CATEGORIZATION IN CONTEXT FOR YOUNG AND OLDER ADULTS

by

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Individuals make sense of the world by grouping items into categories, or clusters of concepts that share certain characteristics. Some research has indicated that older adults may organize concepts differently than young adults; however, findings have been inconsistent - dependent upon the tasks.

Linguistic context influences word meaning. Although common categories (e.g., animals, furniture) are context-independent, exemplars are only activated by certain contextual cues within a message. Common categories are generally well-established in memory; however, it is unclear whether older adults use linguistic context as effectively as younger ones.

The purpose of the current study was to investigate the effect of linguistic context on category structure in young and typical older adults. All participants passed hearing, reading, and category screening tests. They were administered the *Peabody Picture Vocabulary Test - IV* (PPVT-IV), yielding no significant differences between the groups on this measure as well as educational level. In a timed computer-based contextual categorization task, participants (20 young, 20 older) were provided with 150 stimulus sentences containing a superordinate category label. Using the context of the sentence, the 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 by answering ‘Yes’ or ‘No’. There were six exemplar categories (i.e., true related, true unrelated, false related, false unrelated, out-of-set related, out-of-set unrelated). Accuracy of response and reaction time were determined for each sentence for all participants.

Results indicated that young adults were significantly more accurate and responded significantly faster than the older group. Both groups had similar patterns of errors for the six categories. Participant scores on the PPVT-IV correlated with reaction time for both age groups but not with accuracy. Logistic regression indicated that it was possible to predict a participant's accuracy based on age group, category of response, as well as the interaction between the two variables. It appears that categorization is vulnerable to the aging process, which may have further implications for communication effectiveness and cognitive processing.

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In memory of my Daddy, Mike Lewis

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Introduction

Typical aging may be distinguished from pathological aging by the absence of mental or physical disease, though changes in both are expected (Atchley, 2000). Relative to language, it has been observed that vocabulary and sentence structure remain generally unchanged with age (Burke & MacKay, 1997; James & MacKay, 2007; Verhaegen, 2003). Procedural memory also remains intact, whereas episodic and working memory both show subtle declines (Light, 1991; Luo & Craik, 2008; Zahr, Rohlfing, Pfefferbaum, & Sullivan, 2009). Thus, an individual may experience an increase in the "tip-of-the-tongue" phenomenon as they age (Burke & Shafto, 2004; Hough, 2007b; James & MacKay, 2007); however, it is possible to retain adequate communication and retrieval skills throughout one's lifetime. As individuals age, the processes involved in expression and understanding of language may show some behavioral slowing relative to earlier development (Burke & MacKay, 1997; Burke & Shafto, 2004; Dagerman, MacDonald, & Harm, 2006; McCrae, Arenberg, & Costa, 1987). However, while overall language skills may not decline significantly with age, categorization is an active process utilized in communication that requires a continual retrieval of words from the lexicon; thus, it may be more vulnerable to deterioration (Brickman et al., 2005; Hough 2007a).

The purpose of the current study was to examine categorization skills in linguistic context in young and typical older adults. The review of literature begins with a discussion of categorization and age-related changes in typical adults. This will be followed by a presentation of information on context and its effect on categorization abilities as well as its influence on advancing age. The literature review concludes with the plan of study and experimental questions relevant to the present study.

Categorization

A category exists whenever two or more distinct entities are treated equally (Hough, 1989; Hough, 1993; Mervis & Rosch, 1981). Categorization is the ability to group things together based upon similar characteristics or relationships, thus simplifying the world at large (Smith & Medin, 1981). When one is asked to offer members of a category (e.g., *fruit*), there are certain exemplars that are considered more typical (e.g., *apple* or *banana*) than others (e.g., *cherimoya* or *che*) (Barsalou, 1983; Barsalou, 1987; Hough, 1989; Hough, 1993; Hough 2007a; Jordan, 1990; Kiran & Thompson, 2003; McCloskey & Glucksberg, 1978; Sebastian & Kiran, 2007).

Common categories are typically the most frequently examined type of category. These are sets of natural object concepts, such as ‘vegetables’ or ‘sports’, which have a graded structure; that is, some examples are better than others (Barsalou, 1983; Barsalou, 1987; Hough, 1989; Hough, 1993; Hough 2007a; Jordan, 1990; Kiran & Thompson, 2003; McCloskey & Glucksberg, 1978; Sebastian & Kiran, 2007; Smith, Shoben, & Rips, 1974). Common categories are so well established in the memory that retrieval of one member (e.g., *chair*) also may result in activation of subsequent members (e.g., *table* and *furniture*). Common categories are more easily retrieved via taxonomic organization, which allows individuals to cluster similar items in memory (Barsalou, 1983). According to Pennequin, Fontaine, Bonthoux, Scheuner, and Blaye (2006), in taxonomic organization, one would group objects based on membership in the same semantic category (*dogs* and *cats* as ‘animals’). Thus, members are categorically or semantically related items or ideas (Sachs, Weis, Krings, Huber, & Kircher, 2008).

Relational categories are those whose membership is determined by a relationship (e.g., *robbery* contains *thief*, *goods*, and *victim*) (Gentner & Kurtz, 2005). Ad hoc categories are the most studied relational type and are associated with a specific context, such as ‘things to take to the beach’ or ‘things that can be folded’ (Barsalou, 1982; Barsalou, 1983; Barsalou, 1987; Gentner & Kurtz, 2005; Hough, 1989; Hough, 1993; Hough, 2007a; Medin & Smith, 1984). Goal-directed or ad hoc category concepts are difficult to identify without context, as individuals do not typically think of the included items as belonging together (Barsalou, 1983; Barsalou, 1987; Hough, 1989; Hough, 1993; Hough, 2007a). Like common categories, goal-directed categories possess a graded structure so that some members are considered better examples of the category than others (Barsalou, 1983; Barsalou, 1987; Gentner & Kurtz, 2005; Hough, 1993; Sebastian & Kiran, 2007). There may be multiple exemplars for an ad hoc category, but these may differ from person to person with respect to an individual’s experience (Barsalou, 1983). For one individual, *things to take on an airplane* may include ‘laptop, pillow, water’ and for another, items may be ‘backpack, book, iPod’. Ad hoc categories are organized thematically. In thematic organization, items are grouped together based on knowledge relative to scenes or familiar events (*dog* and *bone* since the dog eats the bone). Thematic categorization typically groups members that share semantic associations or functionality (Sachs et al., 2008).

Theories of Categorization

Researchers have put forward several views of concept structure with respect to categorization: classical, probabilistic, exemplar, schema, and explanation-based (Armstrong, Gleitman, & Gleitman, 1983; Komatsu, 1992; Medin & Smith, 1984). The classical view maintains that all category members share a set of features that are necessary and sufficient for classification (Armstrong et al., 1983; Cohen & Murphy, 1984; Keil, 1994; Kiran & Thompson, 2003; Komatsu, 1992; Medin & Smith, 1984; Smith & Medin, 1981). Although this model suggests categories must be clearly defined, most concepts are not. Additionally, this view fails to account for unclear cases (e.g., is a radio *furniture*?) and the inconsistency with which some items are categorized (e.g., is a tomato a *fruit* or *vegetable*?) (Cohen & Murphy, 1984; Komatsu, 1992; Medin & Smith, 1984). Furthermore, the classical model does not explain why nested concepts within an immediate superordinate category (chicken as a subtype of *bird*) sometimes share more defining characteristics with a distant one (*animal*) (Medin & Smith, 1984).

According to the probabilistic or family-resemblance model, concepts are represented by certain characteristics (Komatsu, 1992; Medin & Smith, 1984; Rosch & Mervis, 1975; Smith & Medin, 1981). This means there is a graded structure within categories so some members are better examples of a concept than others (Armstrong et al., 1983; Cohen & Murphy, 1984). Some features are considered to be more critical than others (Keil, 1994; Rosch & Mervis, 1975; Smith & Medin, 1981). Although the probabilistic view is flexible enough to account for unclear cases, concepts bordering two ideas (e.g., *fruits* and *vegetables* in our tomato example above), and nested concepts, some critics also consider this flexibility to be a disadvantage (Armstrong et al., 1983; Medin & Smith, 1984).

The exemplar model suggests that while it is not necessary to completely define properties of a category, the more characteristics a member shares with a best example or exemplar of that category, the more likely the concept can be classified as belonging to the category (Medin & Smith, 1984; Smith & Medin, 1981). Criticism revolves around the lack of constraints necessary to represent a concept, especially complex concepts made up of straightforward ones (e.g., *pet fish* from the simpler ideas of *pet* and *fish*) (Cohen & Murphy, 1984; Komatsu, 1992; Medin & Smith, 1984).

The schema view is a hybrid of the family-resemblance and exemplar models (Komatsu, 1984). Schemata may be defined as packets of knowledge that include rules for use (Cohen & Murphy, 1984; Komatsu, 1992; Rumelhart, 1980). Each scheme contains slots for logical descriptors and constituent parts (Cohen & Murphy, 1984; Komatsu, 1992). For example, *pony* would include attributes (i.e., color, function, location, appropriate size for child rider) as well as components of the animal (i.e., legs, mane, tail). Additionally, schemes allow for relationships with other concepts and specific instances of a particular member (e.g., *Scooby-Doo* as an actual example of *dog*) (Cohen & Murphy, 1984; Komatsu, 1992).

For the explanation-based type, there are several subtypes in this group that share similar characteristics (Komatsu, 1992). Instead of categorization based on judgments of similarity between concepts, explanation-based models group members based on relationships to other concepts or attributes associated with concepts (Keil, 1994; Komatsu, 1992). That is, one cannot understand one concept without understanding how it relates to associated ideas (Keil, 1994; Komatsu, 1992). For example, the concept *piano* includes information about the use of a bench, which is necessary for a pianist to sit on to play (Komatsu, 1992).

In judging whether a category member is typical or atypical of a particular category, good examples receive preferential processing relative to other less typical category examples (Armstrong et al., 1983; Keil, 1994; Kiran & Thompson, 2003; McCloskey & Glucksberg, 1978; Sebastian & Kiran 2007). This is referred to as the typicality effect; it is not accounted for by the classical model of categorization (Medin & Smith, 1984). Interestingly enough, McCloskey and Glucksberg (1978) proposed that categories have unclear, fuzzy boundaries which separate members from nonmembers. However, reaction times are faster for typical versus atypical examples during category verification tasks and event-related potential studies (Keil, 1994; Kiran

& Thompson 2003; McCloskey & Glucksberg, 1978; Rosch, Simpson, & Miller, 1976; Smith et al., 1974). Three models of typicality have been proposed to account for these effects of category member identification: feature comparison, prototype or family resemblance, and exemplar (Kiran & Thompson, 2003; Mervis & Rosch, 1981; Rosch et al., 1976a; Rosch et al., 1976b; Rosch & Mervis, 1975; Smith et al., 1974).

