Semantic Memory and its Role in Verb Processing

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Verbs are a fundamental component of sentences, but they are also complex and require great mental effort to process and understand. Being that verbs are crucial to sentence comprehension, it is important to understand why verbs are often selectively impaired in neurogenic language disorders, such as in certain types of aphasia. The current study tested cognitively healthy younger and older adults as they performed verb and noun-based tasks that required them to tap into their semantic memory network. The goal of this study is to understand the role semantic memory plays in understanding sentences and how impairment to semantic memory, like in the case of many patients with aphasia, can impact the processing of verbs.

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PREFACE

I'd like to thank many people without whom this thesis and defense would not be possible.

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1.0 INTRODUCTION

Aphasia is an acquired communication disorder resulting from damage to the language centers in the brain, thus impairing the ability to process, understand, and produce language. Symptoms of aphasia depend on the location and severity of the lesion. A complex disorder, aphasia has garnered extensive research interest partly due to the fact that some individuals with aphasia seem to have selective impairment of words from different grammatical classes, particularly between nouns and verbs (e.g., Tsigka, Papadelis, Braun, & Miceli, 2013). Starting from the verb-noun dissociation that is commonly observed in patients with different types of aphasia, this study will use aphasia as a theoretical motivation for the study while examining cognitively healthy younger and older adults.

In order to process language accurately and efficiently, we must not only rely on our language-specific abilities and knowledge, but we must also access non-language knowledge as well, including our semantic memory. Semantic memory is the part of our long-term memory system that is responsible for the representation of core knowledge about the world. This part of the mind and brain is not part of the language system, but rather allows us to comprehend a multitude of different stimuli, such as words, pictures, objects, and faces. It also allows us to express knowledge in a wide variety of domains, both verbal (e.g. naming) and non-verbal (e.g. drawing and object use). We continuously and effortlessly activate our semantic memory when we are trying to understand or are about to produce language. Since semantic memory plays a crucial role in our daily lives, impairment of semantic memory can produce devastating effects on language comprehension and production (Riley & Peelle, 2008). Semantic memory is often impaired among people with neurodegenerative disorders such as semantic dementia (Bak & Hodges, 2003; Reilly & Peelle, 2008). This impairment disrupts their ability to retrieve knowledge from their semantic memory when they are producing or understanding words. The current study examines how semantic memory for objects (important for producing and understanding nouns) and actions or events (important for producing and understanding verbs) is activated, by looking at performance on tests of semantic memory which are commonly used with individuals with aphasia and people with neurodegenerative disorders.

Verb are crucial to both sentence production and comprehension. Since they are so important to our language abilities, it is imperative that we understand how and why verbs are sometimes selectively impaired in different neurogenic language disorders. There are several reasons as to why verbs are thought to be inherently more complex than nouns, thus potentially contributing to or causing a dissociation between nouns and verbs. One such reason, which will be discussed in greater detail later, deals with the issue of concreteness and imageability. Actions are less concrete and imageable than objects, which may make verbs more difficult than nouns (Gentner, 2006). These differences are reflected in the semantic memory representations for actions and objects, meaning that actions and events may be harder to process than objects in tasks which measure semantic memory. Another theory (Gillette et al., 1999) deals with the fact that verbs depend on linguistic cues in order to be properly identified. That is, verbs crucially require linguistic information to be learned and distinguished from one another. This theory does not explain the differences between nouns and verbs based on semantic memory representations, but instead is grounded in the idea that the linguistic differences between nouns and verbs are responsible for the dissociations between them.

The importance of gathering this crucial data regarding semantic memory for objects and actions rests on the fact that verb deficits are a central feature of aphasia. Understanding the source of the nature of these verb deficits is important for addressing this feature of aphasic language disorders. Using individuals with aphasia as the motivation for this study, the current study will focus on cognitively healthy adults and their ability to retrieve semantic knowledge important for producing and understanding verbs. This study will help us understand the reasons why verbs are more difficult than nouns, and whether this differences is due to semantic memory representations for actions and objects or to language-based differences between verbs and nouns. The results from this study therefore have the potential to be help guide the development of effective therapy techniques for patients with aphasia, and to improve the quality of life for adults with aphasia.

1.1 NOUNS VS. VERBS

1.1.1 Overview: Nouns and verbs in language and the brain

With the advent of new technology that allows for an in-depth look at neural structures and activity, researchers have long been interested in correlating linguistic data with brain lesion localization, particularly in patients with neurogenic language impairment. Using data gathered from vascular and neurodegenerative conditions, studies have found an association between verb deficits and more anterior areas of the language dominant hemisphere, with noun deficits being more frequently observed with posterior, or temporal, pathology (Tranel, et al., 2003). This verb-noun distinction is also evident when using functional neuroimaging and event-related potentials (Perani et al., 1999). Because the verb-noun disassociation is evident not only in patient populations with a specific language impairment, but in populations where language system is not the main target (e.g. dementia populations), it is important to explore the root of this disassociation.

Studies have widely focused on the dissociation between noun processing and verb processing, which is particularly evident in aphasic populations (Tranel, et al., 2003); Tsigka, et al., 2013). Difficulty with verb retrieval in the aphasic population has been studied extensively in hopes of understanding the underlying factors that influence retrieval and the nature of the impairment. A study carried out by Kim & Thompson (2004), for example, investigated verb impairment in two clinical populations: probable Alzheimer's disease (PrAD) and agrammatic aphasia. Both groups of individuals show verb deficits in regard to verb production and processing of information associated with verbs, but both the underlying nature of the verb impairment and its manifestation in the two groups differ.

The study conducted by Kim & Thompson (2004) sought to examine the presence and nature of verb impairment in PrAD by looking at factors that influence verb retrieval, specifically verb argument structure and semantic properties of verbs, and the use of verb knowledge in sentence processing. Comparison of PrAD subjects with that of aphasic subjects allowed the researchers to explore the hypothesis that PrAD patients' verb deficit involves the semantic aspect of the verb's representation, while agrammatic aphasic patients' verb deficit involves the syntactic argument structure properties of the verb (Kim & Thompson, 2004). Argument structure properties have to do with how many arguments (subject, object, indirect object) a verb requires in a sentence. In order to explore this hypothesis and to examine word retrieval between the two groups of participants, the researchers utilized naming and comprehension tasks that involved both verbs and nouns. Because participants with agrammatic aphasia sustained a single, left hemisphere stroke in Broca's area and surrounding white matter, it was expected that the agrammatic patients would (and did) show more difficulty with verb naming than with noun naming. However, an interesting feature of the PrAD participants was that they likely had primarily posterior damage, yet still demonstrated a verb deficit, which is typically associated with anterior damage. The verb deficit experienced by the PrAD participants tended to be related to semantic features. For example, more general words like 'go' were more readily retrieved than verbs like 'run' for PrAD patients. On the other hand, patients with agrammatic aphasia tended to have verb difficulties associated with lexical-syntactic aspects of verbs. The nature of the verb deficit in patients with AD is still mysterious, as the source of breakdown in verb retrieval is not yet known.

