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Semantic feature distinctiveness and frequency

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Semantic Feature Distinctiveness and Frequency

by

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Abstract

Lexical access is the process in which basic components of meaning in language, the lexical entries (words) are activated. This activation is based on the organization and representational structure of the lexical entries. Semantic features of words, which are the prominent semantic characteristics of a word concept, provide important information because they mediate semantic access to words. An experiment was conducted to examine the importance of semantic feature distinctiveness and feature frequency in accessing the lexical representations of young and older adults in an off-line task using features of animals. The McRae, Cree, Seidenberg, and McNorgan (2005) feature norm corpus is the basis for the selection of stimuli for the current research project. Semantic features were utilized to explore the structure of the lexicon. Stimuli varied in feature distinctiveness based on the study by McRae, et al (2005) in 3 broad stimulus groups: Distinctive (D), Low Frequency Non-Distinctive (LFND), and Non-Distinctive High Frequency (NDHF). Participants were asked to list all of the concepts that came to mind for a given feature in an un-timed task. Distinctiveness was examined between stimulus groups for the number of concepts and variety of first concepts given to the presented feature. It was found that fewer concepts were given and there was less variety in first concepts given for the distinctive features and the most concepts and greater variety of first concepts were given for the high-frequency non-distinctive features. Distinctiveness appears to vary along a continuum, supporting theories of lexical access based on activation and competition between concept words. Additionally, participant age groups were compared for the number of concepts given and the variety of first concepts given. The older adult group produced more concepts and more variety of first concepts than the younger

group, in all three feature categories. These results indicate that greater (lifetime) language experience of the participants in the older group was reflected in their performance. A continued interest in semantic features is important to our understanding of the influence of features on the retrieval of semantic concepts and the changes in those retrieval processes over the lifespan.

Introduction

A great deal of language research has indicated that the word is a privileged unit of meaning (Balota, 1994). Lexical access is the process in which basic components of meaning in language, the lexical entries (words) are activated. This activation is based on the organization and representational structure of the lexical entries. Semantic features of words, which are the prominent semantic characteristics of a word concept in some theories of lexical representation, provide important information because they at least partially mediate access to words (Barsalou, 2003).

It is also important to understand those changes in language processing that are part of the normal aging process. As people age, processing in the brain begins to change. Researchers have suggested that older adults essentially demonstrate a slower neural response compared to younger adults, and presumably, the language processes are also slowed (Fisher, 1996; Salthouse, 1985). For example, older adults generally demonstrate difficulties with recalling information from memory and we would expect this to occur with lexical access as well. Connor, Spiro, Obler and Albert (2004) concluded that lexical access skills with the older adult decrease as they age. However, research in this area has also found that older adults have larger vocabularies than younger adults (Taylor & Burke, 2002; James & Burke, 2000). Thus, as people age, there is also the potential for positive changes in language ability (Verhaeghen, 2003).

Lexical access changes that occur with old age, such as longer access times, are proposed to reflect an inability to match a concept or an idea to a phonological template. It appears that access to word meaning is preserved (Burke, Mackay, and James 2000). With the older adults' word retrieval difficulties appearing to reflect a problem in access to the phonological representations, semantic representations are a promising avenue to explore to promote the retrieval process for words. The primary aim of the present study is to examine lexical semantic organization. This study will also examine the effects of age on access to semantic representations with the goal of improving our understanding of the process of lexical access across the lifespan.

Lexical Access

Lexical access is a complex process. This process involves accessing an interconnected system of representations in the mental lexicon, including the phonological, semantic, orthographic and/or syntactic information about a word. The ability to access a unique lexical item has the potential to be compromised. In speech production, inefficient processing may result in an inability to quickly narrow the search to a unique lexical item, resulting in disfluency or a complete failure to access, as is the case in a tip of the tongue state (Dell, 1986; Levelt, Schriefers, Vorberg, Meyer, Pechmann, & Havinga, 1991). Errors in lexical access can occur as the process of lexical access involves the activation of multiple word candidates and competition between them. For example, competition between semantically related objects occurs with lexical items that are in a semantically related category, such as *bee* and *wasp*, interfering with lexical access (the lexical interference effect, Damian, Vigliocco, & Levelt, 2001; Kroll & Stewart, 1994). In the clinical case of anomia, the activation and competition process is compromised due to brain injury, and clinical clients may present with random and unpredictable errors in lexical access (Burton, Baum, & Blumstein, 1989; Jusczyk & Luce, 2002; Maher & Raymer, 2004).

Production

The process of lexical access in production begins with the identification of those lexical semantic concepts that most closely match the intended concept. Activation of semantic features leads to activation of the most compatible words in the mental lexicon. Lexical access occurs when a unique word form is identified and programmed for production (Connine, Titone, Deelman, & Blasko, 1997; Goldinger, Luce, & Pisoni, 1989; Jusczyk & Luce, 2002; Warren & Marslen-Wilson, 1987).

One of the first models of communication and the speech production process is the one devised by Shannon and Weaver (1949). The model has five main parts: information source, transmitter, channel, receiver, and the destination. The advantages of Shannon and Weaver's model are that it is in a simple, easily understood form and that it can be applied to most types of communication. This is a transmission model, which is linear, suggesting that we simply receive a message as it is sent. However, we interpret messages that are received, adding our own understanding to the process. The message is not just absorbed, but also analyzed in order to comprehend the message.

One of the most influential approaches to modeling the processes of language use employs Spreading Activation Theory (Dell, 1986; Dell & O'Seaghdha, 1991). Spreading activation theory is embodied in a connectionist modeling, neural network modeling, or parallel distributed processing approach (Elman, 1996; McLeod, Plunkett, & Rolls, 1998; Rumelhart, Hinton, and Williams, 1986). This approach implements cognitive processes in terms of parallel activation and competition among a large number of simple neuron-like computational units that spread activation through weighted links. These units are typically grouped into different linguistic levels where activation spreads between levels and inhibition spreads within levels (though see the Levelt, Roelofs, and Meyer (1999) WEAVER model which is based only on activation). The mental lexicon is represented as a set of interconnected levels that encode concepts, words, morphemes and phonemes. Processing creates a pattern of activation where the item with the greatest activation is retrieved. In speech production, activation of a concept would spread to the associated word, which is then spelled out through activation of associated morphemes and phonemes.

Influences on Lexical Access

Word Frequency

Word frequency generally reflects how often a word occurs in usage in a language. For example, the word *egret* is considered an infrequent word as it is found 2 times per 1 million words in a corpus of English (Kučera & Francis, 1967). In contrast the word *chicken,* which occurs 3148 times in the same 1 million word corpus of English, is a high frequency word. The frequency with which a word occurs in the language can influence the ease with which it is recognized and accessed. Numerous studies have reported that low frequency words tend to be recognized and produced more slowly and with less accuracy than more common words (Dirks, Takayanagi, Moshfegh, Noffsinger, & Fausti, 2001; Jescheniak & Levelt, 1994; Lachman, Shaffer, & Hennrikus, 1974; Luce & Pisoni, 1998; Oldfield & Wingfield, 1965). This effect of word frequency has been found not only in young adults, but also in children (Newman & German, 2002, 2005) and in older adults (Spieler & Balota, 2000). Studies on speech production have also demonstrated that high-frequency words are not as susceptible to errors in speech production as low-frequency words (Dell, 1990; Vitevitch, Luce, Charles-Luce, & Kemmerer, 1997; Vitevitch, 1997). High frequency words are recognized more quickly and accurately, suggesting that past experience with words influences the ability to process meaning (Hohne & Jusczyk, 1994; Jusczyk & Aslin, 1995; Landauer & Meyer, 1972; Luce, 1986). A higher resting activation level in high-frequency words may explain the processing advantage of word frequency (McClelland & Rumelhart, 1981). In other words, high frequency words require less activation to reach a threshold for activation. Another explanation for the processing advantage for high frequency words is that frequency may provide a bias in the selection between competing and similar candidate words (Luce & Pisoni, 1998). However, the most appropriate interpretation is dependent on the process. For example, in speech production, it is hypothesized that high-frequency words speed naming because they provide faster access to the phonological features of the words (Roelofs, 1992; Roelofs, 1993).