The feature comparison model suggests that categorization is a two-stage process (Kiran & Thompson, 2003). In the first phase, features are either identified as being grossly present or absent. Typical members and nonmembers are only subject to this initial stage. Atypical members, however, continue on to a second step due to matching with *some* criteria for the category (Kiran & Thompson, 2003).

The prototype or family resemblance model indicates that a category is represented by a set of features that are shared by most but not all members of the category (Kiran & Thompson, 2003; Rosch & Mervis, 1975). A prototype is an ideal representation or benchmark of a category against which all other possible category members are measured (e.g., *robin* as the prototype for *bird*). The level of typicality of a particular category member is related to the degree to which this member possesses qualities in common with the ideal representation as well as other category members (Rosch et al., 1976b). Typical examples of a category share more characteristics with other members, while atypical ones share fewer attributes (Komatsu, 1992; Rosch et al., 1976b).

The exemplar model suggests that a category is represented by members that have been previously encountered (Kiran & Thompson, 2003; Komatsu, 1992; Smith & Medin, 1981). That is, when faced with a new category member, its category membership is judged based on comparison to existing or familiar category exemplars. Typical members match more closely with previous examples, while atypical members show fewer similarities (Rosch et al., 1976b). This is different from the prototype model in that categories are represented as a collection of good examples instead of an exemplar with average values; that is, several concepts represent a single category (Rosch et al., 1976b; Smith & Medin, 1981). For example, the exemplars "robin, chicken, penguin, flamingo" may represent the category *bird* in this model.

Categorization in Typical Aging

Some investigations have noted that older adults give preference to the ad hoc or thematic strategy over taxonomic or common category organization (Lin & Murphy, 2001; Smiley & Brown, 1979). On the other hand, other studies have found no such preference in categorization as adults advance in age (Kogan, 1974; Pennequin et al., 2006).

Guttentag and Siemens (1986) observed that typical older adults tend to favor use of semantic categories over association cues. Using young adults (mean age 20.3) as the baseline for performance, children (2^{nd} and 5^{th} graders) were better at providing personal and unique associations with words than older adults, who tended to automatically encode words into categories. However, Wingfield, Lindfield, and Kahana (1998) observed that typical older adults had difficulty encoding and using temporal information; however, they did not show deficits in making associations to aid word retrieval.

Coppens and Frisinger (2005) observed that confrontation naming performance decreased with increased age. This deterioration occurred faster relative to the naming of living things. With that in mind, the category effect observed in the normally aging population may confound identifying early signs of dementia or other diseases in an individual.

Semantic fluency tasks require an individual to generate members of a specific category. They are often timed and require the individual to generate examples as quickly as possible.

According to Mayr and Kliegl (2000), the typical aging process may affect various brain regions differently; however, lifetime learning may counteract or minimally reduce these declines in brain functioning. The temporal lobes, often associated with semantic fluency and processing, including categorization, may be relatively spared as one ages (Mayr & Kliegl, 2000). However, frontal lobes associated with nonsemantic fluency (e.g., *words that start with letter* ‘p’) may show more biological and functional loss. Semantic knowledge may be organized redundantly in the brain so that as age-related degeneration occurs in one area, other routes remain viable to adequately sustain categorical information (Mayr & Kliegl, 2000).

The ability to generate members of a category appears to decline with age. Hough (1993) found that older adults frequently repeated the same exemplars for particular categories on an exemplar generation task. Hough suggested that category structure may be disrupted possibly related to memory decay, so that fewer category exemplars are available to recall. Alternatively, older adults may compensate for difficulties accessing atypical exemplars by repeating more typical ones (Hough, 1993). It is conceivable that older adults also may have difficulty recognizing that an atypical member of a category is more peripheral to the central prototype.

Researchers have reported that there may be a breakdown between lexical and semantic representations while both individually remain intact (Au et al., 1995; Hough, 2007b). This has been termed the transmission deficit hypothesis (Burke & MacKay, 1997; MacKay & Burke, 1990). Older adults generally make more errors with regard to word or pseudoword production as well as show increased production time as compared to younger adults (James & MacKay, 2007). However, James and MacKay (2007) also found no or minimal difference in comprehension ability between older and younger adults. This asymmetry in input (i.e., comprehension) and output (i.e., production) provides support for the transmission deficit hypothesis and contradicts theories that either support across-the-board sparing or destruction of verbal production abilities. Neither theory provides adequate explanation for why some verbal abilities remain intact while others are decimated (James & MacKay, 2007).

Context

Word meaning is often affected by the context in which it is spoken (Dagerman et al., 2006; Roth & Shoben, 1983; Smith et al., 1974). According to Miller (1978; 1999), there are three types of context that may affect representation of information: situational, topical, and local.

Situational context is general information related to the circumstances of a communication, such as the purpose of the exchange or written record. This type of context relies heavily on the personal and world knowledge of the recipient of the message (Kintsch, 1994; Miller, 1999). For example, an individual's accumulated knowledge about a certain condition (e.g., atrial fibrillation) directs thoughts and actions in a given situation: *The surgeon tried to shock Clayton's heart into sinus.* Without the basic understanding that an irregular heartbeat, or atrial fibrillation, may be converted to a normal rhythm using a procedure called cardioversion, the aforementioned sentence would not relay its intended meaning.

Topical context is another type of context that limits the interpretation of word meanings. It is comprised of the substantive words in a sentence but depends on the current topic of discussion (Chodorow, Leacock, & Miller, 2000; Miller, 1999). The word "shot" means one thing in a discussion among marksmen (the discharge of a firearm), but something entirely different on the golf course or basketball court (an aimed stroke or throw in a game). A "shot" brings one thing to mind when speaking about the profession of a photographer (a snapshot), another for a nurse (an injection), and yet another for a bartender (a small measure of alcohol) (Higgins & Lurie, 1983; Miller, 1999).

The third context, local, refers to information provided by the words in the immediate vicinity of the spoken or written word in question (Chodorow et al., 2000; Miller 1999). This type of context is dependent upon word order and whether the word in question belongs to one syntactic category or another for interpretation. For example, the sentence 'Gibbs aimed his weapon and took a *shot*' uses local linguistic context (i.e., *aimed* and *weapon*) to clarify that the sentence refers to discharging a gun (Miller, 1999). However, the words 'camera' and 'lens' in 'Riley focused the camera lens and took a *shot*' clearly guide the message recipient to understand the statement is about photography.

Influence of Context on Categorization

Categories may be influenced by the context of the situation, topic, or locality. According to Barsalou (1982), concepts have some properties that are context-dependent and some that are context-independent. In the sentence "Chris used X as a life-preserver when the boat sank", the word *basketball* could be placed in the X-slot, bringing "floating" to the forefront of characteristics associated with that word. Without the context provided in this example however, a *basketball* is more likely to represent descriptions of "round" or "bounces". Greenspan (1986) has indicated that linguistic context does not inhibit activation of unemphasized properties of a word or concept. In the previous example, that would mean that "floats" would indeed be instantiated along with "round" and "bounces" even when speaking of a basketball in the context of a college sporting event.

Common categories (e.g., *mammals, vehicles*) have typically been considered to be context-independent (Barsalou, 1983; Sachs et al., 2008). Members of these natural categories are members of the category regardless of the linguistic context, though some are better examples than others (Barsalou, 1983; Barsalou, 1987; Hough, 1989; Hough 2007a; Jordan, 1990; Kiran & Thompson, 2003; McCloskey & Glucksberg, 1978; Sebastian & Kiran, 2007). Ad hoc or goal-derived categories (e.g., *things to sell at a garage sale*) are context-dependent (Barsalou, 1983; Hough, 1989). As noted previously, goal-directed categories are often difficult to identify without linguistic context, as they are organized by association to a particular theme or situation (Barsalou, 1982; Barsalou, 1983; Barsalou, 1987; Gentner & Kurtz, 2005; Hough, 1989; Hough, 2007a; Medin & Smith, 1984).

Context, Categorization, and Typical Aging

Linguistic context provides cues for a listener or reader to use so as to determine the best lexical referent as well as the most appropriate interpretation of a word in a context (e.g., does a *boxer* in a particular sentence refer to a *dog* or a *pugilist*?). For older adults, linguistic context has been found to be more useful for clarifying meaning when it precedes rather than follows target information (Cohen & Faulkner, 1983; Meyer, Schvaneveldt, & Ruddy, 1975; Wingfield, Alexander, & Cavigelli, 1994). Although older adults may take advantage of linguistic context to help derive meaning, memory decline in typical aging may make it more difficult for older adults to use vital contextual cues for clarification of an ambiguous word (Wingfield et al., 1994). That is, memory deficits prohibit the recall of an unclear word distant from context necessary to resolve meaning. In generating category labels for exemplars, typical older adults did not require context for common categories; context was relevant and necessary for generating ad hoc category labels (Barsalou, 1983; Hough, 1989). As noted previously, this may be due to how well-established in memory common categories are (Hough, 1989).

Cohen and Faulkner (1983) theorized that there is an increase in older adults' ability to use contextual information as compensation for typical declines in the processing of sensory information. This conclusion suggests that reduced ability to interpret information from sense organs with age is possibly balanced by more intact retrieval and linguistic skills relative to interpreting information in context.

Summary and Rationale

One of the primary ways that individuals make sense of the world is by grouping items into categories, or clusters of concepts or words that share certain characteristics (e.g., *woodwinds* or *things to take to Tae Kwon Do class*). Many theories have been proposed to explain how concepts are classified into categories. While some research has indicated that older adults may organize concepts differently than young adults, there are no consistent or definitive findings.

Linguistic context appears to be influential in determining the meaning of words in spoken and written language. Although common categories are generally considered to be context-independent, the exemplars of a category may be activated only by the specific linguistic context of the message. Research has revealed an effect of category type, in that common categories, when compared to other types (e.g., relational or ad hoc) are better established in memory and are more easily retrieved as clusters of concepts. However, it is not clear if this observation is influenced by age of the individual. Typical older adults may not utilize linguistic context as effectively as younger adults, thus revealing an age effect for this variable. Furthermore, in the absence of context, older adults have been observed to be more likely to access typical category exemplars repeatedly before they retrieve atypical category members.