Further proof of verb-noun dissociation is explored in a study done by Tsigka et al. (2013), in which researchers used neuroimaging techniques to sort out the differences in verb and noun activity, and to attribute these differences to distinct processing functions. Lesion data supports the known dissociation of nouns and verbs and of their morphosyntactic operations (Tsigka, et al., 2013). These lesion data suggest that the different morphosyntactic operations (linguistic properties) associated with nouns and verbs are responsible for the noun-verb dissociation. However, neuroimaging studies have offered conflicting results. For example, one ERP study found that activity was affected both by grammatical class and by semantic properties (Barber, Kousta, Otten & Vigliocco, 2010), while another ERP study found that differences in the distribution of electrical signals across the scalp between noun and verb were variable

(Gomes, Ritter, Tartter, Vaughan, & Rosen, 1997). Using Magnetoencephalography (MEG), Tsigka et al. (2013) sought to establish whether nouns and verbs stimulate the same neural substrates, to which extent these neural substrates are activated, and if they are activated at the same or different points in time (Tsigka et al., 2013). The stimuli used in this study were Italian homonyms, because homonyms are both orthographically and phonologically identical, despite the fact that they have different grammatical functions depending on their syntactic context. The type of homonyms used were ones that offered an identical word form for both the first person singular of the verb and for the singular of the noun, and for the second person singular of the verb and the plural of the noun. By choosing stimuli along this criteria, the researchers were able to observe morphological changes on identical orthographic forms, while eliminating differences in the way visuo-perceptual, orthographic, phonological and subvocal processes are engaged during MEG recording. Furthermore, Italian homonyms tend to be related semantically, which allowed the researchers to confront the issue regarding whether differences in verb and noun processing is related to grammatical or semantic distinctions. The results of this study found that verbs and nouns are indeed processed differently in the brain. Specifically, verbs cause increased activation to frontal and parietal areas. Furthermore, its findings are consistent with previous reports of the left frontal cortex (such as left inferior prefrontal regions) playing an important role in verb processing (e.g., Tranel, et al., 2003; Kim & Thompson, 2004). Because homonyms with nearly identical semantic relatedness were used, these differences cannot be attributed to distinctions in semantic processing for verbs and nouns. These findings reinforce the understanding that nouns and verbs and their morphosyntactic processes implicate at least partly distinct neural substrates.

The studies described above present data from neuroimaging and from different groups of individuals with neurological damage. They all indicate that nouns and verbs are processed differently in the brain, and that verbs impose special processing burdens. However, they also indicate that different aspects of verbs may be responsible for these differences. Evidence from neuroimaging (Tsigka, et al., 2013) and from the performance of individuals with agrammatic aphasia (Kim & Thompson, 2004) point to the importance of language-related (syntactic and morphosyntactic) factors in explaining the difference between nouns and verbs. However, evidence from individuals with PrAD (Kim & Thompson, 2004) points to the importance of semantic factors in explaining why verbs are difficult. More evidence is needed to help determine whether language-related factors are responsible for the noun-verb dissociation, or whether meaning-related factors based in semantic memory are responsible for the differences. This is the aim of the current study.

1.1.2 Nouns versus verbs in dementia

As noted above and found in the Kim and Thompson (2004) study, deficits in verb use are not unique to individuals with aphasia, but may also be found among individuals with progressive neurological diseases such as Alzheimer Disease. Using the established Pyramids and Palmtrees Test (PPT) as the basis for a task called the Kissing and Dancing Test (KDT), Bak & Hodges (2002) developed and implemented the KDT to sort out the differences between the dissociations between noun and verb processing commonly observed in patients with different progressive neurological diseases. The two patient populations in this study consisted of the two clinical subsets of frontotemporal dementia (FTD): those with frontal variant frontotemporal dementia (fvFTD) and those with semantic dementia (SD). FTD is used to describe individuals with progressive focal atrophy of the frontal and/or temporal lobe who at post-mortem show non-Alzheimer pathology (Hodges & Miller, 2001), while semantic dementia, which is among the most prominent behavioral and anatomic variants of FTD, is a neurodegenerative disease categorized by progressive loss of conceptual knowledge (Peelle & Riley, 2008).

Studies have shown that patients with SD tend to have more difficulty with nouns than with verbs (Breedin, Saffran & Coslett, 1994), whereas patients with fvFTD have shown greater difficulty with verbs (Rhee, Antiquena, & Grossman, 2011). These differences in difficulty with specific grammatical classes is thought to be associated with the location of lesion, with fvFTD patients having frontal lesions (which is linked to verb impairment), and SD patients having more posterior lesion locations (which is linked to noun impairment). Therefore, the hypotheses in this study predicted poorer performance on KDT for patients belonging to the fvFTD group, whereas patients belonging to the SD group would demonstrate poorer performance on the PPT.

PPT is a task designed to assess an individual's ability to access detailed semantic information about nouns both from words and pictures (Howard & Patterson 1992). KDT is analogous to PPT in structure, with the exception that KDT is designed to assess an individual's ability to access detailed semantic information about verbs and actions rather than nouns and objects. Both tasks, the KDT and PPT, are structurally identical, consisting of 52 triads of pictures depicting actions (KDT) and objects (PPT). The participant's task is to determine which of the bottom two pictures is most associated with the picture on top. This design challenges the participant to access his or her semantic memory because semantic memory is necessary for the identification of the analogies, which conceptually link two perceptually and functionally distinct entities.

The results of the study did indeed show that patients with fvFTD were more impaired on the KDT, and those with SD on the PPT. Importantly, fvFTD patients only showed significant differences in accuracy between PPT and KDT in the picture-based tasks. This finding suggests that the disadvantage for verbs and actions appeared even for picture-based tasks, which directly tap semantic memory for actions and objects. Another possible explanation for this significant impairment in this picture-based, verb-processing task may be due to inherent shortcomings that arise when using static, pictorial representations of actions. According to a study done by Hung, Reilly, and Edmonds (submitted), a picture representing an action does not truly capture the complex nature of the action concept, but rather only partially represents a single moment of the entire, larger process. Furthermore, statistical analysis showed an opposite pattern to that found in fvFTD for patients with SD: they performed better on the PPT than the KDT, in both picture and word versions. The dissociation in the performance on the two tests suggests that there are differences in the processing of actions and objects for these two clinical populations.

Bak and Hodges' analysis was based on accuracy data, meaning that reaction times were not taken into consideration. There were no differences between the KDT and PPT for a set of 20 healthy control participants, whose accuracy was very high for both tasks. Since the majority of the fvFTD participants also showed generally high accuracy on both PPT and KDT (with less accuracy demonstrated on KDT), it would be useful to have the data regarding those participants' reaction times. Reaction times are a more sensitive measure and might enable us to detect more subtle differences in the processing patterns between the two tests, KDT and PPT. This would be particularly true for healthy adults, whose accuracy may be near 100% for both tests.

As the study by Bak & Hodges (2003) demonstrates, verb performance deficits do not exclusively arise in patient populations with specific language impairments because we see this in patients with fvFTD. It can also appear in tests of conceptual semantic processing, like picture versions of the KDT and PPT, which tap semantic memory. This offers evidence that conceptual aspects of verbs may lead to problems not only with language components. Difficulty is not unique to individuals with aphasia and provides evidence that this verb difficulty may have to do with conceptual representations for nouns and verbs.

