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SIMILARITIES AND DIFFERENCES BETWEEN CONCRETE AND ABSTRACT SEMANTIC ORGANIZATIONS

ALLISON THATCHER
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Reviewed and approved* by the following:

Chaleece W. Sandberg
Professor of Communication Sciences and Disorders
Thesis Supervisor

Carol A. Miller
Professor of Communication Sciences and Disorders
Honors Adviser

* Signatures are on file in the Schreyer Honors College.

ABSTRACT

This study examines the differences of semantic organization between concrete and abstract words. The participants were divided into two groups: Neurotypical Adults and Persons with Aphasia. Each participant completed a semantic relatedness judgement task. Stimuli in the study were categorized by concreteness (concrete, abstract) and relatedness (association, similarity, unrelated). The results of the study will be discussed by participant group (NTA and PWA) and by accuracy and reaction time. Although I hypothesized that concrete words will be more accurate and have a faster reaction time in a similarity condition, and abstract words will be more accurate and have a faster time in an association condition, no significant effects of concreteness by relatedness were found.

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Introduction

Each day an individual uses words, whether it be through speaking, reading, writing, or listening. However, an individual tends to not consider the type of words being used, and how those type of words are organized in the brain. One way a word can be classified is by its concreteness, or how concrete or abstract the word is. Concrete words are defined as "imageable" concepts (Binder, Westbury, Mckiernan, Possing, & Medler, 2005), or a word that represents an idea or concept that is tangible. Car, house, tree, and flower are examples of concrete words. Abstract words are words that represent a concept or idea that is intangible. Judgement, freedom, love, and success are examples of abstract words.

One reason for paying attention to the concreteness of a word is to better understand how concrete and abstract words are semantically organized in the brain. Learning how these two types of words are organized in the brain may help to develop better speech therapy methods for, as well as develop a greater understanding of, individuals with communication disorders, such as aphasia. Aphasia is broadly defined as an impairment of language that affects the production of speech, comprehension of speech, or both (The National Aphasia Association, n.d.). It is an acquired disorder, typically resulting from a stroke or traumatic brain injury (The National Aphasia Association, n.d.).

The concreteness effect is a phenomenon that shows the behavioral difference between concrete and abstract words. Across linguistic tasks, concrete words have a better performance than abstract words (Jessen, Heun, Erb, Granath, Klose, Papassotiropoulos, & Grodd, 2000). For example, healthy individuals process concrete words faster on tasks such as recall, recognition, and lexical decision (Crutch, Connell, & Warrington, 2009). Behaviorally, concrete words are

recognized more quickly than abstract words and concrete words are remembered better than abstract words (Binder et al., 2005). Neurologically, concrete words are more resilient to brain damage (Binder et al., 2005). There is evidence to support this when looking at patients with neurological impairments. These patients have a tendency to show poorer processing of abstract items.

Although the concreteness effect reveals differences between concrete and abstract words, there are also similarities. Processing speed and accuracy increase with increased frequency of the type of word. Also, both concrete and abstract words have the potential to become impaired following an acquired brain injury, such as a stroke or neurodegenerative disease (Crutch et al., 2009). Neurodegenerative disease is a broad term for a range of conditions that degenerate the neurons in the brain (JPND Research, n.d.).

In addition to behavioral differences, there is a neural representation difference between concrete and abstract words, evidenced by a double dissociation between individuals with aphasia and semantic dementia. The concreteness effect is increased in patients with aphasia that is a result of left hemisphere damage. However, in patients with semantic dementia, a reverse concreteness effect can be observed. Patients with semantic dementia can show more severe impairment for understanding concrete words over abstract words (Wang, Conder, Blitzer, & Shinkareva, 2010). However, this is not always the case for every person with semantic dementia. A study by Hoffman and Lambon Ralph (2011) found that the reversed concreteness effect pattern was not found consistently across all patients with semantic dementia.

In addition to lesion studies, a meta-analysis by Wang in 2010 revealed a neural processing difference that showed there was stronger brain activation for abstract words in the inferior frontal gyrus and middle temporal gyrus in the left hemisphere. This study also revealed

that there was stronger activation for concrete concepts in the left precuneus, parahippocampal gyrus, posterior cingulate, and fusiform gyrus (Wang et al., 2010).