Semantic Similarity

Rosch & Mervis (1975) used semantic features to calculate family-resemblance scores for a set of categories. Family resemblance was a measure of the degree to which a concept's features overlap with those of other concepts. The results showed that family resemblance for concepts within a category can predict distinctiveness (aka typicality) of a concept. The semantic meaning of a word can also be conceptualized as the word's relations to other words in a semantic similarity space (Vigliocco, Vinson, Damian, & Levelt, 2002). Groupings of words in different regions of the space create semantic categories. Within these groupings, some words may be more central to the category (typical) and others may be less central to the category (atypical). Boster (1988) suggested that typical lexical items would be found in a densely populated region of the semantic similarity space. Semantic similarity among words will affect the retrieval of those words, depending upon the task (Dell, Schwartz, Martin, Saffran, & Gagnon, 1997).

Priming or Activation

In some cases of semantic priming, the presentation of a word activates semantic features or semantic associations that lead to more rapid access for related words. Individuals will typically respond faster to a target word such as *doctor*, when it follows a semantically related word, such as *nurse,* than to an unrelated word, such as *turkey* (Neely, 1991). Response time in these studies is typically the time required to begin naming or to make a lexical decision to a target. Semantic relatedness in words can be encoded by feature overlap in the semantic representation. Thus, semantic priming will occur due to a related prime activating a feature that overlaps the target. For example, Rapp & Samuel (2002) found that speakers in a spontaneous sentence completion task were more likely to pick words with phonological and semantic relatedness to other words in the sentence than to pick unrelated words, reflecting semantic and phonological activation between words.

Semantic priming depends upon the modality that is used. While the presentation of related words leads to priming, mixing words and pictures of semantically related concepts leads to interference (Damian & Bowers, 2003). For example, presenting the word *nurse* followed by a picture of a doctor where the task is to name the picture will result in a delay in the production of the word *doctor.* Semantic priming has been utilized extensively in research because priming has been shown to directly mirror semantic memory and semantic organization, whether the process is one that induces priming/facilitation or one of inhibition/competition (Cree, 1999).

Associative priming may also occur. In associative priming, words are related due to frequent co-occurrence. Related associates are not necessarily related by semantic features. For example, *dog* is an associative prime for *bone*, since the words are closely associated and frequently appear together, not because they share essential semantic features. Associative relatedness is encoded by the incidence of which word will follow another based on experience (either through repetition in training or through real-world experience, Plaut (1995)).

Semantic Representation

Semantic representations play an important role in the process of lexical access. As discussed in the previous section, semantic relatedness between words can facilitate or inhibit lexical access. Semantic relatedness for lexical items can be found through shared characteristics (semantic features) or through shared usage (associative relatedness). The focus of the present study is on shared semantic features between words.

Decomposition vs. Non-decomposition

Lexical access theories of semantic representation propose that words are stored in memory using either a decomposition or a non-decomposition process (Vigliocco, Vinson, Lewis, & Garrett, 2004). The decomposition theory states that lexical access involves processing a set of meaning components or features. The complex meaning of a word is built from a composition of simplest feature units. For example, the meaning of *hawk* includes features such as {has a beak}, {has feathers}, {has talons}, and {lays eggs} as illustrated graphically in Figure 1. Semantic features influence the process of lexical activation, for example, activation of *hawk* leads to activation of *bird* through shared features such as {has a beak}. In contrast, a non-decomposition approach takes word meaning to be holistic. This process does not involve manipulating smaller meaning elements. With non-decomposition, words are related through direct conceptual links as illustrated in Figure 2.

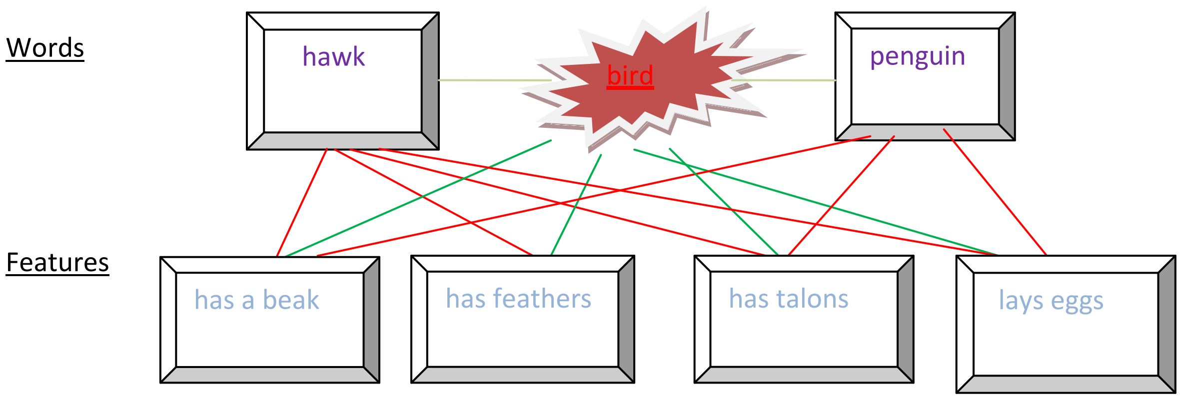

Figure 1: Decomposition: Complex system with activation of shared features.
For example: meaning of a word: activation of *hawk* or *penguin* activates features of *bird.*

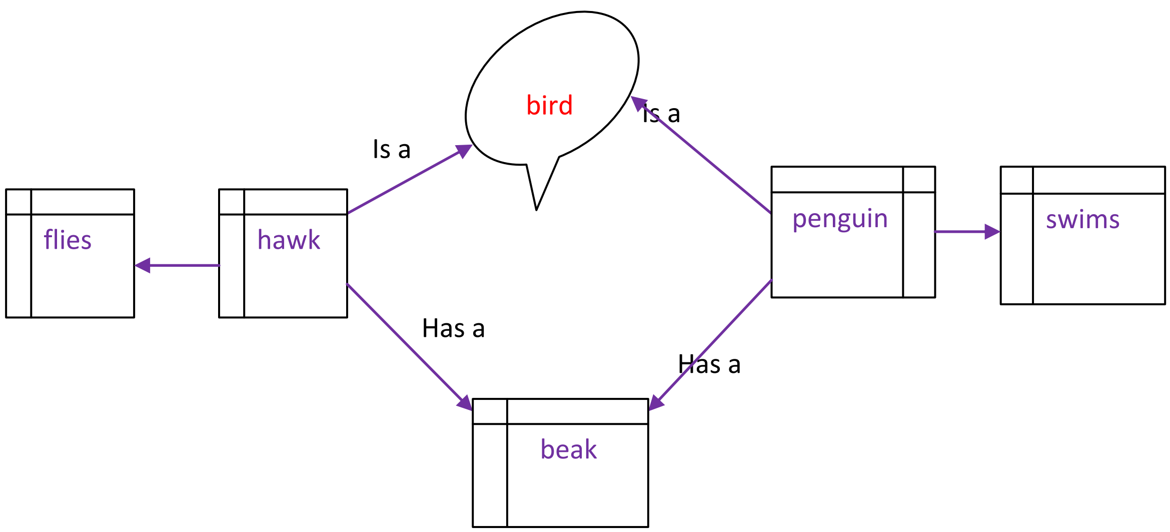

Figure 2: Non-decomposition: One-way relationship: *hawk* is a *bird; penguin* is a *bird.*

For expository convenience, this thesis will use a decomposition approach to lexical meaning and differentiate word concepts from semantic features. However, the experimental methodology and findings are theory neutral. All semantic feature and word relations could be recast as word-word interrelations via meaningful links.

Semantic Features

Individual characteristics that delineate the meaning of a word are the word's semantic features. Semantic feature analysis, or decomposition, breaks down the meaning of a word into featural components of various types. For example, semantic features for the word *car* may include {vehicle} (superordinate category), {has four wheels} (external component), and {is used for transporting people} (function). Another example is the word *vulture*. The meaning of the word *vulture* includes (non-distinctive) features that are shared by many animals and birds such as, {eats} (entity behavior), {has wings} (external component), and {is large} (external-surface property), as well as more distinctive features such as {eats dead fish} (entity behavior), {has talons} (external-component), and {is bald} (external-surface property). As highlighted in this example, semantic features may be identified as properties that apply generally to an entire category, or distinctively to a particular word, as illustrated in Figure 3.