1.1.3 Evidence from language acquisition

Aside from being selectively damaged during certain types of neurological impairments, verbs and nouns may also vary in how they tap into both linguistic and conceptual domains. Evidence from language acquisition studies looks at factors that influence the order of which nouns and verbs are acquired. Given that nouns are more abundant in the early vocabularies of young children, researchers offer differing theories to explain this phenomenon. Some researchers posit that learning verbs imposes more advanced conceptual demands, whereas others believe that verbs require more linguistic information to be learned than do nouns. This division is parallel to the different factors contributing to noun-verb dissociations in neurologically impaired populations above. Using evidence from two important language acquisition studies, we will discuss two contrasting theories in terms of the reasons underlying late verb acquisition. The first study by Gentner (2006) discusses the conceptual requirements that verbs demand in learning, while Gillette, et al. (1999) posit that verbs rely on linguistic information in a way that nouns simply do not have to, making verbs more difficult to acquire.

Verbs can be first observed as being more challenging than nouns when studying normal language development in children. With respect to word acquisition, verbs are acquired much later than are nouns, and this pattern proves to be true across most languages (Gentner, 1982; Gleitman, 1990). Gentner (2006) examines the complexities underlying verbs, and how the multifaceted nature of verbs causes them to be acquired much later in the language development process. A central problem in verb acquisition is the idea of *mapping*, or determining which constellations of the semantic components a given verb refers to (Gentner, 1982). Concrete nouns, which simply label things in the world, are much more easily mapped than verbs (even concrete verbs). Verbs, on the other hand, require information regarding temporal aspects of the action and referents. Even concrete verbs, like *running*, still require us to consider all of the available relational information and figure out just which of the information is relevant to the specified action. The notion that concrete nouns can be more transparently mapped from language to the world, therefore, has important consequences for how language is acquired because it suggests that nouns will inevitably comprise the majority of a child's early vocabulary.

The natural partitions hypothesis (Gentner, 1982) explains the tendency of children to acquire nouns prior to verbs in terms of these semantic mapping differences. This theory states that children acquire concrete nouns more easily than verbs because they are object-reference terms, and therefore have a more transparent semantic mapping to the world (Gentner, 1982). This is in contrast to verbs, which have a less transparent relation to the world, making it difficult for a prelinguistic infant to attach a word to a referent. According to this hypothesis, even a prelinguistic infant has already individuated many entities. So for many nouns, the child has only to attach the noun to a referent that has already been isolated (Gentner, 2006). This claim would only apply to concrete nouns, and obviously not all nouns are concrete. Instead, this view offers the idea that this noun binding is the basis of language acquisition. This early noun advantage is important because it may facilitate later language acquisition, as the process for more complex language learning later on can utilize similar noun-object binding techniques to acquire the binding of semantic relations to verb structures.

This view of verb learning and the noun-verb dissociation focuses strongly on semantic differences between nouns and verbs. It explains the difficulty of verbs for language learners primarily in terms of verbs' conceptual representations and how they are mapped to the world. These differences in conceptual representations will be reflected in semantic memory for the objects and actions that are associated with nouns and verbs.

The inherent conceptual difficulty of verbs may be a partial explanation as to why verbs are often more prone to disruption when the brain incurs damage, but it does not sufficiently explain this phenomenon, as there are patient populations in which verbs are less impaired than nouns. For example, verb comprehension and production are spared and noun processing is affected among individuals with semantic dementia (Bak & Hodges, 2003; Breedin, Saffran & Coslett, 1994). However, it is also known that verb impairment is seen in neurological disorders where language centers in the brain are not affected, and yet verb retrieval abilities are nonetheless reduced, such as patients with fvFTD. The idea, as proposed by Gentner (2006), that verb difficulties may be tied to conceptual demands, rather than linguistic strains, may offer an interesting look as to why verb difficulties are sometimes seen in the aforementioned clinical populations, like individuals with semantic dementia. Another side to the argument is that verb difficulties may be linked to the importance of their morphosyntactic factors, suggesting that linguistic strains, as proposed by Gillette et al. (1999), are the underlying factors that cause verbs to be more challenging than nouns.

Verbs are not only less easily mapped to the world than are nouns, but they are also linguistically shaped, meaning that language-specific factors strongly affect how verb meanings are expressed across languages (Talmy, 1975). For example, motion verbs in Spanish directly encode information regarding the path of the moving figure but express information about the manner of the action elsewhere in the sentence (*entrar corriendo*, "enter while running"). In English, verbs offer information regarding the manner of motion but describe the path through additional phrases (as in, "ran into the room"). Because verbs are strongly constrained by their linguistic context, children must learn to navigate the nuances of their language prior to understanding verb meanings. Gillette et al. (1999) provides experimental evidence that verbs depend on linguistic context in ways that nouns do not. Specifically, they provide evidence that verbs require extra linguistic input to be learned, instead of relying on images or sensory evidence of the sort that would be stored in semantic memory. Gilette et al. (1999) demonstrated that just like young children show a preference to learning nouns faster and more easily than verbs, so do adults. Using the 'Human Simulation' paradigm, this study showed adults silent video clips of mothers interacting with their children, using beeps to mark the instances of a particular verb or noun. The adults were then asked to guess which word was uttered at the moment of the beeps. The adults were able to identify almost three times more nouns than they were verbs, showing an advantage in drawing connection from language to the world. However, when the adults were provided with syntactic information, such as the part of speech that occurred either before or after the word, then their ability to identify the verb increased. This difference showed that verbs benefited from extra linguistic information, while nouns did not.

The generally accepted theory regarding early noun acquisition is that verbs are more conceptually complex than nouns, and so their acquisition will not be achieved until certain mental developments in the infant occur (Gillette et al., 1999). Gillette et al. (1999) chose to instead explore another hypothesis for the early noun preference over verbs, one that that examined the linguistic information requirements of verb learning rather than the conceptual requirements. Their findings suggest that verbs are difficult to learn (and to process) because of the linguistic information needed to encode verb meaning in language (Talmy, 1975).

The two perspectives from language acquisition differ in terms of what exactly makes verbs complicated, and therefore acquired more slowly as compared to nouns. While Gentner (2006) suggests that verb processing draws on conceptual knowledge, or knowledge residing within semantic memory, Gillette et al. (1999) focuses on the linguistic properties of verbs, and theorizes that verbs require more detailed linguistic information in order to process. These differences are parallel to the different mechanisms that underpin verb deficits evident in various clinical populations with neurological impairment. For example, individuals with aphasia and with semantic dementia both display verb impairment, but in different forms. While the former population struggles with language impairment, the former struggles with impairment to the long term memory system that stores conceptual knowledge. The current study focuses on the theory provided by Gentner (2006), by assessing participants' ability to access semantic memory for actions (important for verb processing) and objects (important for noun processing).

1.2 AGING AND ITS EFFECTS ON SEMANTIC PROCESSING

The discussion above focused on semantic and conceptual as well as language-specific (morphosyntactic) factors which contribute to noun-verb dissociations, among neurologically impaired adults as well as in language acquisition. This section describes evidence that suggests that certain aspects of language processing, particularly semantic processing, are affected by aging. This evidence provides motivation for examining noun and verb processing and access to semantic memory among healthy older adults, as in the current study.

Wlotko et al. (2011) examine the effects of normal aging on the higher-level processes that are required for successful comprehension of meaning abstracted from words. Previous studies have shown that both older and younger adults typically display similar performance on tasks that are comprehension-based (Burke & Shafto, 2008); however, this consistency in comprehension abilities over time is surprising considering the many cognitive and neural changes that are related to the aging process. The fact that comprehension abilities remain stable in spite of neural changes may suggest that comprehension goals may be successfully achieved using different cognitive and neural resources (Wlotko et. al., 2011).