Questions remain regarding how adults utilize context to group concepts into categories as well as how aging may affect the ability to categorize information. Furthermore, it is unclear whether typical older adults are able to utilize linguistic context as effectively as young adults for adequate and appropriate retrieval and interpretation of concepts. If older adults have reduced abilities relative to this process, comprehension may be adversely affected, as subsequent communication and cognitive processing (e.g., responding to questions appropriately, memorization, judgment) may be based on inaccurate information.

Plan of Study and Experimental Questions

The purpose of the current study was to investigate the effect of linguistic context on category structure in typically-aging young and older adults. Specifically, young and older adults' ability to use local context was examined relative to selecting appropriate category exemplars when provided with a superordinate category term. In a timed semantic decision task, participants were provided with sentences containing a superordinate category label. Using the context of the sentence, the participants were required to determine if a specific exemplar was the best example of the target category concept in the sentence. Accuracy of response and response time were determined for each sentence for all participants. The following experimental questions were addressed:

1) Is there a significant difference between young and older adults in accuracy of identification of exemplars for category labels relative to linguistic context?
2) Is there a significant difference between young and typical older adults in response time in identifying exemplars for category labels relative to linguistic context?
3) Is there a significant difference between young and older adults in their pattern of errors for identifying exemplars for category labels relative to sentence context for

accuracy? Is there a significant difference between groups relative to response time of error responses?

4) Are there significant correlations between PPVT-IV scores and response time and/or accuracy on the experimental task for the young group? The older group?

Chapter 2

Method

Participants

Participants consisted of two groups of individuals: a group of young adults and a group of older adults, based on age at the time of testing. The participants were 40 typical adults who were recruited from two age ranges: 20-35 (i.e., younger) and 65-80 (i.e., older). The young adults ranged in age from 22-35 years. The older adults ranged in age from 65-80 years. Participant demographic data is disclosed in Table 1.

Every participant who completed the study attained at least a high school diploma or its equivalent. All participants were native speakers of American English. Due to participant availability, more females than males contributed to this study; thus, gender was not considered as a factor for analysis. Participants reported no history of learning disability, attention disorders, neurological problems, including head injury, or psychiatric disturbance. A participant questionnaire is presented in Appendix A.

All participants had hearing acuity within normal limits or typical for their age group. Young adults were administered a hearing screening at 1000, 2000, and 4000 Hz. at 25 dB HL in a quiet room based on American Speech-Language-Hearing Association standards (ASHA, 2004). Older adults passed a modified hearing screening at the same frequencies as the younger adults, but at 40 dB HL (Ventry, 1992). All participants had adequate vision and reading proficiency to perform the experimental task. This was determined by reading the Rainbow Passage (Fairbanks, 1940) aloud with 100% accuracy. The selected paragraph reflected the length and complexity of the experimental material (i.e., 6^{th} grade level). The sentences of the passage were presented in the font and size identical to those encountered in the experimental

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

task; that is, 40 point Times New Roman. All participants passed a category-screening test with at least 80% accuracy (*M* = 0.932, *SD* = .056). Three choices were offered; the task was to select the best category exemplar. Category and reading screening tests are presented in Appendices B and C, respectively.

All participants were administered the *Peabody Picture Vocabulary Test-IV* (PPVT-IV) (Dunn & Dunn, 2007). The PPVT-IV is a test of receptive vocabulary that has been found to correlate very highly with tests of intelligence such as the Wechsler Adult Intelligence Scale (WAIS), thus offering a measure of vocabulary-oriented cognitive ability. The PPVT-IV requires presentation to the participant with four pictures; then the participant is asked to indicate the picture that best illustrates the word spoken by the examiner. Participants achieved a standard score within normal limits (>85) to be included in this investigation. Individual demographic data for age, gender, education, and PPVT-IV scores are presented in Appendix D.

General Procedures

All potential participants were informed of all aspects of the study outlined in the informed consent document by the principal investigator. Each potential participant was required to sign the informed consent form in order to take part in the investigation. This form was the only documentation containing identifying information about the participant. Otherwise, a number was assigned to each participant; only these codes were used to identify each participant. A sample consent form is presented in Appendix E.

The principal investigator administered or supervised administration of all pre-experimental and experimental tasks. The entire battery including participant questionnaire, hearing screening, reading screening, category screening, *Peabody Picture Vocabulary Test – IV*, and experimental task took approximately 2 hours to complete including breaks as needed. In all cases, testing was completed in a quiet room to minimize distractions. When geographically possible, testing was completed at the Health Sciences Building on the East Carolina University campus. Some participants were in locations at an inconvenient distance from Greenville. Thus, for these individuals, testing was completed in their respective locales in quiet areas in their homes.

Experimental Testing

Materials. Twenty-seven sentences were developed or based on the work of Roth and Shoben (1983) for use in this study. Using the Fry Readability Graph (1968) for predicting readability, the samples taken reflected a 6^{th} grade-level difficulty. Appendix F is a display of information to determine readability level.

In the experimental task, for each of 25 sentences and 2 practice sentences, one noun was replaced with a superordinate category label for the target word. Six exemplars were developed for the category label target word in each sentence. These exemplars varied in degree of 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 the meaning of the sentence. The six exemplars were identified as true related, true unrelated, false related, false unrelated, out-of-set related, and out-of-set unrelated. These designations were based on previous research with college-aged students (Roth & Shoben, 1983) and adults with aphasia (Hough & Jordan, 1991; Jordon, 1990).

True related examples (T/R) are the most appropriate category exemplars associated with the superordinate label for the particular sentence context (e.g., *blue* in the sentence 'At noon today, the summer sky was a lovely shade of *color*.'). True unrelated choices (T/U) are category exemplars that are members of the superordinate category label indicated in the sentence but are less typical based on the linguistic context of the particular sentence (e.g., *sapphire* in the sentence ‘Jan loved the *gem* in her engagement ring.’). False related (F/R) choices are referents of the category term in isolation, but violate constraints based on linguistic context (e.g., *Uranus* in the sentence ‘Melissa looked at the ringed *planet* through the telescope.’). False unrelated (F/U) exemplars are members of the category in isolation but are less typical based on the linguistic context of the particular sentence (e.g., *McDonald’s* in the sentence ‘Lydia found her favorite wine at the *restaurant*.’). Out-of-set related (O/R) choices are nonmembers of the superordinate category label in the sentence, but are members of a related category within the particular linguistic context of the sentence (e.g., *bucket* in the sentence ‘Mike relaxed on the *furniture*.’). Out-of-set unrelated (O/U) choices are exemplars that are not members of the superordinate category label within the sentence (e.g., *tuba* in the sentence ‘After the game, Jon’s *clothing* was wrinkled and muddy.’). All practice items and experimental stimuli are presented in Appendix G.

Procedures. The practice and experimental sentence stimulus items were presented visually on the 14” screen of a Dell Inspiron 8500 laptop computer. While all participants were offered the chance to have the researcher read all stimuli aloud, only one participant accepted this offer. All stimuli were displayed using SuperLab 4.0, a product from the Cedrus Corporation (2007). However, specific procedures relative to the task for the practice stimuli also were presented using a PowerPoint® presentation. Procedures for the practice stimuli and experimental stimuli on the computer using SuperLab Pro were as follows.

Practice items were initially presented using Microsoft® PowerPoint® to ensure the participants’ understanding of the task format. Two target stimulus sentences were utilized as practice items. Each practice sentence appeared twice; the participant determined the meaning of the superordinate category based on the linguistic context. One of the two trials with each sentence included presentation of the true related (T/R) meaning of the superordinate category label in the particular context. The other trial included presentation of the false related (F/R) exemplar relative to the superordinate category label. The target sentence was presented auditorally and visually with the investigator providing highlighting with vocal stress. Participants were asked to indicate "YES" or "NO" with an RB-834 response pad to familiarize themselves with the protocol in response to the practice items, although these were not timed during the PowerPoint® presentation. If the participant had difficulty with the 2 trials for each of the two practice stimuli in the PowerPoint® presentation, then all six trials for each practice sentence (12 stimuli) would have been presented; this scenario did not occur with any participant in the study. The same practice items (2 sentences with 6 exemplars = 12 stimulus items) were presented on SuperLab Pro once the participant understood the task format. Both trials for the two practice items were presented to all participants before moving onto presentation of practice and experimental stimuli in SuperLab Pro. Dimensions of the RB-834 response pad with task set-up are included in Appendix H.

A fixation cross appeared in the center of the screen for 5 seconds as a signal for the participant to attend. Next, a target sentence was presented visually in 40 point Times New Roman font to facilitate readability. The target word was capitalized and placed within single quotation marks. The stimulus sentence remained on the screen for 10 seconds. Then, the participant was asked visually if, in the context of the sentence presented on the original screen, the category term meant "A". The participant answered "YES" or "NO" by pressing one of two clearly labeled switches. The Model RB-834 response pad was chosen as the answer key due to its relatively large (1 inch x 1.25 inch) activation surface. The contextual sentence remained on the screen for 12 seconds or until the participant responded, whichever came first. Then, another fixation cross appeared center-screen; this was followed by another sentence and corresponding categorization question. The 12 practice stimuli (2 target sentences with 6 exemplars for each sentence) were initially presented followed by the experimental stimulus items.

The sentences and corresponding yes/no category questions were randomized by the SuperLab 4.0 software. A flowchart illustrating these procedures is presented in Appendix I. Latency of response and accuracy were determined for each of the 150 experimental stimulus items (25 sentences paired with each of the six exemplars).

The protocols and specific instructions for both the practice and experimental stimuli are presented in Appendix J.

Chapter 3

Results

Pre-Experimental Testing

Independent t-tests were conducted between groups for education and standard scores on the *Peabody Picture Vocabulary Test – IV*. The findings revealed no significant differences between the two groups with respect to either education ($t(23.5) = 1.5$, $p = .147$) or PPVT-IV scores ($t(38) = .482$, $p = .633$).

Experimental Task

Accuracy. Accuracy data was recorded for the 150 semantic decisions made by each participant. As many of the participants achieved 100% accuracy in their decisions about some category exemplars, there was less variation in the sample mean than expected in view of the central limit theorem. According to the central limit theorem, with this number of participants, there should be normal variation in data points. This violation of the central limit theorem skewed the distribution, the mean, and the variance structure of the sample. Thus, a mathematical formula was used to calculate new variables with more normal variance structures. In particular, an arcsine square root transformation was conducted on the proportion of accurate responses.