Shared semantic features define one aspect of relatedness in the mental lexicon. For example, other birds, such as robins, sparrows, and ravens, share the feature, {has wings} with vultures. This shared property would create priming or shared activation between these words in the process of lexical access. McRae, et al. (2005) hypothesized that the greater the number of a concept's features that can be used to distinguish it, the less confusable the concept will be, which leads to a greater probability of performing correctly when processing a particular concept. Cree, McRae, & McNorgan, (1999) measured feature distinctiveness quantitatively with this in mind. They used one divided by the number of concepts in which a feature occurs as a measure of the degree to which a feature distinguishes a particular concept from all other concepts.

However, it is theoretically possible that a feature may differ in how it is associated with members of a category (feature distinctiveness) and how frequently it occurs (feature frequency). A distinctive feature is specially associated to a particular category member, and would also normally be a low frequency feature such as {lays blue eggs}. In contrast, a non-distinctive feature is shared by many members of a category, which also typically makes it a high frequency feature such as {has four legs}. Is it possible that the distinctiveness of a feature and feature frequency are not equivalent? For example, {has stripes} may be a distinctive feature for *zebra,* but it is rather frequent across the category of animals: a chipmunk, a tiger and a raccoon all have stripes. Analogously, a feature such as {is nocturnal} is a relatively low frequency feature, but it may not be distinctively identified with any particular animal.

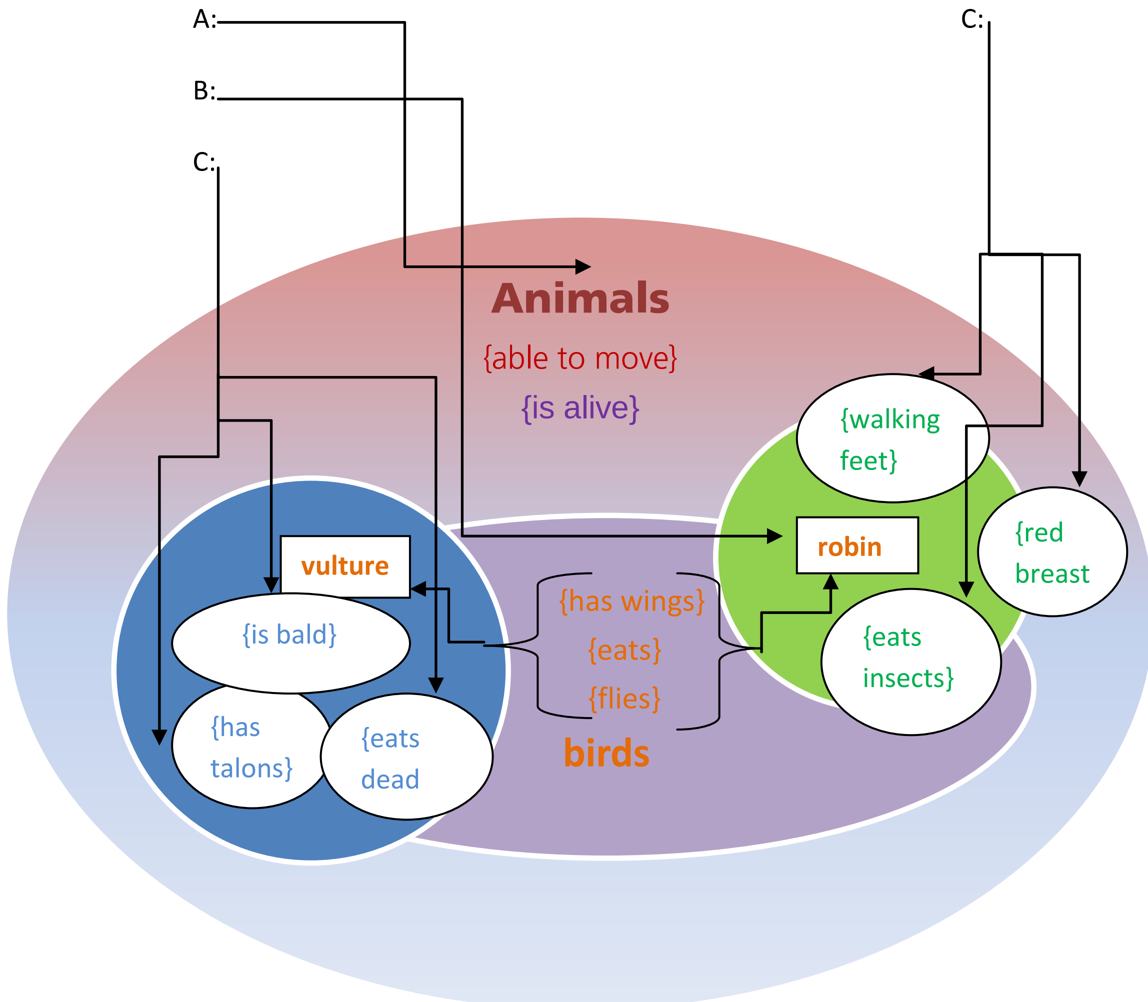

Figure 3: Illustration of a Semantic Feature category
A: The category of animals includes examples of features that are typical of the category.
B: Example of a more distinctive category feature that applies to vultures and robins.
C: Examples of distinctive features related to vultures or robins.

<u>Models of Semantic Representation</u>

The Feature-Comparison model is a theory of semantic memory hypothesized by Smith, Shoben and Rips (1974). The Feature-Comparison model proposes that an individual's semantic memory uses feature lists. These feature lists are basic, one-element properties or characteristics of a concept. For example, when presented with the concept *robin*, an individual will unconsciously compile a list of semantic features, such as {animate}, {red-breasted}, and {feathers}. The model theorizes that the most defining features are located at the top of the list, and those features that are not as common or essential for the meaning of the concept are at the end of the list. Defining characteristics of *robin* match those characteristics of a bird, {animate, feathers, beak}, and leads to robin, as a bird. The greater the overlapping defining characteristics are, the faster the response between the concepts. For example, when presented with *robin*, retrieval for *bird* is faster due to several overlapping defining characteristics. According to the Feature-Comparison model, this the first stage in the retrieval process, because all that remains is the unconscious comparison of features. However, if the concepts are not quickly differentiated, then a second stage is needed. The second stage is a comparison of defining features, in which a slower comparison is done with only defining features. For example, when presented with the concept *chicken*, the response to *bird* is expected to be slower in comparison to *robin* (Baddeley, 1990).

More generally, a Spreading Activation model for concepts and semantic features (e.g. Collins & Loftus, 1975; Neely, 1991) represents concepts and semantic features with two interconnected levels of nodes. The processing of a lexical entry will lead to activation of its semantic features and, especially for this model, this leads to the activation of other semantically related entries. In this model, distinctiveness would be represented by a particularly strong weighted connection between a semantic feature and a word concept.

In contrast to a Spreading Activation model, a distributed model of semantic representation (e.g. Masson, 1995; McRae, de Sa, & Seidenberg, 1997), represents word meaning as a pattern of activation over a set of nodes where the nodes cannot be associated with any particular sub-unit of meaning. The processing of a concept leads to a particular pattern of activation in the featural network. Semantic relatedness is represented as similar patterns of activation between related words. In language processing, the resettling of this network upon presentation of a subsequent word is accomplished faster when the recent entry is semantically similar to the first entry, as the two have overlapping representational patterns. In this model, there is no unitary concept of a semantic feature and so representing distinctiveness is difficult. This model of semantic representation is better suited to a non-decomposition approach to semantic representation.

Semantic Feature Production Norms for a Large Set of Living and Nonliving Things McRae et al (2005)

Featural representations derived from norms have been the basis of accounts of numerous empirical phenomena such as concept categorization (Hampton, 1979; Smith, Shoben, & Rips, 1974), conceptual combination (Hampton, 1997; Smith, Osherson, Rips, & Keane, 1988), feature verification (Ashcraft, 1978; Solomon & Barsalou, 2001; McRae, Cree, Westmacott, & de Sa, 1999), and semantic similarity priming (Cree, McRae, & McNorgan, 1999; McRae, de Sa, & Seidenberg, 1997; Vigliocco, Vinson, Lewis, & Garrett, 2004).