Past ERP studies have demonstrated that the organization of semantic memory in both older and younger adults typically remains intact across the life-span (Wlotko et al., 2011). Yet, as was mentioned before, we know that the aging mind undergoes major changes, like decreased ability to focus and impaired memory abilities. Studies using event-related potentials (ERPs) show that that there are important differences, both age-related and individual, that demonstrate how word-related semantic information is used during on-line language processes. Researchers now believe that older adults have different methods of allocating their mental resources to more efficiently achieve the same cognitive goals as younger adults.

One such method of allocating mental resources in order to efficiently process linguistic information can be seen when studying the N400 in older adults during homograph processing. While it is known that the organization of word and their meanings remains stable over time, a possible exception may be in regard to words with multiple meaning, making homographs a useful area to study. A study done by Meyer and Federmeier (2010) examined the contributions of the left and right cerebral hemispheres during the processing of ambiguous words, in this case homographs, in older adults. They presented the participant with a homograph to either the left or right visual field, and followed this by centrally presenting a target word that was either semantically unrelated to the target homograph or related to either the more frequent or less frequent meaning of the homograph. N400 results showed that both meanings were activated in left hemisphere in younger adults. In contrast, only the dominant meaning was activated in the left hemisphere and the subordinate meaning in the right hemisphere in older adults. This finding suggests that age-related changes created a different hemispheric division of labor, particularly for the processing of meaning (Wlotko et al., 2011).

Using ERP data in this study highlights the usefulness of using time-sensitive measures of neural activity patterns in important areas of the brain. The high temporal resolution of ERP processing makes it an attractive tool for researchers seeking to investigate cognitive processing that occurs at exact moments of interest, as opposed to functional magnetic resonance imaging, which provides a more accurate spatial resolution at the cost of more specific temporal information. One important component that was studied extensively by Wlotko et al. was the N400, which will be discussed again later in the Proverbio & Riva (2009) study. Previous studies have found that N400, which is a large negative deflection that peaks around 400 ms, is activated during semantic integration as well as lexical meaning processing (Kutas & Federmeier, 2000). More specifically, the N400 is related to characteristics such as: word frequency, concreteness, semantic relatedness, and contextual constraint (Proverbio & Riva, 2009), but is not related to other aspects of language, such as syntax (Wlotko, et al., 2011). The N400 has been linked to meaning processing and is a commonly used measure regarding language comprehension. The amplitude of the N400 reveals how compatible the eliciting words fits with the context. The smaller the amplitude of the N400, the more easily it is assumed to be processed because it naturally fits within its context (faster reaction times in behavioral studies) (Kutas & Federmeier, 2000). The fact that the N400 is the primary ERP component which Wlotko, et al. (2011) and others have used to demonstrate age-related differences suggests that aging processes primarily affect semantic processing, rather than syntactic or other language-related processes.

Since ERPs are a valuable tool that allow us to examine neural activity, they are effective at uncovering notable changes that occur with age in the brain. One major pattern of neural changes was observed in terms of the temporal changes that go along with aging. One such change was detected in the N400, as it seemed to decreases in size with age. This decrease in amplitude of N400 may suggest that the effects of semantic violations, for example, may appear less obvious to an older adult. Another change in amplitude was seen in the peak latency of the P300 component, which is associated with working memory (Polich, 1996).

Another interesting finding regarding differences in younger and older adults' language processing, is the claim that older adults are less able to efficiently make use of rich sentential context information to facilitate word processing (Wlotko et al., 2011). A study by Federmeier and Kutas (2005) examined the impact of sentential constraint on the use of message-level information by older adults. In this study, sentences were either constructed as being strongly constraining and having a predictable ending or weakly constraining with an unpredictable ending. ERP data revealed that for both younger and older adults, predictable endings elicited an N400 as compared to unexpected endings. However, this N400 effect was smaller and delayed for older adults than it was for younger adults. This differences suggests that older adults are less able to activate and rapidly use semantic information in memory to understand language.

While overall research shows that the organization and structure of semantic knowledge remains stable across the lifespan, evidence shows that when using this knowledge to integrate meaning across words, older adults show quantitatively and quantitatively different processing patterns (Wlotko et al., 2011). One such example is seen in observing the effects of sentential context are delayed several hundred milliseconds, which is a significant amount considering how quickly comprehension occurs, for older adults. Since older adults continue to be successfully form meaning from sentences, clearly the brain is able to compensate for the timing changes by modifying resources and employing different types of strategies (Wlotko et al., 2011). These adjustments are thought to occur in the form of differences in controlled processing or utilizing a less predictive method of comprehension.

The aging and semantic processing findings described by Wlotko et al. (2011) provide motivation for looking at healthy older controls. Activation of semantic memory to rapidly facilitate language comprehension may be different and delayed among older adults, as there are definite neurological differences that accompany aging. Using sensitive measures like ERPs also points out the importance of using more sensitive and continuous measures (like response times) to look for aging effects on semantic processing. The findings regarding comprehension in older populations is of particular interest to the current study, as the participant groups for this current study are divided on the basis of age. We expect to find innate differences between the younger and older adults groups and their performance on the experimental tasks. Namely, we hypothesize that there will be a main effect of age on accuracy, and especially on response time. We expect to find that older adults' performance will reveal slower response times (and possibly also lower accuracy) on semantic processing tasks.

1.3 MEASURES OF SEMANTIC PROCESSING

There are a variety of different tasks, like the aforementioned mentioned KDT and PPT, which have been used to tap semantic processing, especially at the conceptual level. Both KDT and PPT assess semantic memory by requiring the participant to draw analogies based on semantic relations between objects (PPT) and actions (KDT). However, both of these tasks are challenging and may be difficult for some individuals, since they require processing of multiple picture stimuli. It would be desirable to find an alternative and less burdensome task for assessing semantic memory, particularly for complex and multi-faceted actions.

One such method may come from examining people's responses to pictures of simple actions. Proverbio & Riva (2009) used event-related brain potentials (ERPs) to investigate the visual processing of actions in cognitively unimpaired young adults. This study developed a novel task, the Event task, to use as the stimuli for the study. The Event task, which is also utilized in the present study, consists of two hundred and sixty colored photographs of people taking part in simple actions. Some of these actions are meaningful and sensible (e.g. a father and his son raking leaves in the yard) and some are neither meaningful nor sensible (e.g. a couple having a candle-lit dinner in the middle of the sea). The pictures representing incomprehensible actions were chosen specifically because they represented activities that violated our world knowledge, which is housed in our semantic memory, about what typical human behavior would look like in the given environment.

ERP studies have long been used as a way to understand the neural bases of cognitive processes, particularly in language. Similarly to the Wlotko et al. (2011) study, this study makes use of the information offered by analyzing the N400 component to the action processing. By analyzing the N400 activation patterns, we have been able to gain knowledge as to how meanings are retrieved, stored, and integrated in the lexical semantic system. Furthermore, the N400 is also associated with violations of world knowledge. This brings us to the goal of the Proverbio and Riva (2009) study, which was to determine whether N400 is sensitive to semantic violations in action representation using the aforementioned Event task. Based on the information given concerning the conditions in which the N400 is evoked, it was expected that pictures representing incomprehensible actions would (and did) elicit a large N400. The large N400 seen in young cognitively unimpaired adults led researchers to believe that participants were having difficulty understanding the behaviors taking place in the picture, and integrating the information in the picture with previously held knowledge about the world.