Figure 1 is a display of accuracy data in percentages with respect to category of response for both groups. A two-factor mixed analysis of variance (ANOVA) was conducted on the task accuracy data for the two groups. The independent variables in the model were exemplar category, group, and the interaction (category*group). The dependent variable was accuracy. There was a significant main effect of group ($F(1, 38) = 6.548$, $p = .015$). Using the Greenhouse-Geisser adjustment due to the violation of sphericity there also was a significant main effect for

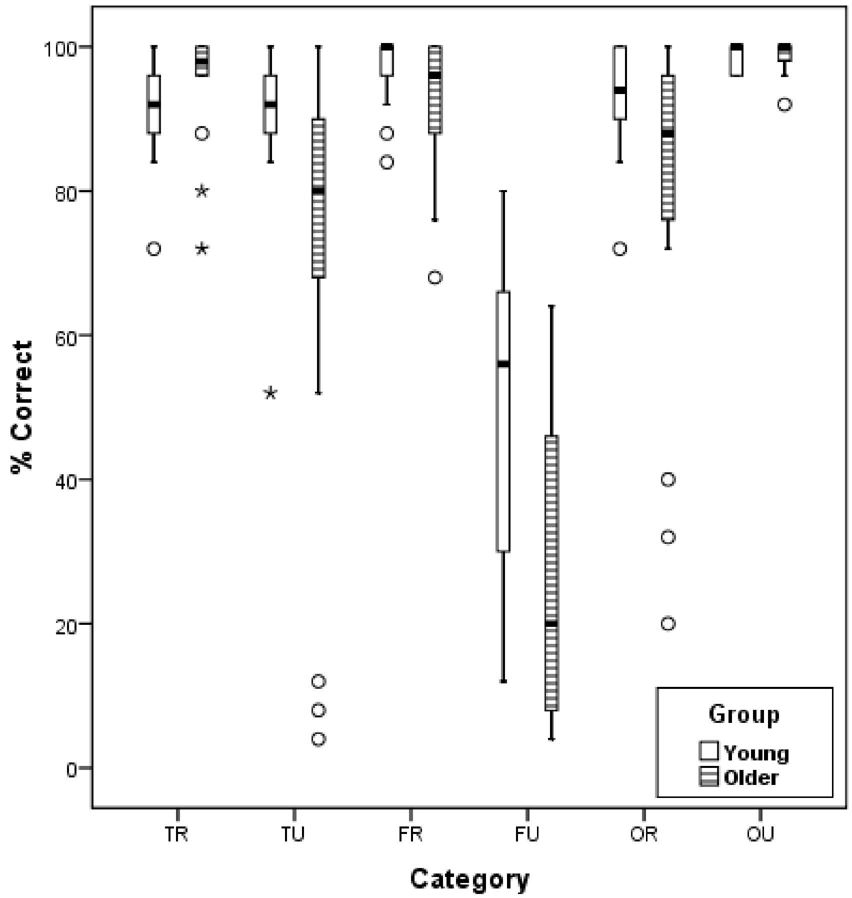

Figure 1: Task Accuracy as a Function of Exemplar Category for Young and Older Adults

exemplar category ($F(3.0, 115.8) = 141.714$, $p < .001$), as well as a significant interaction between the group and exemplar category variables ($F(3.0, 115.8) = 8.039$, $p < .001$).

Post hoc tests were conducted to find the source of significance in the group and category interaction. When comparing accuracy between the two groups, independent t-tests revealed significant differences between young and older adults for true related ($t(38) = -2.051$, $p = .047$), true unrelated ($t(26.4) = 2.874$, $p = .008$), false related ($t(38) = 2.179$, $p = .036$), false unrelated ($t(38) = 3.557$, $p = .001$), and out-of-set related ($t(38) = 2.237$, $p = .031$) responses. It should be noted that for each category, with the exception of the true unrelated exemplars, equal variance was assumed due to lack of significant findings with Levene's test. There was no significant difference between young and older adults with respect to accuracy on out-of-set unrelated exemplar identification ($t(38) = -.190$, $p = .851$).

Five single degree of freedom contrasts were conducted relative to exemplar categories within the young group. True related and true unrelated accuracy was compared, revealing no significant difference between those categories ($F(1, 19) = 1.624$, $p = .218$). All other contrasts (TR/TU/FR/FU vs. OR/OU, TR/TU vs. FR/FU, FR vs. FU, OR vs. OU) were significant at $p < .001$. The same contrasts were conducted relative to exemplar categories within the older group. All contrasts were significant at $p < .001$.

In order to determine whether group membership (i.e., young, older) or exemplar category (e.g., true related, true unrelated, false related) predicted a participant's accuracy on the experimental task, a binary logistic regression was undertaken. Logistic regression is used to describe the relationship between a dichotomous, binary response variable (i.e., task accuracy) and a set of explanatory variables. In this model, the explanatory variables were group, exemplar category, and the interaction (group*category). It is important to note that covariance between responses from the same individual was not taken into account for this model. This particular regression analysis revealed a main effect for group and category, as well as a significant interaction. That is, statistically, each of the explanatory variables predicted accuracy on the experimental task: group (*LR* = 23.0, *df* = 1, $p < .001$), category (*LR* = 1497.0, *df* = 5, $p < .001$), and interaction (*LR* = 41.6, *df* = 5, $p < .001$). The main effect for group suggests that young adults more often respond correctly to the experimental task in general. This information is displayed in Table 2. The main effect for category suggests that individuals respond more accurately to exemplars in the out-of-set unrelated category, but least likely to respond accurately to false unrelated exemplars. The significant interaction suggests that young and older adults respond differently to different exemplar categories. Young adults are more likely to respond correctly to true unrelated, false related, false unrelated, out-of-set related, and out-of-set unrelated exemplars. Older adults, however, are more likely to answer correctly most often to true related items. Additionally, the error rate of this model is 14%, with a 7.8% chance of error for correct responses and a 42.7% chance of error for incorrect responses. This suggests it is difficult for the model to predict an incorrect response.

Reaction Time. Mean reaction times for each group are shown with their respective standard deviations in Table 3. Independent samples t-tests were conducted to compare the average recorded reaction times for correct responses to the mean response times for errors for each group. The mean reaction time was significantly different for both groups, ($t(19) = -6.33$, $p < .001$). Additional independent t-tests were conducted to compare the average recorded time for correct responses between the groups ($t(19) = -7.002$, $p < .001$), as well as the mean error times

Table 2

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 3

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

between the groups ($t(19) = -4.826$, $p < .001$). As noted in Table 3, young adults reacted more quickly regardless of whether their responses were accurate.

Figure 2 is a representation of reaction times for each group by exemplar category. A 2 x 6 repeated measures ANOVA was conducted on the reaction time data in milliseconds with independent variables of group and category. The repeated measure was the six exemplar categories. Neither incorrect responses nor time-outs (i.e., items for which the participant did not respond within 12 seconds) were included in the reaction time analysis. The analysis revealed a significant main effect for group ($F(1, 38) = 40.182$, $p < .001$), as the young adults completed task items faster than the older group. Making an adjustment for a violation of sphericity, there also was a significant effect of exemplar category of response ($F(2.1, 81.6) = 26.677$, $p < .001$), as well as a significant interaction between the two variables ($F(2.1, 81.6) = 3.950$, $p = .021$).

Post hoc tests were conducted to find the source of significance in the group X category interaction. When comparing reaction time between the two groups, independent t-tests revealed a significance difference between the two groups for each exemplar categories, with the young adults responding significantly more quickly for all categories. Thus, all t-tests were statistically significant: T/R $t(38) = -5.187$; T/U $t(38) = -4.763$; F/R $t(38) = -6.654$; F/U $t(38) = -5.036$; O/R $t(38) = -5.842$; O/U $t(38) = -5.362$; all $p < .001$.

Five single degree of freedom contrasts were conducted relative to exemplar categories within the young group. All contrasts were statistically significant: TR/TU/FR/FU vs. OR/OU ($F(1,19) = 30.165$, $p < .001$); TR/TU vs. FR/FU ($F(1,19) = 6.039$, $p = .024$); TR vs. TU ($F(1, 19) = 9.565$, $p = .006$); FR vs. FU ($F(1, 19) = 39.327$, $p < .001$); OR vs. OU ($F(1, 19) = 12.750$, $p =$

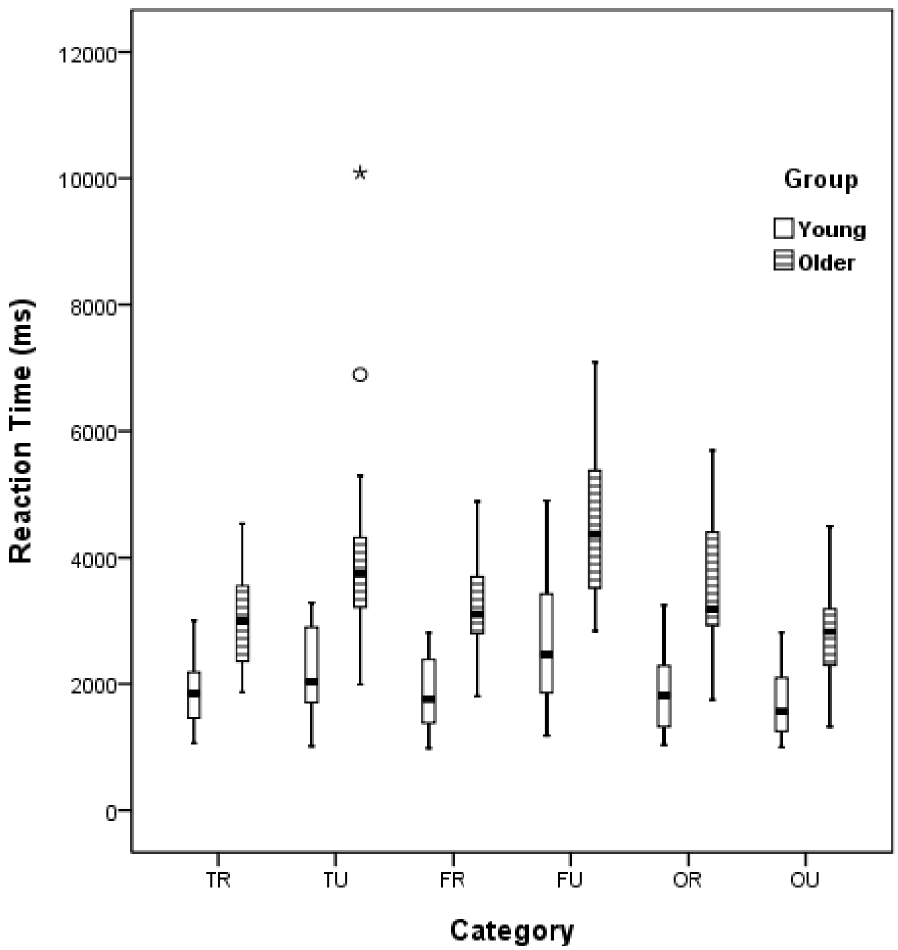

Figure 2: Reaction Time as a Function of Exemplar Category for Young and Older Adults

.002). The same contrasts were conducted relative to exemplar category for the older group. Reaction time for true related and true unrelated were compared to false related and unrelated, revealing no significant difference ($F(1, 19) = 1.955$, $p = .178$). All other contrasts were statistically significant at $p \leq .001$.