The McRae corpus is the largest set of feature norms that has been developed to date. The McRae et al. (2005) feature norm corpus contains concepts frequently used in studies of semantic memory. There have been several other sets of norms collected, but these have not been published (McRae, et al, 2005).

The aim of collecting semantic feature norms was to produce empirically derived decomposition representations for concepts. The norms were collected for 541 living and nonliving concepts. Collection of these norms was completed over three phases between 1990 and 2003. Thirty participants gave responses for each concept in the database. Participants were presented with 10 blank lines for each concept and were instructed to fill in as many of the lines as possible with properties of the concept to which the word refers. The collection of these norms provided a direct representation of the participants' experiences and interactions with the concept. The results are presumably a valid record of semantic representations (Barsalou, 2003). The McRae, et al (2005) feature norm corpus provides an important collection of semantic features as one aspect of understanding semantic representations of words.

Semantic feature production norms have also been vital in the study of feature distinctiveness. Research into feature listing tasks has uncovered differences in how distinctive features are distributed across categories (McRae, 2002). Features will vary along a continuum in which some are relatively specific to a concept, while others apply to most concepts in a category.

In contrast to the methodology of McRae, et al (1997, 2005) the current study presented a feature and elicited related concepts. Overall, a pattern similar to that found by McRae, et al (2005) was observed, with features varying in their frequency and distinctiveness. However, there was also some evidence that features indicated as distinctive in the McRae database actually connected to a wide variety of concepts. In part, this is likely because the possible concepts related to a feature were limited in the McRae corpus. The methodology of the present study better informs our understanding of the features that are likely to provide a more direct link to a concept as it was this direction of lexical access that was elicited.

Aging and Lexical Access

As the population ages, the need to understand how language is affected with age becomes increasingly important, because word retrieval difficulties are one of the most noticeable changes as individuals age (Hebb, 1978; Skinner, 1983; Salthouse, 1996; Burke & Shafto, 2004). However, the exact nature of this perceived difficulty has not yet been clearly defined. Some research has indicated that word retrieval difficulties are a result of reduced access to lexical phonological representations (Myerson, Ferraro, Hale, & Lima, 1992; Sommers, 1996). Other research has indicated that naming ability remains fairly stable until adults are in their 70s, at which point there is a significant decline in performance. Lexicon size has been shown to increase throughout the middle adult years, and then decline into old age (Albert, Miller & Heller, & Milberg, 1988; Botwinick & Siegler, 1980; Eisdorfer & Wilkie, 1973; Hultsch, Doxon & Snall, 1998; Schaie, 1983, 1996; Schaie & Willis, 1993). The older adult generally exhibits better existing vocabulary than that of the younger adults (Burke & Peters, 1986; Daneman & Green, 1986; Kausler, 1991). Other research has also proposed that the older adult makes active use of their existing vocabulary in order to learn and incorporate new vocabulary (Craik & Jennings, 1992).

Older adults have been shown to use and process language differently than younger individuals (Botwinick & Storandt, 1974; Burke, MacKay, Worthley, & Wade, 1991; Davis & Ball, 1989, Morrison, et al, 2003; Nicholas, et al, 1985; Obler, Fein, Nicholas, & Albert, 1991; Ramsay, et al, 1999). A wide variety of language measures have been shown to decrease with age, including the ability to define words (Botwinick & Storandt, 1974). It has also been reported that retrieval errors (Cohen & Faulkner, 1986; Martin, 1986; Ryan, 1992), and significant word finding failures are found in older adults (Rabbit, Maylor, McInnes, Bent, & Moore, 1995; Sunderland, Watts, Baddeley, & Harris, 1986). Goulet, et al (1994), found inconsistencies with their results when they reviewed picture naming accuracy with normal older adults. In a review of literature from 25 research studies, they indicated that there were diverse naming abilities in the older adult, and no clear evidence that naming declines with age.

In contrast to these findings, other research has indicated access to an individual's storehouse of words is an aspect of intelligence, called "crystallized knowledge," that is relatively stable and can increase over adulthood. Bowles, Grimm, & McArdle (2005) found when analyzing age differences between young and old adults that basic vocabulary skill peaks at approximately 50 years of age. From this point vocabulary knowledge may slowly decline as the individual advances to old age. However, results for advanced vocabulary abilities did not reveal any relation to age for those adults between 35 and 70 years of age. In this study, the General Social Survey (GSS) vocabulary test was given to 20,560 adults between 1974 and 2000. The GSS has 10 multiple-choice items, with each item consisting of a target word with 5 options (words or phrases). The participants choose the option most similar in meaning of the target word. An example of basic vocabulary, from this collection, could be *infant* or *huge*, whereas an example of advanced vocabulary could be *apex* or *effulgence* (Bowles, et al, 2005).

Reviews of language function have consistently concluded that conceptual representations underlying the meaning of a word are well-preserved during adulthood (Botwinick, 1984; Burke, et al, 2000; Kemper, 1992; Kliegl & Kemper, 1999; Thornton & Light, 2006; Wingfield & Stine-Morrow, 2000; Zacks & Hasher, 2006). There is no evidence that older adults lose the meanings of words they know. However, this is only true for words that are used through their life. Research has also indicated that an individual's knowledge base can increase throughout the life span (Kausler, 1991), and as adults, there are more opportunities to increase vocabulary. An increased exposure to new words occurs as a result of more experiences and more conversations (Salthouse, 1988). Daneman & Green (1986) report that, although there are individual differences in comprehending and producing words with young and older adults, the older adults typically have a stronger existing vocabulary. Results of several studies have shown that older adults have a strong knowledge base in vocabulary, and show little decline in vocabulary until the last decades of life (e.g., Kaufman, 1990; Kaufman, Reynolds, & McLean, 1989; Kausler & Puckett, 1980; Salthouse, 1991; Salthouse, 1993; Smith & Earles, 1996). Light (1991), concluded that "neither the organization of concepts nor the characteristics of semantic activation varies with age" (p. 342). Younger and older adults encode and organize information similarly, although older adults may be slightly slower to access that information (Bowles, 1994).

Older adults demonstrate a slower response than that of younger adults in most experimental tasks. It has been hypothesized that older adults have a general slowing in the processing of information (Fisher, 1996; Salthouse, 1985). Older adults tend to be slower in their decision to label an object into a category, than younger adults (Burke, Mackay, Worthly, & Wade, 1991; Light, 1992). These age-related changes are believed to be the result of a general decline in processing speed in older adults. Despite the slower response, the older adults maintained the correct response in category decision tasks, and demonstrated stable semantic knowledge (Burke, Mackay, Worthly, & Wade, 1991; Light, 1992).

Subsequent studies found similar results. Moberg, et al, (2000) used the Boston Naming Test (BNT) to compare naming abilities between a younger group (mean age of 22.1) and an older group (mean age of 68.1) in a lexical decision task. The younger group displayed a shorter response time than the older group. However, results indicated that there were no significant differences in the accuracy of the responses found between the younger and the older groups, suggesting lexical access was not impaired. Older adults do present with slower processing and require more time to process lexical information, when in search of a particular word (Cohen & Faulkner, 1986; Martin, 1986; Ryan, 1992).

The Transmission Deficit Hypothesis offers the most specific mechanism to explain the asymmetric effect of aging on language processing, where certain aspects of language processing, such as semantic representations and retrieval, are preserved into late adulthood (Burke, et al, 2000). In this framework, linguistic information is stored as nodes in a vastly interconnected network separated into multiple systems, including a semantic system for word meanings, a phonological system for sounds, and an orthographic system for spellings (MacKay, 1987; MacKay & Abrams, 1998). As people age, the strength of connections between these nodes becomes gradually degraded throughout the entire network (Burke & MacKay, 1997; MacKay & Abrams, 1996; MacKay & Burke, 1990), which influences the speed and amount of activation that is transmitted between nodes. The architecture of the network leaves the phonological and orthographic systems particularly vulnerable to age-related transmission deficits because it relies on single connections between the semantic representation of a word’s meaning and the word's phonological/orthographic form.