PPT and KDT have the ability to serve as complementary tasks to the Event task, which uses different kinds of stimuli. Namely, the Event task utilizes naturalistic pictures that involve whole situations. In doing the Event task, participants consult semantic memory for actions similar to the ones in depicted in the picture. Specifically, the participant must decide if the action in picture is similar to an action stored in the long term memory that has been encountered before in real life. If the action does not fit with prior experiences, then it is implausible.

Using this novel Event task as a complement to the already established KDT, this test may serve to provide useful data to supplement knowledge as to how individuals use semantic information to process action concepts. The Event task differs from both KDT and PPT, but measures similar constructs. As a test that will examine conceptual aspects rather than linguistic ones, the Event task has the potential to be a clinically useful tool for determining how semantic memory, and not language abilities, contributes to action and object processing.

1.4 SUMMARY

Verbs and nouns are processed differently in the brain. Evidence of this disassociation is evident in a multitude of types of studies, ranging from ERP to neuroimaging experiments and studies of neurologically impaired adults and language learners. An important question arises in regard to the difference in verb and noun processing that is apparent in certain types of populations with neurological impairment, namely semantic dementia and aphasia. The root of this verb-noun processing disassociation is unknown. Verbs tend to be more difficult to acquire during language development and verbs processing tends to be at a greater disadvantage in terms of language preservation after neurological impairment. Does this inherent verb disadvantage reflect linguistic capabilities, or can it be connected to conceptual abilities that are rooted in semantic memory?

2.0 CURRENT STUDY: GOALS AND HYPOTHESES

This study aims to add to the discussion of the role that semantic memory plays in verb processing. This study seeks to answer three major questions: 1) What is the role semantic memory plays in understanding verbs, 2) are the differences between verb and noun processing due to differences in semantic memory representations for actions versus objects? and lastly, 3) how do the three tasks in this study- Kissing and Dancing Test, Pyramid and Palm Trees, and the Event Task- compare with one another in terms of assessing semantic memory for actions (related to verbs) and objects (related to nouns)?

To answer these questions, this study will compare the results of the three tests used to assess semantic memory across two groups of participants, younger cognitive healthy participants and older cognitively healthy participants. By comparing the two age groups, it will be possible to detect whether there are processing differences that coincide with aging. Furthermore, comparison of performance on these three tasks allows the researchers to draw connections between the three tasks, meaning that performance on the two verb-related tasks (KDT and Event) should be correlated with one another, and not with performance on the noun-related task (PPT).

Lastly, an additional goal of this study is to potentially validate a novel test called the Event task, as a possible tool to assess semantic memory for verb processing. The Event task has not yet been used clinically, and so this study aims to help prove its potential as a useful clinical tool.

2.1 HYPOTHESES

Because studies have shown that there verbs have more complex and less concrete semantic-memory representations than nouns, it is expected that the participants, both younger and older, will show greater difficulty with the verb- or action-based tasks, namely KDT and Event task. These tasks tap semantic memory for the actions and objects that correspond to verbs and nouns, but do not involve linguistic stimuli. The greater difficulty with action-related tasks will be represented in the form of slower response time and overall lower accuracy. Furthermore, older adults are expected to show greater difficulty for action-related tasks than younger adults, since older adults have been found to be slower in accessing semantic memory. The specific hypotheses of this study are as follows:

1) Performance on the two verb-related tasks, KDT and the Event Task, will be closely correlated with one another, while performance on PPT and KDT, as well as PPT and Event Task, will not have a strong correlation.

2) Given that verbs and actions are generally less concrete and imageable than are nouns and objects, and therefore have less distinct and/or more complex semantic memory representations, overall accuracy will be lower and response time will be slower for KDT and Event Task than for PPT.

3) Given that older adults are slower to access semantic memory representations than younger adults, their reaction times will be slower for all tasks than younger adults' reaction times, and they may show special difficulty for verbs and actions, which have less distinct and/or more complex semantic memory representations.

3.0 METHODS

This cross sectional experimental design utilized two groups of participants that each had to complete three tasks. Their response time and accuracy were measured. The division of participant groups was based on age: the older adult group was composed of adults who were 50-90 years old, while the younger adult group was composed of adults who were 18-30 years old. Different age groups and task were the independent variables. The dependent variables were accuracy and response time.

3.1 PARTICIPANTS

This study consisted of 40 adults, who were divided into two groups of twenty adults on the basis of age. The two groups consisted of: younger adults between the ages of 18-30 without cognitive impairment and older adults between the ages of 50-90 without cognitive impairment. The presence of a potential cognitive impairment was determined based on self-report and on performance on screening tasks, which are described below. The mean age of the younger adults was 19.9 (SD= 2.43), ranging from 18 to 29. All younger adults were students at the University of Pittsburgh and were recruited using the University of Pittsburgh psychology subject pool. Students received class credit for the Introduction to Psychology courses in exchange for their participation. The mean age of the older adults was 63.7 (SD=8.99), ranging from 50 to 80.

Older adults were community dwelling individuals from the greater Pittsburgh Area. They were recruited from Osher, the Lifelong Learning Institute, as well as the Research Participant Registry. All older adults were compensated monetarily ($10 per hour) for their participation.

All subjects were required to have normal or corrected-to normal vision and have no history of neurological, neuropsychological, or neuropsychiatric conditions that could cause language problems. Additionally, all participants were screened to make sure they did not report a history of speech-language or hearing disorders.

3.2 MATERIALS

3.2.1 Screening tests

All participants completed the following screening tests: Raven's Coloured Progressive Matrices and Mini Mental Status Exam.

1. Raven's Coloured Progressive Matrices (Raven, 1965): The RCPM is a test to assess an individuals' nonverbal reasoning ability. Participants were required to receive a score of at least 30/36 correct in order to proceed with the study.
2. Mini Mental State Examination (Folstein, 1975): the MMSE is a brief test to screen for cognitive impairment. Participants were required to receive a score of at least 27/30 correct in order to proceed with the study.

In addition to the tasks outlined above participants were also asked to complete two questionnaires that inquired about their medical history, language status (e.g. whether English is their native language), and personal background information (e.g. years of education).

3.2.2 Experimental tasks

In order to assess semantic memory, three tests were employed: Pyramids and Palm Trees (PPT), Kissing and Dancing (KDT), and Event Task. PPT assessed semantic memory for objects by presenting one picture above two others. The participant then needed to identify which of the bottom items was most closely associated with the top item. For example, if the top item is a picture of a pyramid, and the bottom two are pictures of a palm tree and a pine tree, then the correct answer would be the pyramid.