There has been a great debate in the language community over how an individual's semantic system is coordinated, and how the similarities and differences of concrete and abstract words mold into an organizational system. Several theories have been proposed to explain how concrete and abstract words are semantically organized. The Dual Coding Theory was proposed by Paivio, originally in 1971, but has since been revised and updated to include more systematic modifications. This theory states that there are two distinct systems for processing word meanings. One system is composed of word-based verbal knowledge, and the other system is composed of image-based, non-verbal knowledge. Concrete words access the image-based system, which uses both hemispheres. All words access the verbal based system, however, concrete words activate the image based system to a greater degree, which results in concrete words having a processing advantage (Paivio, 1991). Other research has been done that supports Paivio's Dual Coding Theory. The results of an experiment by Binder et al. (2005) show that processing of abstract concepts is left-lateralized, whereas the processing of concrete concepts is bilateral. However, research has also been done where the results do not support Paivio's theory. Several functional imaging studies have failed to provide evidence for right hemisphere involvement in concrete word processing. Also, concrete word advantages are not always seen in all tasks (Binder et al., 2005).

An opposing theory, the Context Availability Theory was originally proposed by Schwanenflugel (1988). The main principle of this theory is that there is a single system for accessing the meaning of both abstract and concrete words (Schwanenflugel, 1988). The differences between concrete and abstract words result in the differences in accessing each type

of word due to the amount and quality of available context. Abstract words have a looser set of associated knowledge than concrete words. This theory does not rule out right hemisphere involvement, but does attribute the concreteness effect to access of verbal information, which is left lateralized (Jessen et al., 2000). However, multiple neuroimaging studies, such as those by Binder and Jessen have not found support for this theory.

A third theory is the Embodied Cognition Theory proposed by Barsalou (2008). Otherwise known as grounded cognition, this theory supports a multimodal semantic organization, and rejects the standard view that amodal symbols represent knowledge in semantic memory. Barsalou proposed that when knowledge is needed later to represent a category, multimodal representations that were stored when an experience happened reactivate to simulate how the brain represented, perceived, took action, and self-examined. Abstract concepts draw metaphorically on knowledge about one's body and situations (Barsalou, 2008). For example, one can understand eating as part of the body, and can understand happy or sad, as happy is up and sad is down. However, there is evidence rejecting this theory also. There is a lack of support for abstract semantics (Shallice & Cooper, 2013). Also, there is a lack of form and computational accounts, and unanswered questions for full support of this theory, such as how the brain uses symbolic operations and abstract concepts (Barsalou, 2010).

Differences between concrete and abstract words can also be distinguished by qualitative characteristics versus quantitative characteristics. Quantitatively, concrete words have more sensory referents, more contextual information, and more semantic features, compared to abstract words (Crutch et al., 2009). Additionally, there is a difference in the age of acquisition.

The qualitative differences between concrete and abstract words tie into a fourth theory of semantic organization. The Differential Representation Theory states that abstract concepts

rely on qualitatively different representations than concrete concepts (Crutch & Warrington, 2005). Concrete words are organized primarily by their similarity to other concepts (Crutch et al., 2009). Abstract words are organized primarily by their association to other concepts (Crutch et al., 2009). This theory is based upon concreteness and relationship type: concrete versus abstract and similar versus associated. Support for this theory is evidenced in a study by Crutch and Warrington (2005) where a double dissociation between concrete and abstract words was found. Abstract concepts showed an effect of semantic contextual association, but not semantic similarity. Concrete concepts showed an effect of semantic similarity, but not semantic association. This was further supported in a study by Crutch et al. (2009) that showed a highly significant interaction between concreteness and relationship type. There was a faster response time for concrete words that were similar than concrete words that were related by association. Abstract words had a faster response time for words that were associated, versus words that were related by similarity.

While there is still no consensus on the organization of the semantic system, the more research that is completed, the more we will know. Thus, the goal of this project is to add to this body of evidence by having participants complete a semantic relatedness judgement task. In this task, participants will have to identify concrete and abstract words based on conditions of relatedness (association, similarity, and unrelated). Based on the Differential Representation Theory, it is hypothesized that concrete words will be more accurate and have a faster reaction time in a similarity condition than an association condition, and abstract words will be more accurate and have a faster time with an associative condition than a similarity condition. This study will look at data from both Neurotypical Adults and Patients with Aphasia. If the data

support this hypothesis, then it is further evidence of the Differential Representation Theory that concrete and abstract words are organized differently within the semantic system.