Evidence from studies of lexical semantics, including studies of vocabulary knowledge and semantic priming, suggests that semantic connections between words are well-preserved in old age. Declines in vocabulary occur only in very old age and may reflect declines in learning rather than in semantic processing (Taylor & Burke, 2002; James & Burke, 2000). Since older adults have more items to choose from in their lexicon, they may have more difficulty in accessing a particular word because of increased competition or due to a reduced ability to inhibit competitors (Sommers, 1996). Inhibition deficits may explain age differences in processes such as competition between words during lexical selection (Sommers & Danielson, 1999; Ackerman & Rolfus, 1999; Beier & Ackerman, 2001). Access deficits may also be explained by a reduced inhibitory capacity. Hasher, Zacks, and May (1999) proposed that a lack of inhibitory control might account for deficits associated with aging. Specifically, failure to suppress irrelevant information in working memory, which reduces its capacity, will result in less access to relevant information. However, access deficits in the older adult may also be explained by the diminished-resource hypothesis. In this theory, the older adult is proposed to have reduced processing resources for lexical access. Therefore difficulty in lexical access may be explained due to insufficient cognitive resources for the older adult to dedicate to lexical access (Burke & Shafto, 2004).

Burke, et al. (1991) argued that older adults were more affected by word frequency than younger adults. Burke asked two groups of study participants to read written words aloud; the younger group with a mean age of 21.2, and the older group, with a mean age of 74.2. The older adults displayed a longer response time than the younger group. However, these researchers also discovered that lexical access may be impaired only for the low frequency items, when compared to the higher frequency words. In a replication study, Almore (2005) confirmed that older adults were more affected by word frequency, in comparison to younger adults, in the oral reading of written words. Recall that in a spreading activation model of the lexicon, high frequency words have a higher base activation than low frequency words, therefore excessive spread of activation or reduced inhibition would put low frequency words at an even greater disadvantage in the older adult.

It is also possible that there are no processing differences in older adults, rather that older adults simply do not want to make any errors at all, and that causes them to slow down (Ratcliff& McKoon, 2000). It may be that they adopt a cautious approach that prompts an accumulation of more information before settling on a decision. This suggests that age-related slowing may be partly due to unwillingness on behalf of older study participants to adopt a fast and careless attitude (Rabbitt, 1979). The older adult is reluctant to make a mistake, and attaches more importance to responding accurately than to responding quickly (Rabbitt, 1979; Salthouse, 1979; Smith & Brewer, 1985, 1995; Starns & Ratcliff, 2010). A risky response will place the older adult within a sensitive part of the Speed-accuracy tradeoff (SAT) curve. This suggests voluntary control of a response with older adults and an unwillingness to adopt a fast SAT.

Older adults may also avoid a risky response because of reduced efficiency in activations. They will be slow and cautious because their brains do not have adequate processing to reduce the competition with the accumulation of information. Age-related changes in brain connections produce more interference from competitors as the older adult processes information (Forstmann, Tittgemeyer, Wagenmakers, Derrfuss, Imperati, & Brown, 2011).

In summary, older adults do not lose the meanings of words that they already know and evidence supports a stable accumulation of word meanings, when actively used, across the lifespan. It is this entrenched knowledge that has also enhanced the older adults’ ability to learn and incorporate new vocabulary, which may explain one reason why older adults have a better vocabulary than younger adults. There is no clear evidence that the older adults’ ability to retrieve a word declines with age. Despite longer latency times, older adults do not show a decrease in accuracy.

Current Research

The McRae, Cree, Seidenberg, and McNorgan (2005) feature norm corpus is the basis for the selection of stimuli for the current research project. In their study, semantic features were utilized to explore the structure and conceptual features of the lexicon. Research in semantic feature production norms have been a critical element in the development of semantic memory models. McRae, et al (2005) collected features on 541 concepts. For each of these concepts, the features provided by study participants were recorded to create a database, and were analyzed for the production frequency of the features. Production frequency is the number of subjects that listed a particular feature for a concept presented (a range from 1 to 30). In addition, the collection was ranked for feature frequency, which is the number of concepts in which each feature occurs in the norms. Based on the number of concepts that elicited a feature, the features were considered frequent or inverse to frequent, as distinctive.

However, the McRae, et al (2005) feature norm collection procedure conflates feature frequency with feature distinctiveness. Low frequency features are assumed to be distinctive. The database did not directly address whether features are distinct or non-distinct, as the database used word concept cues to elicit features. For example, there are two cold-blooded animals (*frog* and *toad*) in the database. Features for cold blooded animals (such as {an amphibian}, {a reptile}, or {has scales}), will be considered distinctive, even though they apply to many cold blooded animals in the full range of concepts in the lexicon. McRae, et al (2005) also did not analyze the order of production of the features, which might have provided a cue to the privileged lexical access that occurs with distinctiveness. For example, for a feature like {has stripes}, there are many related concepts, but perhaps for some concepts, it is always the first feature to come to mind. This would suggest distinctiveness of the feature, even though the feature's frequency is high.

The current research addressed whether feature frequency and distinctiveness are separate dimensions. In this study, features are used to elicit concepts so that variation in the feature frequency is not limited by the available concepts in the study. In addition, the variety of first responses will be considered. Despite whether or not features are low or high frequency, those features with less variety in the first response may be more distinctive. Therefore, in contrast to the McRae database, this study will attempt to differentiate distinctiveness from frequency as illustrated in Figure 4.

This study will also examine age effects on concept elicitation to determine whether there are any differences in the lexical access process for semantic features between older and younger adults in an off-line task, comparable to a clinical therapy task. Within the older adult's lexicon are concepts gained from repetitious experience in the access of those concepts. Older adults may have an advantage in lexical access due to such experience. This experience may also build more neural interconnections in the lexicon of the older adult. In the present study, it is anticipated that older adults will produce a greater number of concepts when presented with a feature given this experience. Older adults may also have developed more detailed semantic feature representations with more clearly defined boundaries. Older adults, with more clearly defined categories, may also produce less variety in their initial concept response to features, showing stronger more distinctive connections between features and concepts.

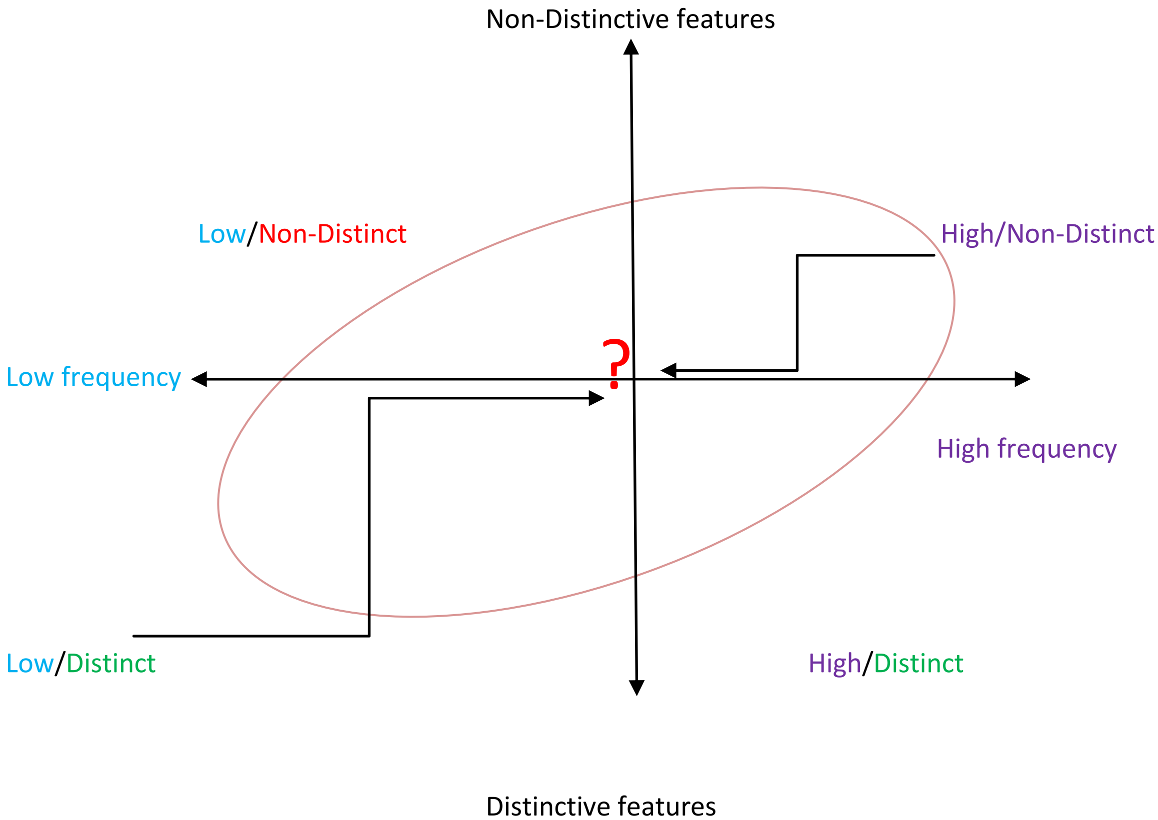

Figure 4: Are low frequency/distinct and high frequency/non-distinct separate dimensions, or aligned into a comprehensive dimension?

