Figure 2: Reaction Time as a Function of Exemplar Category for Young and Older Adults
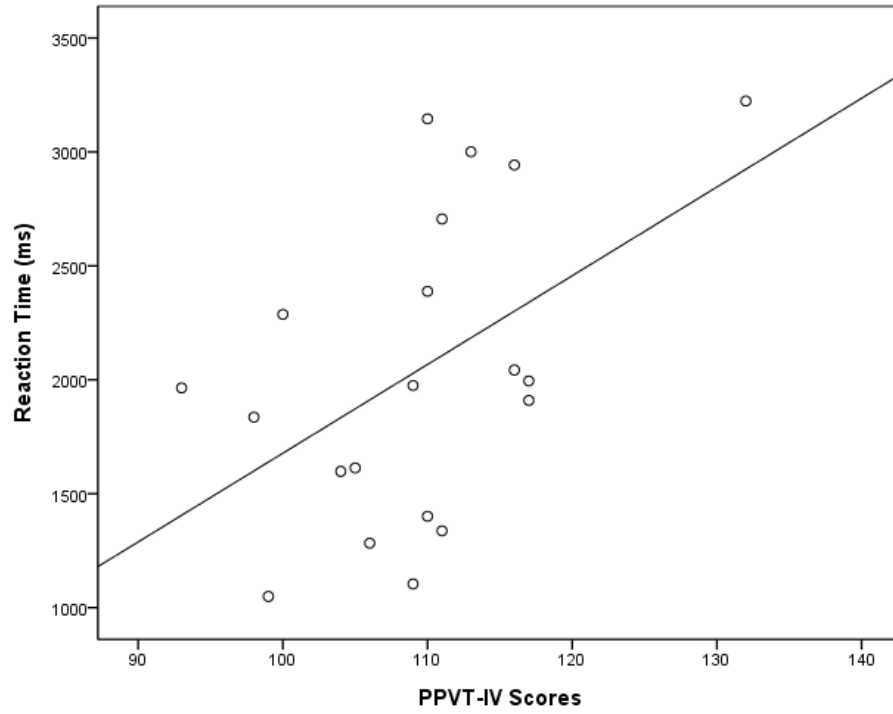
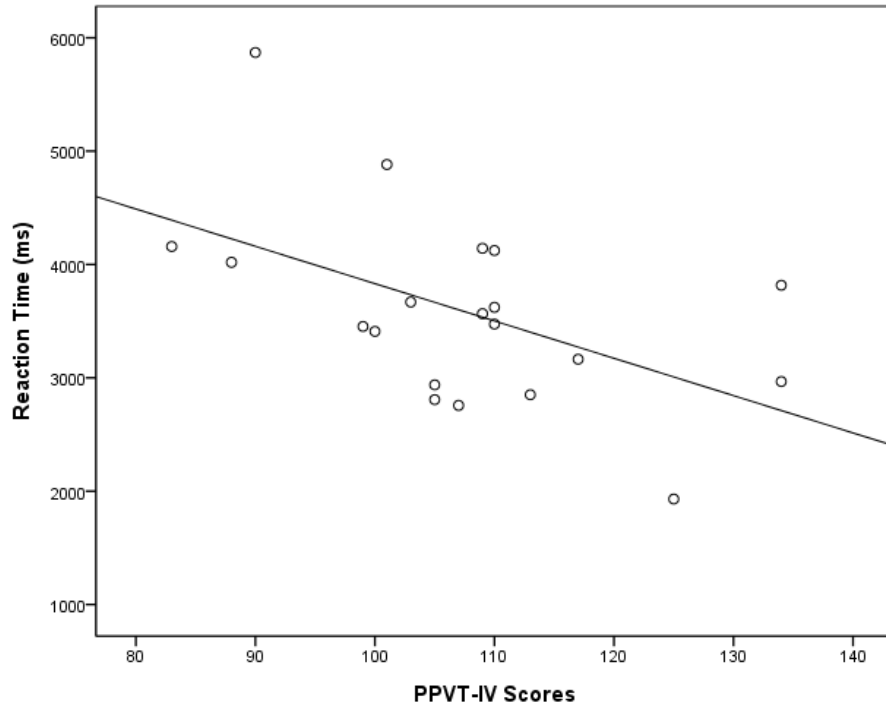*Figure 3: Correlation between Reaction Time and PPVT-IV for Young Adults*

Figure 4: Correlation between Reaction Time and PPVT-IV for Older Adults