Correlation Data. Pearson Product-Moment correlations were conducted to examine relationships between PPVT-IV standard scores and reaction time and accuracy for both young and older adults. With respect to reaction time, there was a significant positive correlation between PPVT-IV scores and reaction time for the young group ($r = .490$, $n = 20$, $p = .028$). The scatterplot in Figure 3 illustrates this relationship. Interestingly, these results suggest that higher PPVT-IV scores were significantly related to slower responses on the experimental task. There also was a significant negative correlation between PPVT-IV standard scores and reaction time for the older adults ($r = -.515$, $n = 20$, $p = .020$), indicating that as PPVT-IV standard scores increased, participants responded to experimental items more quickly. These data are presented on the scatterplot in Figure 4. The correlations for accuracy were weak and not significant. The relationships between PPVT-IV standard scores and accuracy were as follows: young group ($r = -.261$, $n = 20$, $p = .266$), older group ($r =.372$, $n = 20$, $p = .106$).

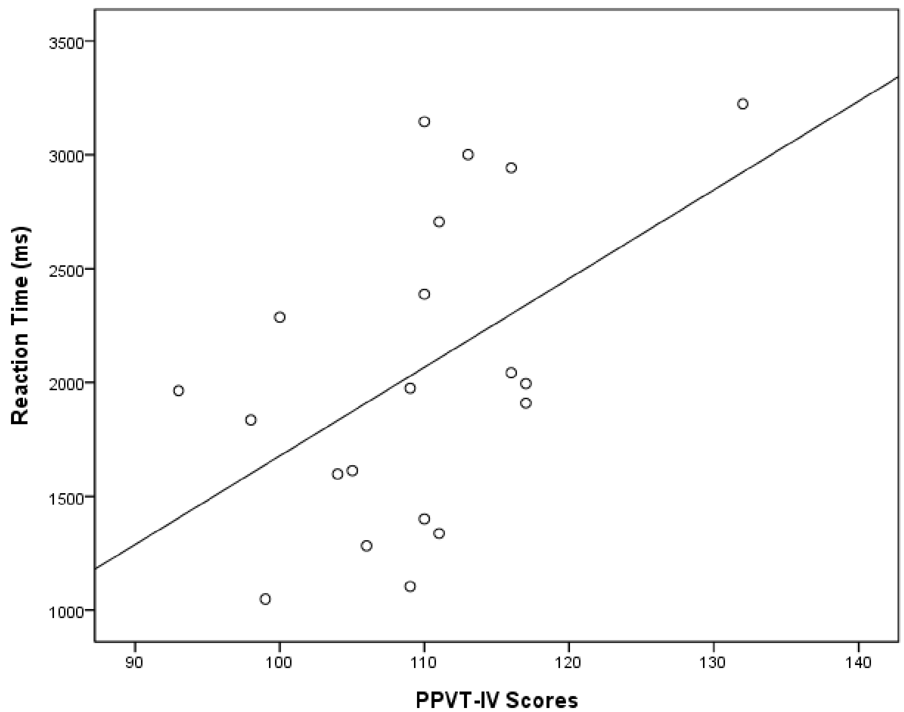

Figure 3

Correlation between Reaction Time and PPVT-IV for Young Adults

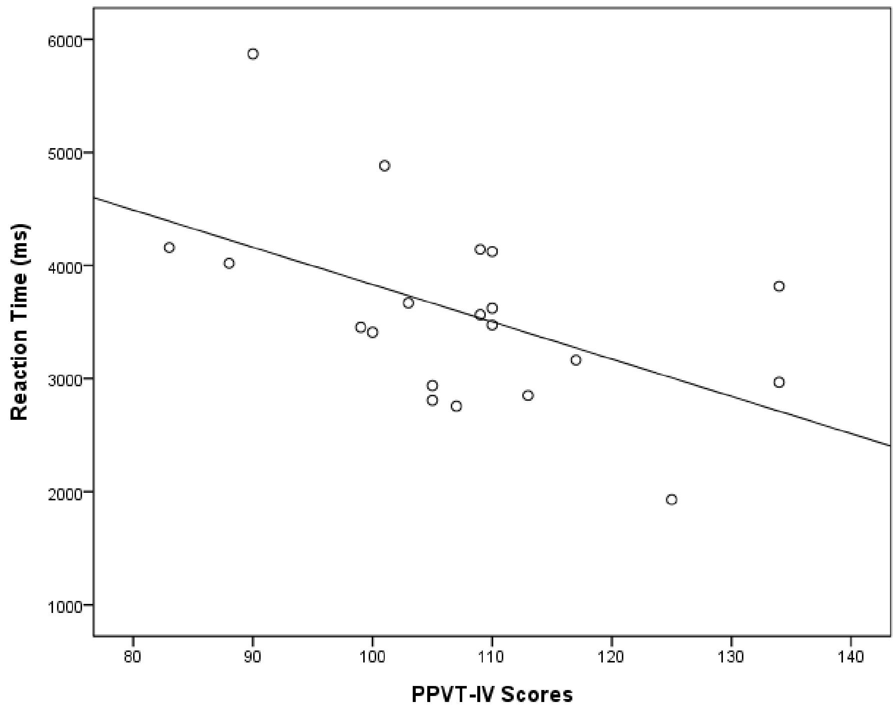

Figure 4

Correlation between Reaction Time and PPVT-IV for Older Adults

Chapter 4

Discussion

The purpose of this investigation was to examine the effects of linguistic context on category structure in young and older typical adults. To do this, experimental questions addressed accuracy and reaction time differences between the groups, patterns of error with respect to accuracy and reaction time, as well as correlations between vocabulary scores on a norm-referenced test and performance (i.e., accuracy, reaction time) on the experimental task.

Accuracy in Identification of Exemplars

The first experimental question addressed differences in task accuracy for young and older adults. The young adults were significantly more accurate in their identification of exemplars relative to linguistic context. That is, when asked "in the previous sentence, does 'X' mean 'Y'", young adults correctly decided whether the superordinate category label in question was equal in meaning to the proffered exemplar more often than older adults did. Hough (1993) suggested that category structure may be disturbed by memory decomposition associated with the aging process. Furthermore, when older adults have difficulty accessing atypical category exemplars, they may compensate by relying on typical category responses (Hough, 1993). Thus, when presented with uncommon exemplars (e.g., *'SEAL'* in *Everyone enjoyed watching the intelligent air breathing 'ANIMAL' perform tricks in the water at the marine amusement park.*), the older adult may have been overloaded by exemplars that satisfied basic semantic needs of the sentence (i.e., seals are marine animals) and answered in the affirmative despite the contextual violations simply because he was unable to effectively process the atypical exemplar.

Reaction Time for Identification of Exemplars

The second experimental question dealt with the differences in reaction time on task items for young and older adults. There was a significant difference between young and older adults with respect to reaction time in identifying exemplars for category labels relative to linguistic context. The young adults responded faster overall; they also responded more quickly than older typical adults when considering each of the six category types (i.e., true related, true unrelated, false related, false unrelated, out-of-set related, out-of-set unrelated) individually.

Previous research has shown that response latencies were shorter for typical exemplars rather than atypical ones (Keil, 1994; Kiran & Thompson, 2003; McCloskey & Glucksberg, 1978; Rosch et al., 1976b; Smith et. al, 1974). The current investigation revealed that when considering six constructed exemplar types that differed in degree of category relatedness, this pattern was only observed in the older adults. Both young and older adults responded most rapidly to those exemplars that were out-of-set unrelated responses (e.g., *coat* in *The monkey peeled and ate the 'FRUIT'.*). These exemplars are neither typical nor atypical; in fact, they are not members of the superordinate category at all. Reaction time increased for young adults through false related, true related, out-of-set related, true unrelated, and false unrelated; simply put, the false unrelated exemplars yielded the longest associated reaction times. Older adults showed a slightly different pattern of increase through true related, false related, out-of-set related, true unrelated, and false unrelated. Specifically, older adults responded fastest to both out-of-set unrelated and true related exemplars, which are the most typical examples.

Brickman et al. (2005) and Hough (2007a) have suggested that categorization is vulnerable to the aging process, as it relies on active and continuous lexical retrieval. Older adults appear to have reduced ability to utilize linguistic context for appropriate interpretation and subsequent retrieval of categorical concepts. These behaviors may contribute to problems with comprehension in situational context. Specifically, these difficulties may interfere with effective communication, by disrupting adequate suppression of less relevant or irrelevant information in various linguistic contexts.

Pattern of Accuracy for the Groups

The third experimental question addressed the difference in the pattern of errors on the task for the groups. Both young and older adults correctly identified exemplars for category labels in the same pattern. True and false related exemplars were more accurately identified than true and false unrelated ones. For the out-of-set exemplars, however, the trend shifted in the other direction; that is, the participants correctly identified the out-of-set unrelated examples with higher accuracy than the out-of-set related category members. Barsalou (1982) noted that concepts have associated properties that may or may not depend upon contextual cues. Natural or common categories (e.g., furniture, vegetables) such as those used in the experimental task are usually context-independent, which makes common categories easier to identify than ad hoc categories (Barsalou, 1983; Barsalou, 1987; Hough, 1989; Hough, 2007a; Jordan, 1990; Kiran & Thompson, 2003; McCloskey & Glucksberg, 1978; Sebastian & Kiran, 2007). Offering typical and atypical exemplars with a graded goodness-of-fit in the guise of our six category constructs with the added requirement of satisfying contextual demands, however, made the task of exemplar identification more difficult for many participants.