Research Question: What is the relation between feature frequency and distinctiveness, and how does it change with age?

Hypothesis 1: The use of features to elicit concepts will result in similarities and differences in comparison to the McRae corpus.

a. Similar to the McRae corpus, features will vary in frequency, when utilizing the method of data collection in this study.

b. Distinctiveness is a separate dimension from frequency, so there will be a variety of patterns in the first responses across features with different frequencies.

Hypothesis 2: The number and variety of responses will be different for older adults:

a. Older adults will produce a greater number of concept responses to features due to more interconnections in the mental lexicon.

b. Older adults will produce less variety in their initial concept response to features due to clearly defined boundaries in the mental lexicon.

Significance: This study will examine the influence of feature frequency and feature distinctiveness on semantic processing during lexical access, and the effects of aging on these dimensions, with an eye toward the use of semantic features as a clinical tool for word retrieval in adults with anomia.

Experimental Methods

The current experiment addresses the effects of frequency and distinctiveness of semantic features in lexical access. This experiment was an attempt to directly investigate semantic feature frequency and distinctiveness by using semantic features to elicit concepts. Semantic feature frequency would be reflected in the number of concepts a participant is able to name. Semantic feature distinctiveness would be reflected by the consistency among participants in the concepts that come to mind, in particular the first concept that comes to mind. Data are collected for two groups of participants in order to also examine the effects of age on performance in the task, younger participants (ages 19 to 39) and older participants (ages 55 to 75). Differences between age groups may reflect differences in conceptual organization within the lexicon, or in the process of access to lexical concepts between younger and older participants.

Stimuli

The McRae, et al (2005) feature norm corpus is the basis for the development of 120 features utilized in the experiment. The initial reductions of the feature list for the present study were completed from the features contained in the 541 concept word corpus (McRae, et al, 2005) with the elimination of all features for non-animate concepts in the corpus. For the current experiment, it was decided to focus on features of animals that are based on visual properties, essential characteristics, or group behaviors that are expected of animals as a relatively well-defined and commonly known semantic domain.

The 120 features came from different frequency ranges in the McRae database and were either distinctive (D), with frequency 1, low frequency but not distinctive (LFND, frequency 3 to 8), or not distinctive and with high frequency (NDHF, frequency 11 to 121). The appendix provides the full list of features used in the study. Table 1 provides a summary of the feature characteristics for the three groups of features used from the McRae database.

Table 1: Frequency statistics for feature stimuli by category

Feature Category	N	McRae Mean Frequency	McRae Median Frequency	Minimum of McRae Frequency	Maximum of McRae Frequency
D	40	1.0	1.0	1	1
LFND	40	3.8	3.0	3	8
NDHF	40	39.1	37.5	11	121

Participants

Young adult participants were recruited from the undergraduate and graduate student population at the University of South Florida. There were 30 young adult participants, 25 females and 5 males. The young participants were between 19 and 39 years of age. The average age was 27.3. There were 30 older adult participants, 20 females and 10 males. The older adult group was recruited from the cognitive lab in the school of Aging Studies at the University of South Florida, and from the community. The age of the older adult participants ranged from 55 to 75 years of age. The average age was 65.8. Among the older adults, 3 had high school diplomas, 11 had some college, 11 had college degrees, and 5 had advanced degrees.

All participants were mono-lingual native speakers of English, had normal or corrected-to-normal bilateral hearing acuity, and normal or corrected-to-normal vision. The young adults were screened with the Montreal Cognitive Assessment (MoCA) by the author or a research assistant. Many of the older adults were screened through the cognitive lab in the school of

Aging Studies. The remaining older adults were screened by the author. Each participant passed the MoCA with a score of 26 (26/30) or better, which indicates the subject is free of mild cognitive dysfunction. Participants were also free from a history of mental illness or substance abuse, as reported during the pre-experiment interview or screening.

A total of 101 participants were recruited across both groups, with a total of 60 qualifying for participation in the study. Participants were excluded from the data analysis if they: failed the MoCA (2), were not available for MoCA screening (19), were bilingual (14), were unable to follow instructions (4), or required an extensive amount of time for completion of the experimental task (2).

Procedures

Each participant was seated in front of a laptop computer and with their dominate hand readied to manipulate a computer mouse, arrow buttons, or the space bar on a standard QWERTY keyboard. Stimuli were presented visually in 20 point black Arial font located on a white computer screen background using the Microsoft Office PowerPoint 2007 program. Each trial began with a presentation of a feature characteristic as a short phrase on the computer screen. There were six randomized lists that were used across the participants. The participants' task was to verbally produce a list of animals related to the feature presented on the screen. They were allowed to take as much time as they needed to respond to each feature presentation. The participant advanced each slide following the completion of their responses. An Olympus digital recorder, model number WS700M, was utilized to record the participants' responses. The feature remained on the screen until the participant advanced to the next feature. The participants were instructed that once they had advanced the screen, they would not be able to return to the previous item. Prior to presenting the experimental stimuli, each participant completed a brief practice session with the presentation of three animal features that were not part of the experiment. All participants completed the experiment in 30 to 120 minutes. The average completion time was 57 minutes for the younger adults and 85 minutes for the older adults.

Analysis

Recordings of the experimental sessions were coded by the author into computerized lists of concept responses, in order, for each feature provided to each participant. The data were then inspected for cases where responses were alternates of the same concept word. For example, *cat, cats, kitty*, and *kitty cat* were all considered variant responses for the concept *cat*. The most common situation was combination of singular and plural forms to the singular form. For example, *dogs* and *dog* were both considered as the concept *dog*. Cases of related terms with a recognizable semantic distinction were not collapsed. For example, *kitten* was considered a distinct concept from *cat*. The most common situation where concepts were not collapsed was more general (basic level) versus more specific instances of a category. For example, *German Shepherd* was considered a distinct concept from the concept of *dog*.

The data were analyzed for the average number of animals listed and for the variety of the first animal listed across participants in response to each feature. Analysis of the participants' responses across features was compared for the three stimulus groups: distinctive (D), low frequency non-distinctive (LFND), and non-distinctive high frequency (NDHF). These measures were chosen to capture feature frequency in the average number of responses and feature distinctiveness in the variety of first responses. In other words, features with consistent first responses are considered more distinctive, while features with a variety of first responses are considered to be less distinctive, regardless of how many total responses were given.

Separating the analysis of feature frequency from feature distinctiveness allows some initial understanding of whether feature frequency and feature distinctiveness are separate dimensions of lexical-semantic organization.

Results

To examine the questions of feature frequency and feature distinctiveness in the concept elicitation task, results for the average number of responses for each feature category for each age group were examined, as presented in Figure 5 and Table 2. A repeated measures analysis of variance (ANOVA) including younger and older groups as a within (stimulus) factor was completed on the number of responses for each feature, with feature category (Distinctive, Low Frequency Non-Distinctive, and Non-Distinctive High Frequency) as a between stimulus factor. The main effect across feature categories, $F\ (2, 39) = 62.0$, $p < .001$, was significant. The greatest number of responses was given for the Non-Distinctive High Frequency features and the smallest number for Distinctive features, with Low Frequency Non-Distinctive in between. Post-hoc analysis was carried out across feature category groups using Holm-Bonferroni correction. There were significant differences between each feature category, D < LFND < HFND, supporting the idea that distinctiveness is a continuum.