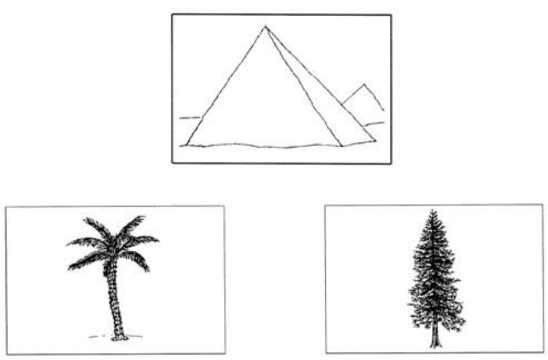

Figure 1- PPT (Howard & Patterson, 1992)

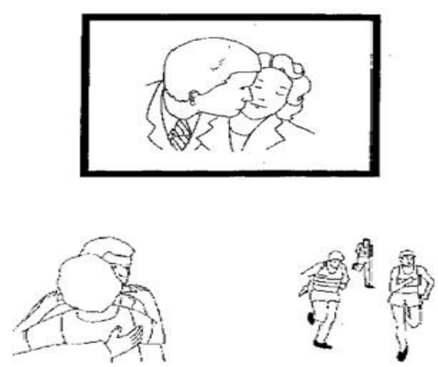

Figure 2- KDT (Bak & Hodges, 2003)

This challenges the participant to tap into their semantic memory because semantic memory is necessary for the identification of the analogies, which conceptually link two perceptually and functionally distinct entities. While PPT assesses semantic knowledge for objects, KDT and

Event Task assess semantic memory for events. KDT is identical to PPT in structure; however, it replaces pictures of objects with pictures of actions.

In Event Task, the participant is presented with a picture of a person engaged in simple actions, some meaningful, others lacking an understandable goal. The premise of this test is to determine whether an action is “sensible.” For example, a comprehensibly action would be a father and son raking leaves in the yard, while an incomprehensible action would be a couple eating dinner in the middle of the ocean.

Figure 3-Event Task, 'Comprehensible Action'

Figure 4- Event Task, 'Incomprehensible Action'

Although the Event Task is a new tool that has not yet been used on aphasic populations or older populations, it has been validated using an ERP study as an effective way of eliciting brain response in reaction to pictorial representations (Proverbio & Riva, 2009). In order to accurately complete the Event Task, the participants must rely on knowledge of the world, which is stored in his or her semantic memory. Like KDT, the Event Task assesses verb knowledge since its stimuli represent actions.

3.3 PROCEDURES

This study received IRB approval from the Institutional Review Board at the University of Pittsburgh. Prior to beginning the study, all participants signed a consent form and filled out two medical questionnaires regarding medical history and personal background information. Participants were then asked to perform two screening tasks, which took about 20 minutes to complete. First, participants completed the Mini Mental State Exam, which is a brief, 30 point test that is used to screen for cognitive impairment. Participants were asked to answer a series of questions and to perform a series of tasks, such as counting backwards from 100 by 7 or responding to the question "What is the day of the week?" Next, participants completed the Raven's Coloured Progressive Matrices, where participants were asked to select a missing element that best complete the given pattern. Participants identified which image best completed the incomplete picture by pointing at their selection.

Once screening tasks were complete, participants entered a sound-attenuated booth, where all the experimental tasks took place. All three experimental tasks were performed on a laptop, and all responses were recorded using a response box. Participants were asked to use their non-dominant hand and press either "1" or "5" on the response box. The first task was KDT. Participants were told that they would see three pictures on the computer screen, and they were instructed to look at the picture on top and decide which of the two pictures beneath the top picture were most related to the picture on top. Participants made their selection by pressing either "1" if they thought the picture on the left went best with the picture on top, or by pressing "5" if they thought the picture on the right went best with the picture on top. Participants had three practice trials, in which they received feedback prior to beginning the experimental trials. Next, participants completed the Event Task. Participants were instructed to look at the picture on the screen and determine if the action taking place in the picture was one that would normally happen. “You will see a picture and your job is to decide if this picture is ‘good’ or ‘bad.’ ‘Good’ meaning that the action is comprehensible, or one that makes sense, and ‘bad’ meaning that the action is incomprehensible, or it just doesn’t makes sense to you. You will press “1” on the response box if the action is ‘good’ and ‘5’ if the action is ‘bad.’ Keep in mind that the experiment is timed, meaning it will move on without a response if you take too long to respond. If this happens, do not worry and just focus on the next presented picture. Please be as accurate and quick as you can be.” Finally, participants completed PPT. They were given the same exact instructions for PPT as they received for KDT.

Upon completion, the older adults were paid $10 per hour, and the younger adults were given class credit. Older adults were also compensated for their parking fees, if they chose to drive to the study. These three experimental tasks took about 20-30 minutes to complete, with Event task being the longest task. The total time to conduct the full experiment ranged from 40-60 minutes.

4.0 RESULTS

This was an experimental study which utilized a cross-sectional design. Two participant groups, 20 younger cognitively healthy adults (ages 18-30) and 20 older cognitively healthy adults (ages 50-90) participated in three tasks: Kissing and Dancing (KDT), Pyramids and Palm Trees (PPT), and the Event Task. The dependent variables were response times and accuracy performance on each of the three tasks. All analyses were performed using SPSS.

4.1 PERFOMANCE ON SCREENING MEASURES

The mean years of education for younger and older adults was 13.2 and 16.1, respectively. The mean score on Raven's Coloured Progressive Matrices for younger and older adults was 34.3 and 33.7, respectively. An independent-samples t-test was conducted to compare years of edcation and Raven's scores between the younger and older adults. The difference in years of education for younger adults (M= 13.20, SD= 1.11) and older adults (M= 16.15, SD= 2.01) was significant (t [38] = -5.758, p= .000), but not the difference in Raven's scores for younger adults (M= 34.30, SD= 1.13) and older adults (M= 33.70, SD= 2.15); (t [38] = 1.103, p= 277).

4.2 EXPERIMENTAL MEASURES

For all three tasks, KDT, PPT and the Event Task, accuracy and response time for correct responses only were analyzed. The between-subjects factor was age group, and the within-subject factor was task. Figures 5 and 6 display the accuracy and reaction time averages across the three tasks, as compared to the two age groups. The error bars represent the standard deviation.