Pattern of Errors and Reaction Time for the Groups

The third experimental question also addressed the difference in the pattern of reaction times for young and older adults in time to complete task items. While it was noted earlier in this section that young adults responded correctly more quickly than did older adults, there was also a significant difference between the response times of error responses. That is, even when young adults were unable to identify exemplars for category labels, they reacted faster than the older adults. Mayr and Kleigl (2000) suggested that while there is evidence of neurodegeneration with typical aging, information related to both processing and semantic fluency is stored in multiple locations. This redundancy of stored information may spare skills such as categorization because data may be inaccessible due to deterioration in one area of the brain, but remain available in a different region. It is conceivable that collecting information from relatively distant regions of the brain would increase reaction time.

Correlations between Vocabulary Scores and Accuracy for the Groups

The fourth experimental question addressed the relationship between *Peabody Picture Vocabulary Test – Fourth Edition* (Dunn & Dunn, 2007) performance and task accuracy for the groups. Scores on the PPVT-IV did not correlate with accuracy on the experimental task for either young or older adults. It is important to recall that the experimental task was on a 6^{th} grade reading level and all participants attained at least a high school diploma and satisfactorily passed several screening tests. Truly, an individual's vocabulary is related to experience, but to communicate effectively, one must also be able to retrieve desired items from the lexicon.

Correlations between Vocabulary Scores and Reaction Time for the Groups

The final experimental question addressed possible relationships between vocabulary scores and reaction times for the groups in the investigation. PPVT-IV scores were significantly correlated with reaction time for both groups. Interestingly, there was a significant positive correlation for young adults, indicating that individuals with higher PPVT-IV scores took longer to identify exemplars in the experimental task. Coyle (2003) suggested that individuals with higher achievement scores on cognitive tests (e.g., *PPVT-IV*) tend to demonstrate poorer task performance; this may have been illustrated in the current investigation in the form of slower reaction times.

There was a strong negative correction for older adults, indicating that those who scored higher on the PPVT-IV responded to the items on the experimental task more quickly. Deary, Allerhand, and Der (2009) found that as individuals age, higher achievement in various tasks of intelligence (e.g., verbal ability) may be related to factors that preserve processing speed. In the current investigation, this could have allowed the older adults with higher receptive vocabulary scores to retrieve items and make semantic decisions more quickly than those with lower scores.

General Discussion

On a timed semantic decision task, young adults generally responded more quickly and more accurately than older adults. Although previous research has suggested that context is not necessary to instantiate exemplars for common categories, it has also shown that this process is dependent on how well those common categories are established in memory (Barsalou, 1983; Hough, 1989). The categories used for this investigation (e.g., animals, vehicles, furniture, clothing, vegetables, appliances) should be considered among those deeply ingrained groups, but context and successfully navigating the concept of goodness of fit were critical to performing well during the task. The fact that a word is part of an individual's lexicon does not necessarily mean that it will be used correctly in every situation (Kegl, 1989). Word knowledge must come together with world knowledge in order to successfully navigate language. Semantics (i.e., meaning) as well as pragmatics (i.e., world knowledge) must function in order to determine if the meaning that comes to mind fits the context and world knowledge in order to be considered true.

Research has suggested that adults experience a decline in working memory during the typical aging process (Light, 1991; Luo & Craik, 2008; Zahr et al., 2009). Hasher, Zacks, and

May (1999) proposed that aging adults have difficulty discarding irrelevant information due to deterioration of working memory. Perhaps deficits in working memory are responsible for nullifying the advantage that older adults should have experienced with respect to world knowledge and its relationship to word knowledge.

Limitations

Both limited sample size (i.e., 20 participants per group) and unequal gender distribution within the groups were limitations to the current investigation. The imbalance with respect to inclusion of males versus females prohibited the consideration of gender differences in identifying exemplars for category labels relative to sentence context.

Implications for Future Research

Additional investigation of error patterns as well as exploration of the nature of exemplars that were false unrelated (F/U) is warranted. This latter response type presented surprising processing problems relative to accuracy and reaction time for both age groups.

Another area of exploration may be examining categorization through the adult lifespan, specifically examining skills of different age groups through elderly age. This would provide additional information about changes in language skills as well as in executive functioning, especially prediction, inference, and decision making.

Summary

The results indicated that young adults responded more accurately than older adults on a timed semantic decision task. This suggests that young adults were better able to work within contextual constraints to determine category representativeness than were the older adults. With respect to accuracy, older adults were more accurate than young adults in selecting exemplars in the true related category. Both groups performed at similar levels of accuracy when choosing out-of-set unrelated exemplars. For other exemplar categories (i.e., true unrelated, false related, false unrelated, out-of-set related), young adults were more accurate than older adults.

Young adults responded more quickly across categories on this timed semantic decision task. The gap between reaction time for the young group and that of the older group varied, though, with the smallest difference noted in true related, false related, and out-of-set unrelated exemplars. This suggests that older adults appeared to have more difficulty with irrelevant exemplars, with the exception of the out-of-set unrelated category.

Analysis indicated that it was possible to predict a participant's accuracy on the experimental task based on whether the individual was young or older. An interesting finding was that both groups had lower accuracy percentages and slower response times for the false unrelated category than for any other category.

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APPENDIX A

PARTICIPANT QUESTIONNAIRE

Please answer the following questions to the best of your ability. Your confidentiality is important to us. The information provided will be used for research purposes only and will be de-identified to the best of our ability.

Date of birth: ___/___/___

Gender: MALE FEMALE

Highest level of education completed (please circle):

1 2 3 4 5 6 7 8 9 10 11 12	High School Diploma
College 1 2 3 4	Associate Degree Bachelor's Degree
Graduate/Professional 1 2 3 4	Master's Degree Doctorate

Have you ever been diagnosed with any of the following conditions?

___ Learning disability

___ Attentional deficit (ADD, ADHD)

___ Neurological disease or insult (head injury, stroke, Parkinson disease)

___ Psychiatric disturbance

If yes to any of the above, please explain briefly.

Do you wear corrective lenses? YES NO

Do you wear hearing aids or other amplification? YES NO

APPENDIX B

CATEGORY SCREENING TEST

In the following exercise, you will be given a category label and three choices for members in that category. Please circle the option that would BEST fit in the given category.

PETS:	horse rock dog	INSTRUMENTS:	bucket fly flute
SPORTS:	leg basketball gymnastics	FRUITS:	avocado marshmallow banana
INSECTS:	sandpiper aphid wasp	TREES:	azalea oak palm
VEHICLES:	roller skates truck ferry	FURNITURE:	couch mirror brick
BIRDS:	duck ostrich cod	VEGETABLES:	cucumber broccoli fig
FISH:	trout finch mahi-mahi	METALS:	uranium tin oxygen
WEAPONS:	candle rifle bow and arrow	N.C. TOWNS:	Raleigh Boston Siler City

APPENDIX C

READING SCREENING

The Rainbow Passage

When the sunlight strikes raindrops in the air, they act as a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

APPENDIX D

INDIVIDUAL PARTICIPANT DEMOGRAPHIC DATA

Participant	Age	Gender	Education	PPVT
1	22	F	17	117
2	22	F	17	110
3	27	F	16	109
4	22	F	16	105
5	23	F	17	99
6	23	F	18	104
7	25	F	16	113
8	23	F	17	100
9	22	M	17	110
10	27	F	17	109
11	35	F	18	117
12	35	F	17	116
13	24	F	17	116
14	22	F	17	111
15	23	F	17	98
16	23	F	17	93
17	23	F	17	110
18	25	F	18	106
19	24	F	18	132
20	32	F	21	111
21	69	F	18	107
22	77	F	14	105
23	66	M	18	113
24	73	M	18	110
25	65	F	21	125
26	67	F	15	109
27	65	F	13	100
28	77	M	21	117
29	75	F	21	110
30	70	F	14	101
31	78	F	15	134
32	69	F	18	109
33	74	M	18	134
34	71	M	17	110
35	79	F	16	105
36	80	F	18	103
37	70	F	12	88
38	73	F	12	83
39	77	M	12	99
40	72	M	12	90

APPENDIX E

INFORMED CONSENT

Purpose and Procedures:
You are invited to participate in a study examining categorization skills. Categorization is the ability to group things together based upon similar characteristics or relationships. We hope to learn what differences, if any, younger and older typically-aging adults have in categorizing words in sentence context. You were selected as a possible participant in this study due to your age and positive health status.

If you decide to participate, you will complete the following tasks:

- We will give you a questionnaire to complete. This is to ensure you fall within the parameters set out for participants in the study. The questionnaire will ask you to provide information about your age, gender, education level, and medical history. This task should take ten minutes to complete.
- We will screen your hearing acuity throughout the speech frequencies at 1000, 2000, and 4000 Hz HL. This screening will take 5-10 minutes and will ensure that your hearing is within limits appropriate for completing the study.
- We will have you read a short list of sentences aloud. This is a reading proficiency screen and will ensure you are able to read the length and complexity of the study material. The sentences will be presented to you in the same size and font as the experimental task to make sure you can see and read the material comfortably. This task may take 5 minutes at most.
- We will administer a category screening test. This will take approximately 5 minutes to complete and will give us information about your ability to group objects that are similar.
- We will administer the *Peabody Picture Vocabulary Test – IV.* In this test, the examiner will say a word aloud and you will select which of four pictures best illustrates the given word. This test will take approximately 10 to 15 minutes. The PPVT-IV is a measure of your ability to understand vocabulary.
- In the experimental task, we will use a laptop computer to show you twenty-five sentences. For each sentence, a word will be highlighted and you will need to make decisions about whether a word belongs to a certain category, given the context of the sentence. This task will give us information about categorization skills in linguistic context. The task will take approximately 30 minutes to complete.

Risks and Benefits of this study:
The risks associated with this study are minimal. The examiner will attempt to minimize fatigue by providing breaks between tasks as needed.

There may be no personal benefit to you for your participation in this study; however, the knowledge obtained from the investigation may enhance understanding of typical aging relative to the processing, retrieval, and interpretation of words using language.

Identifying Information and Confidentiality:
Your privacy and confidentiality will be maintained by having you sign only this document. Any other information collected will be done so by using a number that will randomly be assigned to you.

Your decision whether or not to participate will not prejudice your future relation with East Carolina University or the individual investigators. You will not receive compensation for your time in the study. If you decide to participate, you are free to discontinue participation at any time without prejudice.