Table 2: Number of Responses by feature category

Feature Category	N	Mean McRae Frequency	Mean Number of Responses
		Young Adults	
D	40	1	1.83
LFND	40	3.8	2.72
NDHF	40	39.1	4.59
Grand Total	120	14.6	3.0
		Older Adults	
Feature Category	N	Mean McRae Frequency	Mean Number of Responses
D	40	1	2.47
LFND	40	3.8	3.99
NDHF	40	39.1	6.26
Grand Total	120	14.6	4.2

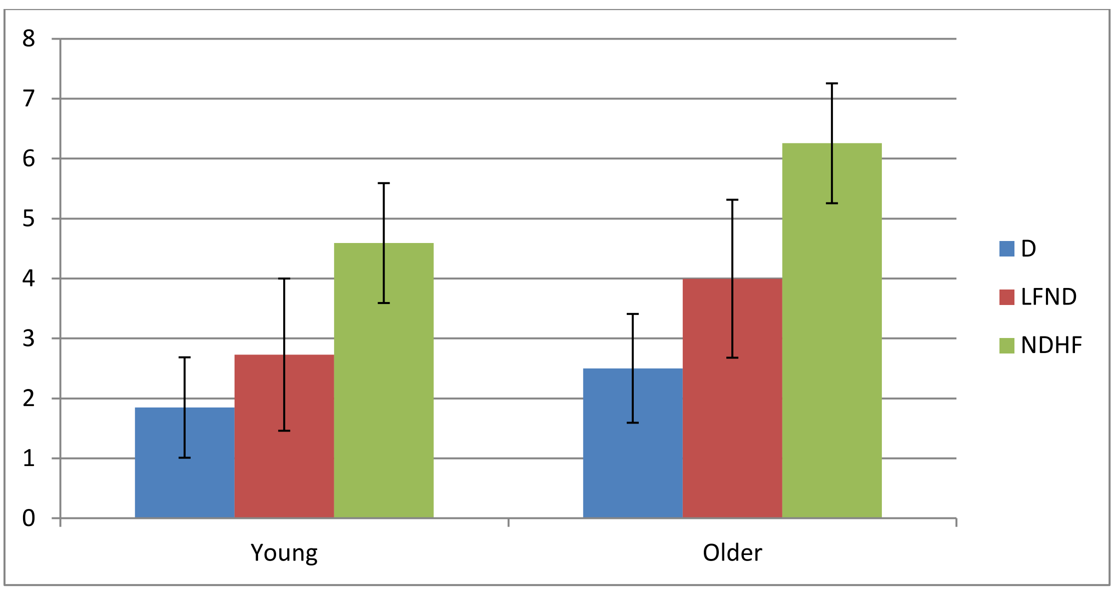

Figure 5: Average number of responses per group, young and older participants

In the repeated measures ANOVA, the main effect for number of responses across age groups, F (1, 39) = 319.6, p = < .001, was significant. An effect of age is seen over the number of responses, with older adults providing a greater number of responses than younger adults for all feature categories. There was also a significant interaction, F (2, 39) = 20.2, p < .001. The greater number of responses given for participants in the older group was largest for High Frequency Non-Distinctive features and smallest for Distinctive features, with Low Frequency Non-Distinctive features in between. This interaction is likely due to a floor effect for distinctive features, where both groups gave very few concepts and less variety of concepts.

Results for the variety of first responses for each feature category divided by age group are presented in Figure 6 and Table 3. A repeated measure ANOVA was conducted on the variety of first responses given for each feature with age group as a within items variable and feature category as a between items variable. The main effects for the variety of first response across feature category, $F\ (2, 39) = 21.6$, $p < .001$ was significant. Post-hoc analysis for variety of first response for each feature category using Holm-Bonferroni correction found significant differences between each feature category, providing the most direct evidence that distinctiveness is a continuum (D < LFND < HFND).

Table 3: Variety of First Responses by feature category

Young Adults					
Feature Category	N	Mean McRae Frequency	Mean Number of Distinct First Responses	Minimum Number of Distinct First Responses	Maximum Number of Distinct First Responses
D	40	1.0	5.68	1	14
LFND	40	3.8	7.65	2	15
NDHF	40	39.1	10.20	3	19
Grand Total	120	14.6	7.84	1	19
Older Adults					
Feature Category	N	Mean McRae Frequency	Mean Number of Distinct First Responses	Minimum Number of Distinct First Responses	Maximum Number of Distinct First Responses
D	40	1.0	5.73	1	13
LFND	40	3.8	8.80	2	17
NDHF	40	39.1	10.50	5	18
Grand Total	120	14.6	8.34	1	18

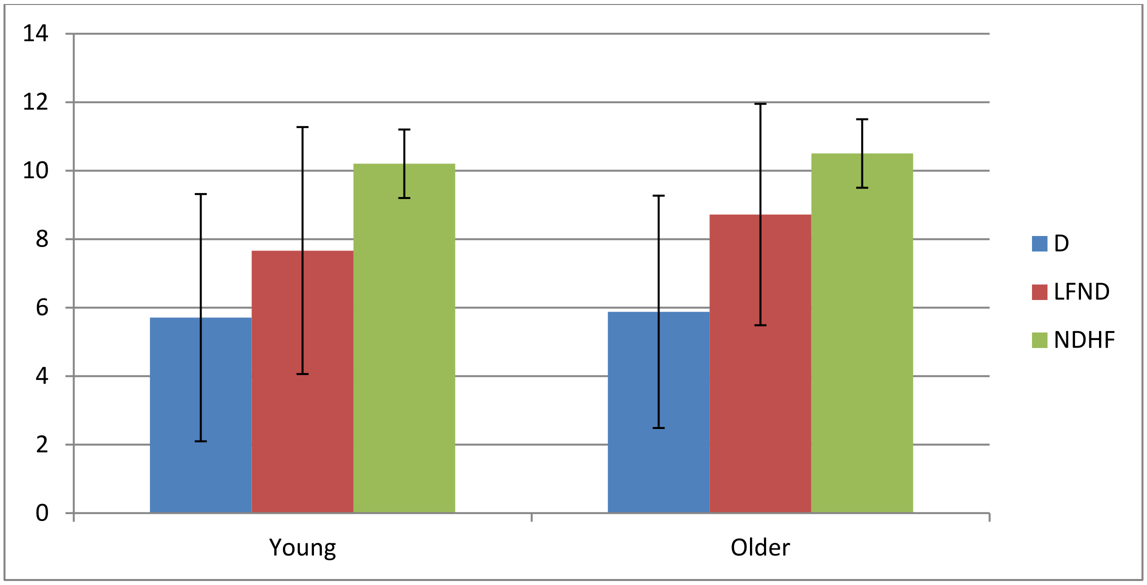

Figure 6: Results for the variety of first responses per group, young and older participants.

In the repeated measures ANOVA, the main effect for the variety of first response across age group, F (1, 39) = 4.6, p =.034 (<.05) was significant (but is a small overall difference). The interaction was not significant, F (2, 39) = 1.3, p =.267 (>.05). Overall, the older adults provided a slightly greater variety of first responses compared to the young adults.

Discussion

Overall, the concept elicitation task presenting features showed similarities and differences with the feature elicitation results presented in McRae, et al (2005). For example, within their Distinctive category are features that were only elicited once in the McRae study. In some cases, when these features were presented to participants to elicit concepts, a single concept was elicited or all participants gave the same first response. However, in other cases, many concepts were elicited and a wide variety of first responses were given, suggesting that these features are not distinctive, but instead were infrequently elicited by McRae due to the concept set that was used. For example, the McRae concept list includes *spider* but no other arachnids, and so the feature {has 8 legs} was only elicited once. When given this feature, participants produced a wide variety of concepts such as *scorpion* and *tick* as well as *squid*, *octopus*, and *crab*.

An effect of age is seen in both the number of responses, and variety of first responses across the three categories; Distinctive (D), Low Frequency Non-Distinctive (LFND), and Non-Distinctive High Frequency (HFND). The older adult group produced more concepts and more variety of first concepts than the younger group, in all three categories. These results suggest that the older adult group have a greater variety of semantic relationships among concepts compared to the younger group, as hypothesized. However, contrary to hypothesis, they are slightly less consistent in their first response (presumably, the first concept that comes to mind) showing that their representations are not better defined or more entrenched. Instead, greater semantic connectivity seems to also result in a greater variety of competitors for the first thing to come to mind when given a feature and asked to respond.