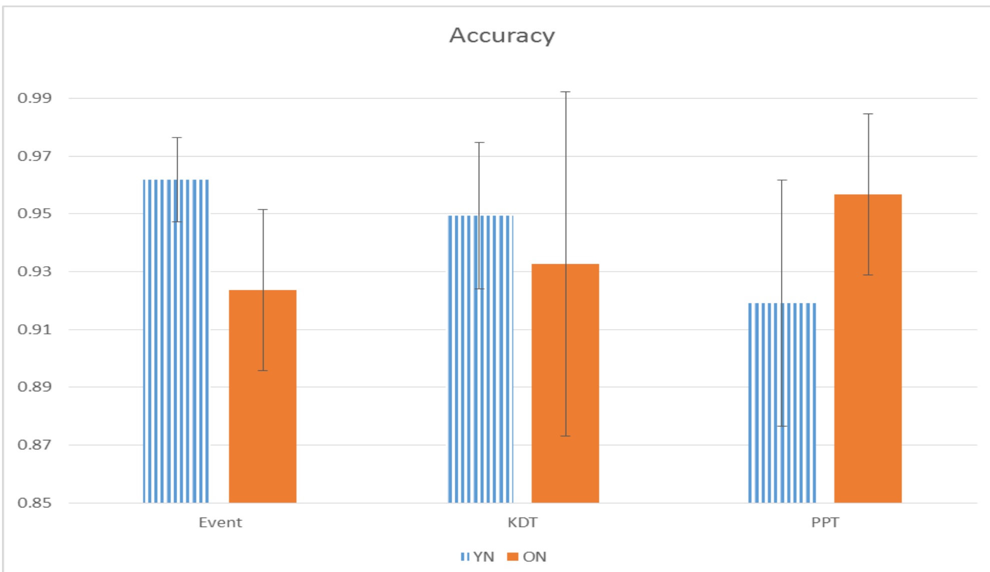

Figure 5- Average accuracy for both groups of participants on all three tasks

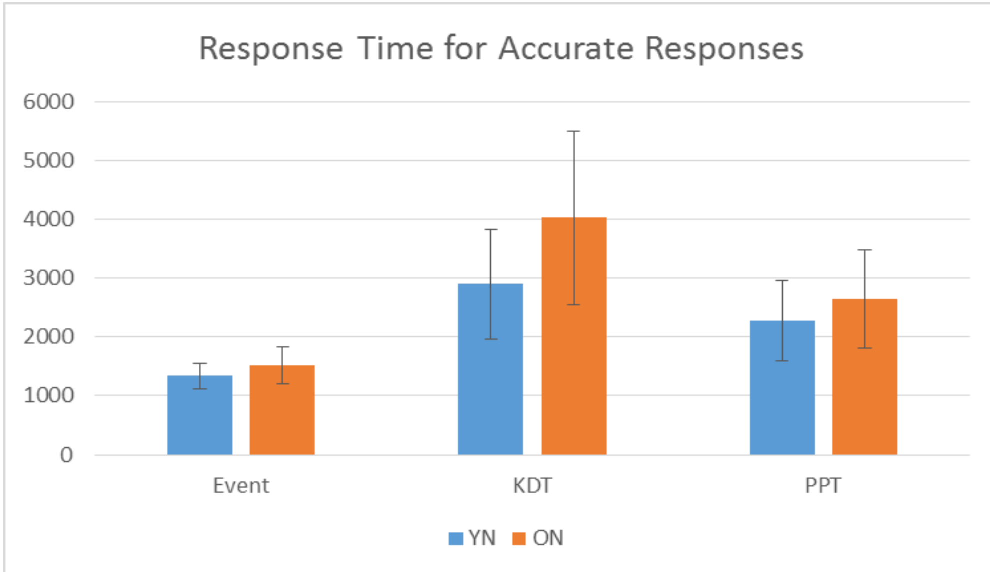

Figure 6-Response time for accurate responses for both older and younger adults

The three principal questions that were posed were 1) how does performance on noun versus verb tasks compare to one another? 2) What are the effects of aging on non-verbal tasks that tap conceptual knowledge, and lastly 3) how do the three tasks in this study- Kissing and Dancing Test, Pyramid and Palm Trees, and the Event Task- compare with one another in terms of assessing semantic memory for actions (related to verbs) and objects (related to nouns)?

4.2.1 Nouns versus Verbs

It was hypothesized that, generally, verbs will be more difficult than nouns on these non-verbal tasks that tap semantic memory. When looking at both younger and older adults, tests of within-subject effects revealed a main effect of task on reaction time (F [2, 76] =102.457, p=.000), but no main effect of task on accuracy (F [2, 76] = .272, p = .762). The ANOVA for older adults revealed a significant main effect of task on accuracy (F [2, 38] =5.775, p=.006), as well as a significant main effect of task on reaction time (F [2, 19] = 53.87, p=.000). The ANOVA for younger adults revealed a significant main effect of task on accuracy (F [2, 38] =12.672, p=.000), as well as a significant main effect of task (F [2, 38] =53.075, p=.000) on reaction times.

A paired-samples t-test was conducted to compare reaction times for older adults across the three task conditions, KDT, PPT, and the Event Task. There was a significant difference in the reaction times for KDT (M= 4024.12, SD= 1479.67) and PPT (M=2649.18, SD= 804.32); t (19) =-5.899, p = 0.000, as well as a significant difference in the reaction times for KDT (M= 4024.12, SD= 1479.67) and the Event Task (M=1521.04, SD=311.82); t (19) = 8.076, p = 0.000. Finally, there was also a significant difference in the reaction times for PPT (M=2649.18, SD= 804.32) and the Event Task (M=1521.04, SD=311.82); t (19) =7.186, p = 0.000.

An additional paired-samples t-test was conducted to compare accuracy for older adults across the three task conditions, KDT, PPT, and the Event Task. There was a marginal difference in accuracy for PPT (M= .96, SD= .028) and KDT (M= .93, SD= .060); t (19) = 2.005, p= .059). There was also a significant difference in accuracy for PPT (M= .96, SD= .028) and Event Task (M= .93, SD= .028); t (19) = 5.056, p= .000). There was not, however, a significant difference in accuracy for KDT (M= .93, SD= .060) and Event Task (M= .93, SD= .028); t (19) = .836; p= .413).

A paired-samples t-test was conducted to compare reaction times for younger adults across the three task conditions, KDT, PPT, and the Event Task. There was a significant difference in the reaction times for KDT (M= 2903.71, SD= 932.67) and the Event Task (M= 1338.96, SD= 215.84); t (19) = 8.563, p = 0.000. There was a significant difference in the reaction times for KDT (M= 2903.71, SD= 932.67) and PPT (M=2274.54, SD=690.58); t (19) =

4.383, p = 0.000. There was a significant difference in the reaction times for Event (M= 1338.96, SD= 215.84) and PPT (M=2274.54, SD=690.58), t (19) = -7.377, p = 0.000.

An additional paired-samples t-test was conducted to compare accuracy for younger adults across the three task conditions, KDT, PPT, and the Event Task. There was a significant difference in accuracy for PPT (M= .919, SD= .043) and KDT (M= .95, SD= .025); t (19) = -3.138, p = 0.005. There was a significant difference in accuracy for PPT (M= .919, SD= .043) and Event Task (M=.962, SD=.015); t (19) = -4.309, p = 0.000. However, there was no significant difference in accuracy for KDT (M= .95, SD= .025); and Event Task (M=.962, SD=.015); t (19) =-2.003, p = 0.060.

4.2.2 Aging Effects

Tests of between-subject effects reveal a signficant main effect of age group on reaction time (F [1,38]=7.435, p=.010), while showing no main effect of age group on accuracy (F [1,38]= .517, p=.476). In addition, there was a significant interaction between task and age group for reaction time (F [2,76]=5.776, p=.005), as well as a significant interaction between task and age group for accuracy (F [2, 76] = 17.214, p= .000).

An independent-samples t-test was conducted to compare response time for KDT, PPT, and Event between younger and older adults. There was a significant difference in response time for Event between youngers (M= 1338.96, SD=215.84) and olders (M= 1521.04, SD= 311.82); t (38)= -2.147, p=.038). There was also a significant difference in response time for KDT between youngers (M= 2903.71, SD= 932.67) and olders (M= 4024.12, SD= 1479.67); t (38)= -2.865, p.007. However, there was not a significant difference in response time for PPT between youngers (M= 2274.54, SD= 690.58) and olders (M= 2725.89, SD= 833.42); t(38)= -1.865, p= .070.

An independent-samples t-test was conducted to compare accuracy for KDT, PPT, and Event between younger and older adults. There was a significant difference in accuracy for Event between youngers (M= .962, SD= .015) and olders (M= .924, SD= .028); t (38)= 5.454, p=.000). Surprisingly, there was not a significant difference in accuracy for KDT between youngers (M= .95, SD= .025) and olders (M= .933, SD= .060); t (38)= 1.194, p- .240. However, there was a significant difference in accuracy for PPT between youngers (M= .919, SD= .043) and olders (M= .957, SD= .028); t(38)= 3.297, p= .002.