Person to Contact with Questions
The investigator will be available to answer any questions concerning this research, now or in the future. You may contact the investigator, **Skye Lewis**, at (xxx) xxx-xxxx (days) or (xxx) xxx-xxxx (nights and weekends) or the director of the project, Dr. Monica Hough (xxx) xxx-xxxx. If you have questions about your rights as a research subject, you may call the Chair of the University and Medical Center Institutional Review Board (252) 744-2914 (days). If you would like to report objections to this research study, you may call the ECU Director of Research Compliance at (252) 328-9473.

Consent to Participate:
I have read all of the above information, asked questions and have received satisfactory answers in areas I did not understand. (A copy of this signed and dated consent form will be given to the person signing this form as the participant or as the participant's authorized representative.)

____

Participant's Name (**PRINT)** **Signature** **Date** **Time**

If applicable:

____

Guardian's Name (**PRINT)** **Signature** **Date** **Time**

PERSON ADMINISTERING CONSENT: I have conducted the consent process and orally reviewed the contents of the consent document. I believe the participant understands the research.

____

Person Obtaining Consent **(PRINT)** **Signature** **Date**

____

Principal Investigator (**PRINT)** **Signature** **Date**

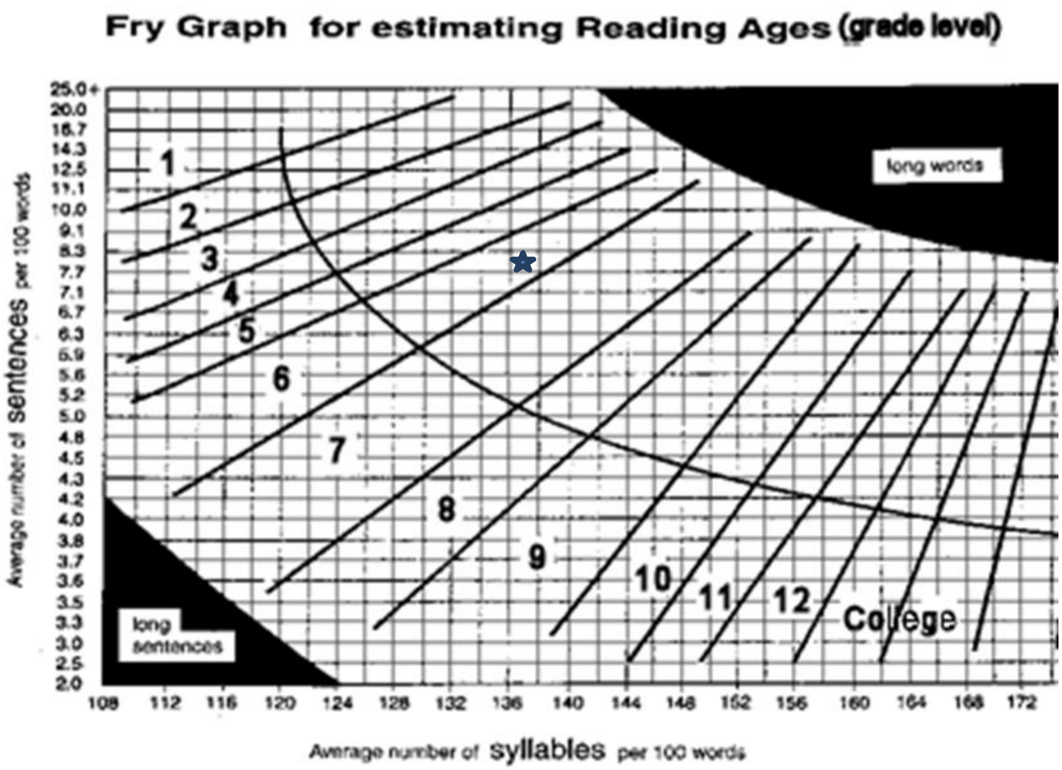
APPENDIX F

FRY READABILITY GRAPH

The Fry Readability Graph (Fry, 1968) uses a syllable and word count to determine grade-level difficulty. Three random samples were taken and syllable, word, and sentence counts were noted. The following table illustrates the totals tallied for each sample.

	Number of Sentences	Number of Syllables
First 100-Word Passage	7	142
Second 100-Word Passage	9	128
Third 100-Word Passage	8	141
Total	24	411
Average	8	137

Average number of sentences per 100 words has been graphed against average number of syllables per 100 words. The intersection of the averages represents the grade level of the reading material.



APPENDIX G

STIMULI

T/R: True Related Exemplar	T/U: True Unrelated Exemplar
F/R: False Related Exemplar	F/U: False Unrelated Exemplar
O/R: Out-of-Set Related Exemplar	O/U: Out-of-Set Unrelated Exemplar

When Mike sat down to play the ‘INSTRUMENT’, the family gathered around to sing along.

T/R: Piano	T/U: Harmonica
F/R: Drums	F/U: Symbols
O/R: Stereo	O/U: Bowl

The old man played the accordion while the ‘ANIMAL’ danced for coins.

T/R: Monkey	T/U: Dog
F/R: Cat	F/U: Shark
O/R: Squirrel	O/U: Table

Professor Anderson’s ‘BOOK’ on the life of Queen Victoria was well received.

T/R: Biography	T/U: History
F/R: Autobiography	F/U: Encyclopedia
O/R: Magazine	O/U: Shoe

The teacher counted the thirty children as they got on the ‘VEHICLE’.

T/R: Bus	T/U: Ferry
F/R: Car	F/U: Bike
O/R: Horse	O/U: Hat

No matter how hard Harry tried, he could not reach high enough to pick a ‘FRUIT’ from the tree.

T/R: Apple	T/U: Pear
F/R: Strawberry	F/U: Pumpkin
O/R: Lettuce	O/U: Chair

Mark told Denise she could find a pen in the center drawer of the ‘FURNITURE’.

T/R: Desk	T/U: Dresser
F/R: Chair	F/U: Mirror
O/R: Refrigerator	O/U: Dog

The hunter shot at the ‘BIRD’ flying high overhead.

T/R: Duck	T/U: Crow
F/R: Chicken	F/U: Penguin
O/R: Squirrel	O/U: Broom

When he saw it was about to rain, Bill took out the waterproof ‘CLOTHING’ from his backpack and put it on.

T/R: Raincoat	T/U: Jacket
F/R: Sweater	F/U: Sandals
O/R: Ring	O/U: Football

With the first frost of autumn, the leaves on the ‘TREE’ turned brilliant colors.

T/R: Maple	T/U: Birch
F/R: Spruce	F/U: Palm
O/R: Rose	O/U: School

The private detective always carried the ‘WEAPON’ in his coat pocket.

T/R: Revolver	T/U: Knife
F/R: Shotgun	F/U: Cannon
O/R: Screwdriver	O/U: Baby

Janet tried to shoo away the ‘INSECTS’ flying around the melon.

T/R: Flies	T/U: Wasps
F/R: Ants	F/U: Ticks
O/R: Cups	O/U: Robins

When Sandra found a stain on the ‘CLOTHING’ she planned on wearing to prom, she took it to be dry cleaned.

T/R: Gown	T/U: Coat
F/R: Tuxedo	F/U: Bathrobe
O/R: Necklace	O/U: Table

Fran told Mark to tear some leaves off the ‘VEGETABLE’ for the salad.

T/R: Lettuce	T/U: Spinach
F/R: Carrot	F/U: Corn
O/R: Orange	O/U: Leg

Cathy burned her fingers as she took the toast out of the ‘APPLIANCE’.

T/R: Toaster	T/U: Oven
F/R: Percolator	F/U: Refrigerator
O/R: Chair	O/U: Boy

The young soldier panicked and stabbed his prisoner with the sharp end of his ‘WEAPON’.

T/R: Bayonet	T/U: Dagger
F/R: Chain	F/U: Bomb
O/R: Pliers	O/U: Desk

Emilie thought the colorful pattern on the ‘INSECT’ flying by was very pretty.

T/R: Butterfly	T/U: Ladybug
F/R: Caterpillar	F/U: Cockroach
O/R: Bluejay	O/U: Church

One of the reasons Jeff outperforms others at ‘SPORT’ is the grace and style with which he enters the water.

T/R: Diving	T/U: Swimming
F/R: Gymnastics	F/U: Volleyball
O/R: Chess	O/U: Door

We loved watching the intelligent air breathing ‘ANIMAL’ do tricks in the water at the marine amusement park.

T/R: Dolphin	T/U: Seal
F/R: Shark	F/U: Monkey
O/R: Ant	O/U: Stamp

Matthew disapproved of the ‘SPORT’ because he did not like the idea of killing for pleasure.

T/R: Hunting	T/U: Fishing
F/R: Wrestling	F/U: Basketball
O/R: Checkers	O/U: Bowl

One of Stacy’s chores on the family farm was to milk the ‘ANIMAL’ every morning.

T/R: Cow	T/U: Goat
F/R: Steer	F/U: Bear
O/R: Spider	O/U: Pen

The uniform Jane found in the attic had intricate buttons made of yellow ‘METAL’.

T/R: Brass	T/U: Gold
F/R: Chrome	F/U: Lead
O/R: Bracelet	O/U: Milk

Marcy included the ‘VEGETABLE’ in the salad because of its nice red color.

T/R: Tomato	T/U: Beet
F/R: Cucumber	F/U: Broccoli
O/R: Pear	O/U: Box

In the morning, the ‘BIRD’ walked across the barnyard

T/R: Chicken	T/U: Robin
F/R: Ostrich	F/U: Seagull
O/R: Rabbit	O/U: Lamp

The grocer stared at the ‘FISH’ in the bowl.

T/R: Goldfish	T/U: Trout
F/R: Starfish	F/U: Eel
O/R: Dolphin	O/U: Rock

The monkey peeled and ate the ‘FRUIT’.

T/R: Banana	T/U: Mango
F/R: Coconut	F/U: Orange
O/R: Potato	O/U: Coat

The square dance musician played his ‘INSTRUMENT’ very well.