The older adult group took more time in the completion of the study task. This may be the result of competition between features from spreading activation to other semantically and/or associatively related entries. However, these connections, which are distributed throughout the network, have various connection strengths, and thus can influence the process. It is also possible that the older adults' increased time may be an affect of reduced inhibitory capacity. Finally, the older adults' differences in their response time may be from directing attention to providing a higher level of accuracy in responses.

Limitations to the Study

This study used an untimed task. A timer to advance each slide after 20 to 30 seconds may have limited the number of responses given, as well as encourage a participant to respond with more than just one response. This has the potential to remove outliers for those participants who completed the experiment too quickly (only taking the time to provide one response for each feature stimulus), or those that took extended length of time (who may then have been using unusual mental search strategies in order to provide as many responses as possible). A controlled advancement of the slides has the potential for increasing the uniformity for the participants' approach to the task, and thus providing more reliable data. Care would have to be taken, though, in setting the time limit as time pressure may have a greater impact on the performance of older adults in the task.

A second limitation in this experiment is that it was restricted to the semantic domain of animals. The participants would have to engage additional cognitive processes in order to limit or filter their responses to the domain of animals. This extra processing demand might have introduced additional differences in performance between younger and older adults.

In addition, it is possible that the measures of feature frequency or distinctiveness would be different if these features were used in a task where both animate and inanimate concepts could be listed (e.g. {has wings} could include *airplane*). A broader study that covers the full range of features for the animate and inanimate concepts from McRae, et al (2005) is needed for a couple reasons. First, investigating such as study would provide a more accurate picture of feature frequency and distinctiveness. Secondly, a broader study would also allow for a greater variety of studies on semantic features and concepts to utilize this data.

<u>Future Directions</u>

Aphasia is the inability to use or understand language, and anomic aphasia is the inability to name objects or to recognize written or spoken names of objects, due to a brain lesion. Patients who make a good recovery from either a fluent or non-fluent aphasia may have a persisting residual anomia. According to Kiran and Thompson (2003), naming deficits are one of the most prevalent language deficits that individuals with aphasia present. Follow up research to the present study will compare the performance of normal older adults to those with acquired language disorders in the concept elicitation task using semantic features. This has potential to determine whether distinctive connections between features and concepts remain in those with language impairments. This may assist in intervention as feature cueing is used clinically with this population.

In addition, the focus of cueing intervention can be targeted with a better understanding of the relationships between semantic features and word concepts. Knowledge of the distinctiveness of a feature will assist in a more direct activation of the desired concepts in semantic cueing and has the potential to result in improved functional outcomes with cueing therapy. By highlighting distinctive features, lexical retrieval may be more successful with fewer cues. For example, in the semantic domain of animals from this study, features related to the object can be used, similar to cueing for function for common household objects.

E.g. Features for *cheetah*:

Distinctive: Is fast, has black spots

Low frequency, non-distinctive: Lives in Africa, is yellow

Non-distinctive high frequency: A mammal, a carnivore

Leads to a distinctiveness based cuing hierarchy such as:

1. "What is this called?" Show picture of cheetah (desired response "Cheetah")
2. Describe object with distinctive features. ("It's fast; It has black spots")
3. Demonstration of distinctive features of the object. (Demonstrate moving fast; Point out the black spots)
4. Add additional less distinctive features to the object description. ("This animal is fast and has black spots; it is also yellow and lives in Africa".)
5. Sentence or phrase completion with features related to the object. ("A carnivore that is a fast animal with black spots that lives in Africa is a _______.")

With the methodology used in this dissertation, it would be possible to elicit features for all of the objects in a set of picture cards typically used by speech therapists. This data could be used to create cueing hierarchies based on semantic features for each of the objects similar to the example above. The efficacy of such an approach in therapy for anomia is a topic for future research.

Conclusions

The methodology in the current research study has provided an explicit tool for investigating distinctiveness in the relationship between semantic features and concepts. Feature distinctiveness was directly examined by eliciting concepts from features and it was found that distinctiveness between a feature and a word concept lies along a continuum.

The results also revealed that older adults provided more responses than the young group in this untimed, metalinguistic task. This suggests that older adults have access to a more richly interconnected lexicon than younger adults when processing time is not a factor, and this should be considered in the clinical application of semantic feature cueing to the older adult.

Semantic feature production norms have played and continue to play an important role in the constructing of theories and models of semantic memory, concepts, and categorization. A continued interest in semantic features is important in our understanding of the influence of features on the retrieval of semantic concepts. The present study introduced new methodology for examining the relationship between features and concepts, by presenting phrases representing feature characteristics for concept elicitation.

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<u>Appendix 1: Stimuli and instructions</u>

Feature stimuli by category:

Distinctive (D) (n=40)	Low Frequency Non-Distinctive (LFND) (n=40)	Non-Distinctive High Frequency (NDHF) (n=40)
a pest	an amphibian	a carnivore
barks	bites	a mammal
becomes a butterfly	buzzes	a pet
builds dams	chirps	an animal
clucks	climbs trees	different colors
cocoons	crawls	eats
eats cheese	digs holes	flies
eats small animals	eats flies	has 4 legs
found in dens	eats garbage	has a beak
gobbles	eats leaves	has a tail
has 2 humps	eats mice	has claws
has pointed ears	eats rodents	has eyes
has 8 legs	eats seeds	has feathers
has 8 tentacles	eats worms	has fins
has a curly tail	has 6 legs	has fur
has a hump	has a long neck	has legs
has a long mane	has a long tail	has teeth
has a rattle on tail	has a long tongue	has wings
has a snout	has a mane	is a bird
has a stripe	has antlers	is black
has a strong beak	has fangs	is brown
has large tusks	has horns	is dangerous
has long tail feathers	has sharp teeth	is edible
has pinchers	has spots	is fast
has powerful jaws	has stripes	is furry
has quills	has webbed feet	is green
hates red	has whiskers	is grey
honks	hibernates	is large
hoots	hops	is long
is hairy	is fuzzy	is orange

king of the jungle	is nocturnal	is small
lays blue eggs	lives in a nest	is soft
likes mud	lives in lakes	is tall
man's best friend	lives in mountains	is white
produces honey	lives in swamps	is yellow
sprays water	lives in woods	lays eggs
swings from trees	migrates	lives in water
wiggles	produces manure	lives on farms
will snap at people	runs fast	sings
wobbles	slithers	swims

<u>Instructions and sample features</u>

You are going to see features of animals appear one at a time on the computer screen before you. List the animals that come to mind when you see the feature on the screen. There are no right or wrong responses; I want you to tell me what comes to your mind. Tell me as many as you are able to think of. I am not timing you on this task; please tell me the animals that come to mind in your leisure. Here is the first example:

Provide all the animals that you can think of that relate to this feature:

lives in oceans

Example responses were provided, such as:

- Dolphins
- Sharks
- Whales and so on…
- Turtles
- Octopus
- Eel
- Jellyfish
- Lobster

Appendix 2: IRB Approval

USF
UNIVERSITY OF SOUTH FLORIDA

DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd. MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-5618

7/14/2011

Katherine Lamb
Communication Sciences and Disorders
1651 Heron Cove Drive

RE: **Expedited Approval** for Initial Review
IRB#: Pro00000578
Title: Semantic feature distinctiveness and word frequency

Dear Ms. Lamb:

On 7/14/2011 the Institutional Review Board (IRB) reviewed and **APPROVED** the above referenced protocol. Please note that your approval for this study will expire on 7/14/2012.

Approved Items:
Protocol Document:

Proposal 0.04

Consent Document:
IRB_Adult IC minimal risk_final copy to IRB application.docx.pdf 0.01
Please use only the watermarked/stamped consent form(s) found under the "Attachment Tab" in the recruitment of participants.

It was the determination of the IRB that your study qualified for expedited review which includes activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the categories outlined below. The IRB may review research through the expedited review procedure authorized by 45CFR46.110 and 21 CFR 56.110. The research proposed in this study is categorized under the following expedited review category:

(6) Collection of data from voice, video, digital, or image recordings made for research purposes.

(7) 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.