4.2.3 Correlation among experimental tasks

A Pearson product-moment correlation coefficient was computed to assess the relationship between performance on Event and performance on KDT. When comparing accuracy across all three tasks for older adults, there was a positive correlation between Event and KDT, r= .599, n= 20, p= .005. Interestingly, there was also a positive correlation between Event and PPT, but at the .05 level, r=.446, p=.049. When looking at reaction times for older adults, KDT and PPT revealed to be significantly correlated at the .01 level, r= .735, p=.000. A Pearson product-moment correlation coefficient was computed to assess the relationship between performance on Event and performance on KDT for younger adults. When looking at reaction times, KDT and Event were not found to be significantly correlated, r= .396, p=.084, but somewhat surprisingly, PPT and Event were found to be significantly correlated at the .05 level, r= .677, p=.001. When looking at accuracy for younger adults, no significant correlations were found between any of the three tasks.

5.0 DISCUSSION

As has been previously discussed, verb impairment is prominent in many types of patient populations, such as certain types of aphasia and semantic dementia. This study evaluates two theories that attempt to explain why difficulties in verb processing arise. Namely, this study aims to sort out whether these verb difficulties stem from the linguistic or conceptual demands that are imposed by verbs. Gentner (2006) proposed that conceptual demands – specifically, the notion that actions, which are conveyed by verbs, are less concrete and less imageable than objects – underlie verb difficulty. Gillette, et al. (1999) proposed that verbs are more challenging to process because verbs require more linguistic input to be successfully identified than do nouns. By this account, one would not expect to find a difference between verb and noun processing on tasks that access semantic memory without making reference to language, as semantic memory is not a part of the linguistic system. The results of this study seem to better align with the former idea, as differences between verb and noun tasks arise in these tests that assess semantic memory without using linguistic input.

The results of this study revealed two interesting findings regarding older adult performance across the three tasks: older adults displayed drastically more variability in their performance across all three tasks than did younger adults, and older adults displayed poorer performance in terms of reaction time on verb-related tasks than did younger adults. The poorer performance on verb-related tasks is consistent with the hypothesis above, that older adults would show a special disadvantage for verb- or action-related tasks, which place greater demands on semantic memory because these items are less concrete and imageable.

The large variability seen in reaction times for older adults, particularly in the KDT, is similar to findings described in to the Wlotko, et al. (2011) study, that revealed that processing differences in older populations are discriminable not in accuracy data, but in more sensitive measures, like reaction times. Although cognitively healthy older adults are still able to access their conceptual memory network, as can be seen in their relatively high accuracy rates across all three tasks, older adults must compensate for the neural changes that accompany the aging process. Namely, older adults must learn compensatory mechanisms, which may make use of more neural resoures. Furthermore, activation of semantic memory to rapidly facilitate language comprehension is delayed among older adults (Wlotko, et al., 2011). The notion that older adults are utilizing different compensatory mechanisms to complete processing tasks not only explains their slower response time, but can also account for the greater variability that is evident in older adults' performance on these conceptually-based tasks. Since young, cognitively healthy adults show relatively little little variability across all three tasks, this suggests that younger adults achieve their processing goals in uniform manner, utilizing similar technqiues to one another. Simply put, the aging process causes older adults to start to lean on different sources of information, thus creating a wider range of possibilities of neural divisions of labor.

Performance on KDT and Event were predicted to be correlated with one another, as both tasks assess verb processing. Analyses found this prediction to be true for older adults when using their accuracy scores; however, analyses also showed that PPT and KDT were correlated for older adults as well when looking at reaction times. One possible explanation for this pattern may be that the task demands for both PPT and KDT are very similar in nature. Unlike the Event task, which requires the participant to simply decide whether an action in the picture is plausible or not, PPT and KDT require the participant to draw analogies based on three pictures.

While KDT and Event were significantly correlated for older adults, this pattern did not hold true for younger adults. When looking at reaction times for accurate responses for younger adults, only PPT and Event were found to be significantly correlated, and when looking at accuracy, there was no significant correlation among any of three tasks. One possible explanation for this result is that the younger normals' performance was at ceiling for all three tasks. With very little variation among the younger normals, it is unlikely to find any sort of correlation between the three tasks. The older normals, on the other hand, exhibited greater variability across all three tasks, but particularly on Event Task. In this case, the reduced variance in the younger normal group decreases the sensitivity of this experiment to determine if performance across the three tasks were correlated with one another.

5.1 LIMITATIONS FOR THE CURRENT STUDY

The current study utilized picture stimuli for all three testing tasks. The use of pictures to represent action concepts may prove to be problematic, as picture stimuli cannot fully represent the complex, temporal aspects of verbs. A study done by Hung and colleagues (n.d.) discusses the implications of using pictorial stimuli to depict action concepts, particularly when trying to enable the participant to access semantic representations of the target concept. Whereas pictures representing objects lead to faster response times and better accuracy when the subject is accessing semantic information for nouns, the opposite effects are seen when the subject is accessing semantic information for verbs.

Most studies analyzing the differences between nouns and verbs use either words or pictures as their testing stimuli. Both formats, words and pictures, have advantages and disadvantages. Using written or spoken words allows for a clearer distinction between the different kinds of nouns and verbs (e.g. action versus nonaction, abstract versus concrete), and are also more easily matched for frequency and familiarity (Bak & Hodges, 2003).

One last possible shortcoming of the current study is that it only looked at cognitively unimpaired adults. While this offered the advantage of identifying whether sources of difficulty for verb processing stemmed from semantic memory limitations, as opposed to language impairments, it would beneficial to compare data obtained from populations with neurological damage. Future research should focus on gaining data for individuals with language impairment (as in the case with individuals with aphasia) and for individuals with impairment to semantic memory (as in the case with individuals with semantic dementia) in order to sort out the differences in how these two groups of individuals would perform on tasks aimed at assessing semantic memory and verb processing.

6.0 CONCLUSION

The results of this study revealed important information regarding the aging process and its effects on rapid processing of semantic memory information. While older adults are not impaired in their ultimate ability to perform a task accurately, changes are seen when looking at processing time. While overall, older adults were able to accurately perform the necessary tasks, their reaction times were significantly slower than the younger adults.

This study also provided insight as to what exactly underlies the verb-noun distinction that is often seen in patient populations with verb disruption. As individuals age, the ability to quickly access conceptual knowledge diminishes, and so individuals must rely on compensatory strategies to quickly retrieve the necessary information. One way this manifests itself is in semantic memory-based tasks like the ones utilized in this study. Although older adults were slower than younger adults across all three tasks, both the verb-related and the noun-related tasks, they showed a significantly greater disadvantage on verb-related tasks, particularly KDT. This suggests that having access to semantic memory is partly responsible for quickly processing verbs. This result, therefore, is in alignment with Gentner (2006), who explained that conceptual demands play a crucial role in verb difficulty. As access to conceptual knowledge becomes more difficult to attain, verb processing time increases. The disassociation between noun and verb performance on the semantic memory tasks for older adults, therefore, suggests that semantic memory plays a role in verb processing.

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