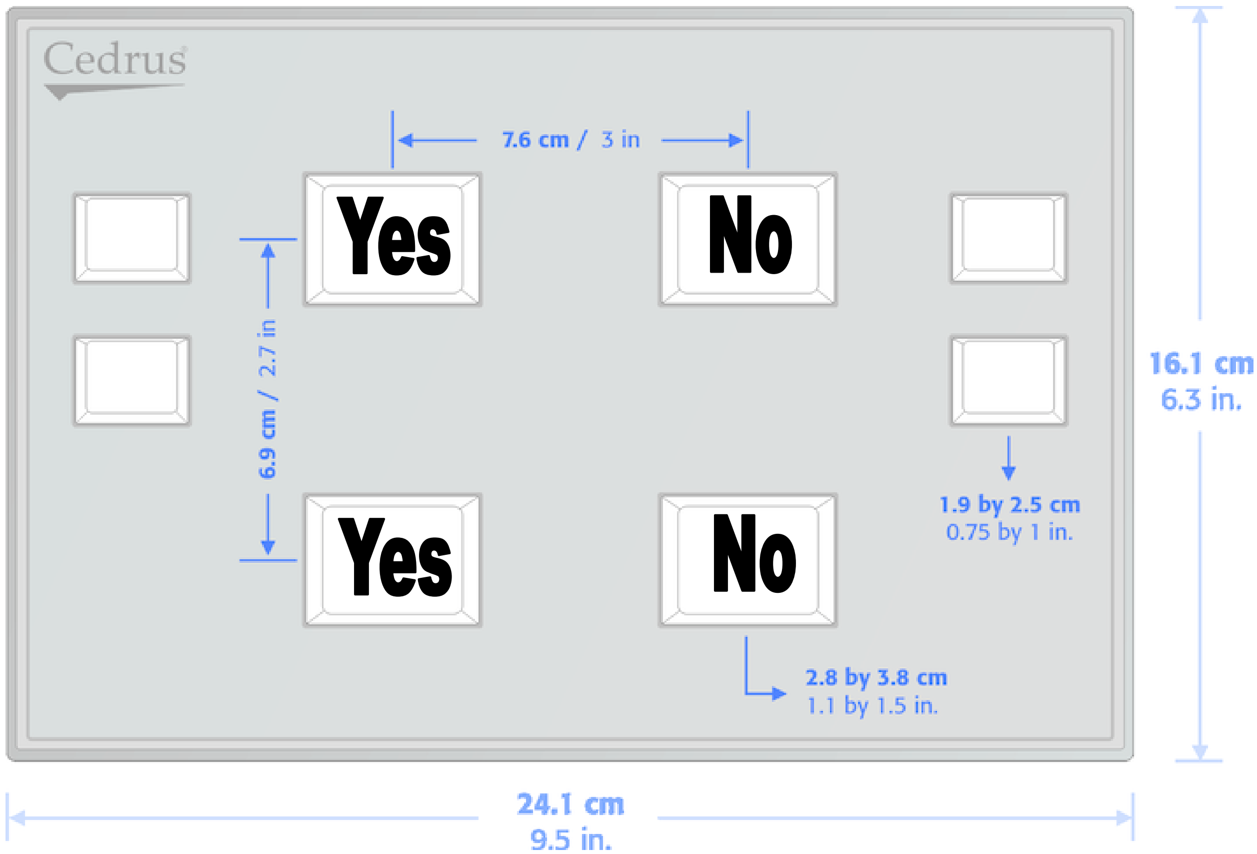
T/R: Fiddle	T/U: Guitar
F/R: Cello	F/U: Piano
O/R: Washboard	O/U: Soccer

The banker’s wife wore her new ‘FUR’ coat to the opera.

T/R: Mink	T/U: Sable
F/R: Raccoon	F/U: Buffalo
O/R: Raincoat	O/U: Cat

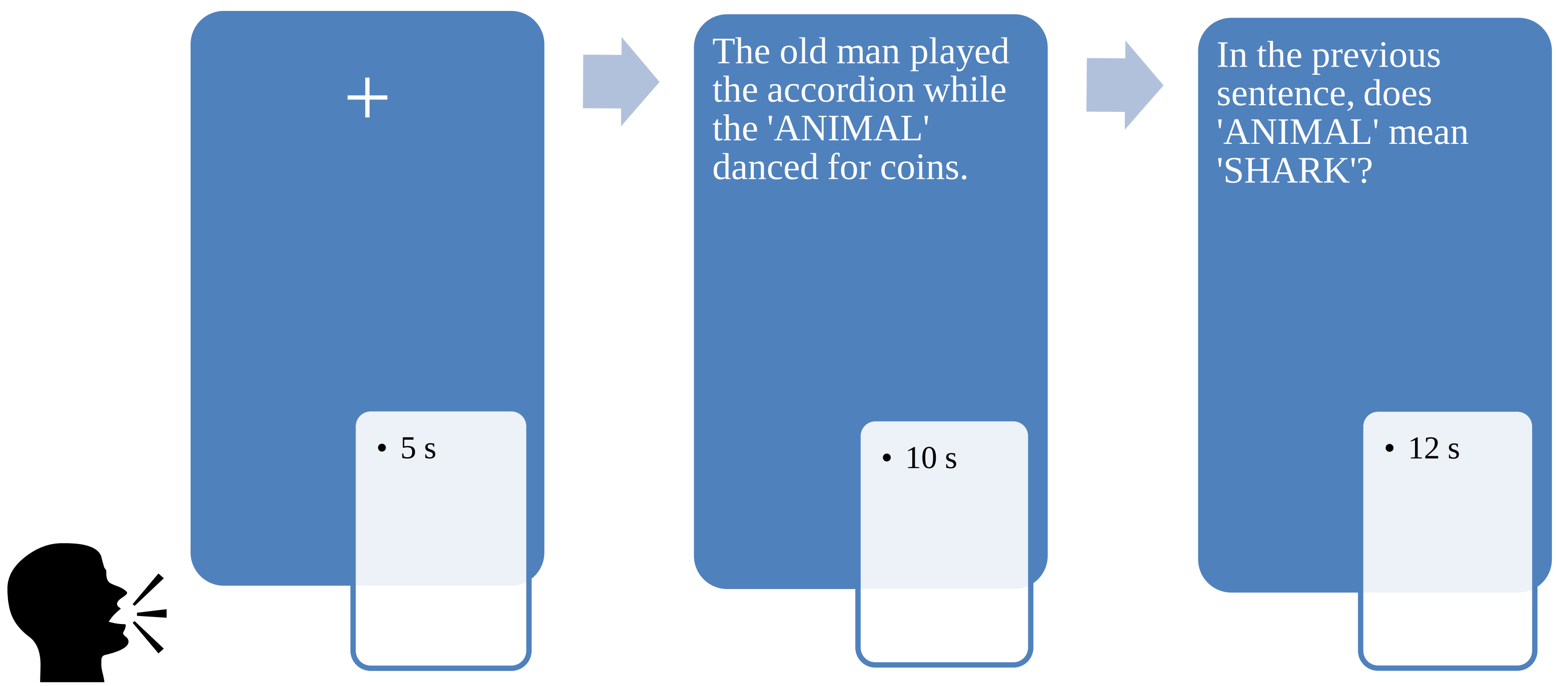
APPENDIX H

RB-834 RESPONSE PAD



Appendix I

FLOWCHART OF STIMULI PRESENTED BY SUPERLAB



APPENDIX J

PROTOCOL FOR PRACTICE ITEMS AND EXPERIMENTAL STIMULI

"I am going to show you a sentence that has a word capitalized between single quotation marks. I will also read the sentence aloud. Then you'll be asked about the meaning of the highlighted word. You'll be asked if that particular word has a certain meaning in that sentence. If you believe that it does, you will press the key labeled "YES" on the left side of the keyboard. If you do not think the word can mean what the sentence asks, you will press the key labeled "NO" on the right side of the keyboard. Between each item, you will see a cross in the center of the computer screen. I need you to complete the tasks as quickly and as accurately as you can. Let's try some practice items first."

When the stimulus sentence appears on the screen, read it aloud, highlighting the capitalized and quotation-enclosed word with verbal emphasis.

When the YES/NO question appears, read it aloud with the same verbal emphasis.
For the practice items, provide the correct response and an explanation if the participant supplies an incorrect response. Add another YES/NO sentence in order to be sure the participant understands the task.

For the experimental task, provide no feedback about correct vs. incorrect answers. Simply remind the participant to do their best and prompt them to select YES or NO using the keyboard. Before the experimental task begins, say, "remember to select YES or NO to indicate whether a particular word has a certain meaning based on the given sentence. Try to answer each question as quickly and as accurately as you can."

APPENDIX K

APPROVAL LETTER FROM THE ECU IRB

University and Medical Center Institutional Review Board
East Carolina University • Brody School of Medicine
600 Moye Boulevard • Old Health Sciences Library, Room 1L-09 • Greenville, NC 27834
Office **252-744-2914** • Fax **252-744-2284** • **www.ecu.edu/irb**
Chair and Director of Biomedical IRB: L. Wiley Nifong, MD
Chair and Director of Behavioral and Social Science IRB: Susan L. McCammon, PhD

TO: Skye Lewis, Doctoral Student, Dept of CSDI, ECU—Mailstop 668

FROM: UMCIRB

DATE: December 18, 2009

RE: Expedited Category Research Study

TITLE: "Categorization in Context for Young and Older Typical Adults"

UMCIRB #09-0878

This research study has undergone review and approval using expedited review on 12.14.09. This research study is eligible for review under an expedited category because it is on collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving x-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.) Examples: (a) physical sensors that are applied either to the surface of the body or at a distance and do not involve input of significant amounts of energy into the subject or an invasion of the subject's privacy; (b) weighing or testing sensory acuity; (c) magnetic resonance imaging; (d) electrocardiography, electroencephalography, thermography, detection of naturally occurring radioactivity, electroretinography, ultrasound, diagnostic infrared imaging, doppler blood flow, and echocardiography; (e) moderate exercise, muscular strength testing, body composition assessment, and flexibility testing where appropriate given the age, weight, and health of the individual. It is also a research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(2) and (b)(3). This listing refers only to research that is not exempt.)
The Chairperson (or designee) deemed this **unfunded** study **no more than minimal risk** requiring a continuing review in **12 months**. Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The investigator must adhere to all reporting requirements for this study.

The above referenced research study has been given approval for the period of **12.14.09 to 12.13.10**. The approval includes the following items:

- Internal Processing Form (dated 12.1.09)
- Participant Questionnaire
- Informed Consent (dated 11.25.09)

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

The UMCIRB applies 45 CFR 46, Subparts A-D, to all research reviewed by the UMCIRB regardless of the funding source. 21 CFR 50 and 21 CFR 56 are applied to all research studies under the Food and Drug Administration regulation. The UMCIRB follows applicable International Conference on Harmonisation Good Clinical Practice guidelines.