The results of this project will be able to be applied to prior knowledge of word finding techniques in speech therapy, especially for problems with abstract word finding difficulties. . For example, the results of this study could help explain the results of a treatment study by Sandberg and Kiran (2014), where there was one way generalization from abstract words to concrete words. One way generalization from abstract words to concrete words, means that by training abstract words, there will by carryover to improving skills with concrete words as well. It is only one way because training concrete words does not have a direct impact on the improvement of abstract words. This research has implications for generalization of therapy, meaning training abstract words will also benefit one's use and understanding of concrete words. This one way link cannot be fully explained by any other theory mentioned, besides the Differential Representation Theory.

Methods

Participants:

There were 26 total participants in this study, separated into two groups: neurotypical adults (NTA) and persons with aphasia (PWA). All participants had at least a high school education. All participants demonstrated normal or corrected to normal hearing and visual acuity.

Neurotypical:

There were 19 neurotypical participants (9 male, 10 female). Eighteen of the neurotypical participants were right handed and one participant was left handed. The average age of the neurotypical participants was 35.89 years, which ranged from 18 to 64 years old. In this group there was no history of neurogenic communication disorders or developmental disorders. Table 1 displays the neurotypical participant demographics.

Table 1. Neurotypical Participant Demographics

	N4	N17	N18	N19	N20	N21	N22	N23	N24	N25	N26	N28	N30	N31	N32	N34	N35	N40	N41
AGE	41	25	32	46	58	59	29	36	20	23	18	28	20	23	22	29	47	64	62
SEX	M	F	F	F	F	F	F	F	F	M	M	M	M	F	F	M	M	M	M
HANDEDNESS	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	L	R

Notes: M: Male, F: Female; R: Right Hand Dominant, L: Left Hand Dominant

Persons with Aphasia:

There were seven participants (5 male, 2 female) in the Persons with Aphasia group. All of these participants were right handed. The average age was 60.14 years, and ranged from 46 to 73 years old. They had an average of 83.45 WAB AQ, which is a measure of Aphasia severity. WAB AQ scores range from 0 to 100, with numbers closer to zero being more severe, and numbers closest to 100 being the least severe. A WAB AQ of 0-25 means the Aphasia is very severe, 26-50 means the Aphasia is severe, 51-75 means the Aphasia is moderate, and 75 and higher means the Aphasia The participants had a mix of types of Aphasia including: Conduction, Anomic, and Transcortical Motor. All of the patients had damage to the left hemisphere, as a result of a left hemisphere stroke. All of the patients were in the chronic stage of recovery as evidenced by time post-onset of at least six months. Table 2 displays the Persons with Aphasia participant demographics.

Table 2. Persons with Aphasia Participant Demographics

	P1	P2	P3	P4	P5	P6	P7
AGE	67	46	56	61	67	51	73
SEX	M	M	F	F	M	M	M
HANDEDNESS	R	R	R	R	R	R	R
WAB AQ	81.2	91.2	93.2	78.5	74.3	93.3	63.3
WAB TYPE	CONDUCTION	ANOMIC	ANOMIC	TRANSCORTICAL MOTOR	CONDUCTION	ANOMIC	TRANSCORTICAL MOTOR

Notes: M: Male, F: Female; R: Right Hand Dominant, L: Left Hand Dominant; WAB: Western Aphasia Battery; AQ: Aphasia Quotient

Task:

Each participant was asked to complete a semantic relatedness judgement task. The participants viewed two words. Then, participants decided whether the two words were related or not. The word pairs were divided into six conditions: concrete association (*farm-tractor*), concrete similarity (*rose-daisy*), concrete unrelated (*wind-brick*), abstract association (*motive-crime*), abstract similarity (*reality-truth*), and abstract unrelated (*mood-item*). The participants saw 40 word pairs in each category, except in unrelated conditions, in which there were 80 word pairs to balance the number of yes and no responses.

The task was administered using E-Prime software. The participants were shown a sequence of screens during the completion of the semantic relatedness judgement task. For each screen, the background was grey and the writing was white. For each word pair, the screen sequence ran as follows: 700 ms of a fixation cross, 300 ms of a blank screen, 500 ms of a screen showing the first stimulus (“rose”), 500 ms of a screen showing the second stimulus (“daisy”), up to 2000 ms of a question mark, up to 2000 ms of a blank screen, and finally a jittered fixation cross. The blank screen after the question mark makes up the difference between when the response is given and 2000 ms. For example, if the participant answered in 1000 ms, the screen with the question mark would disappear, and the blank screen would appear for 1000 ms. The final fixation cross is jittered, meaning it is random whether it will be on the screen for 500, 750, or 1000 ms. Figure 1 illustrates an example of the task.

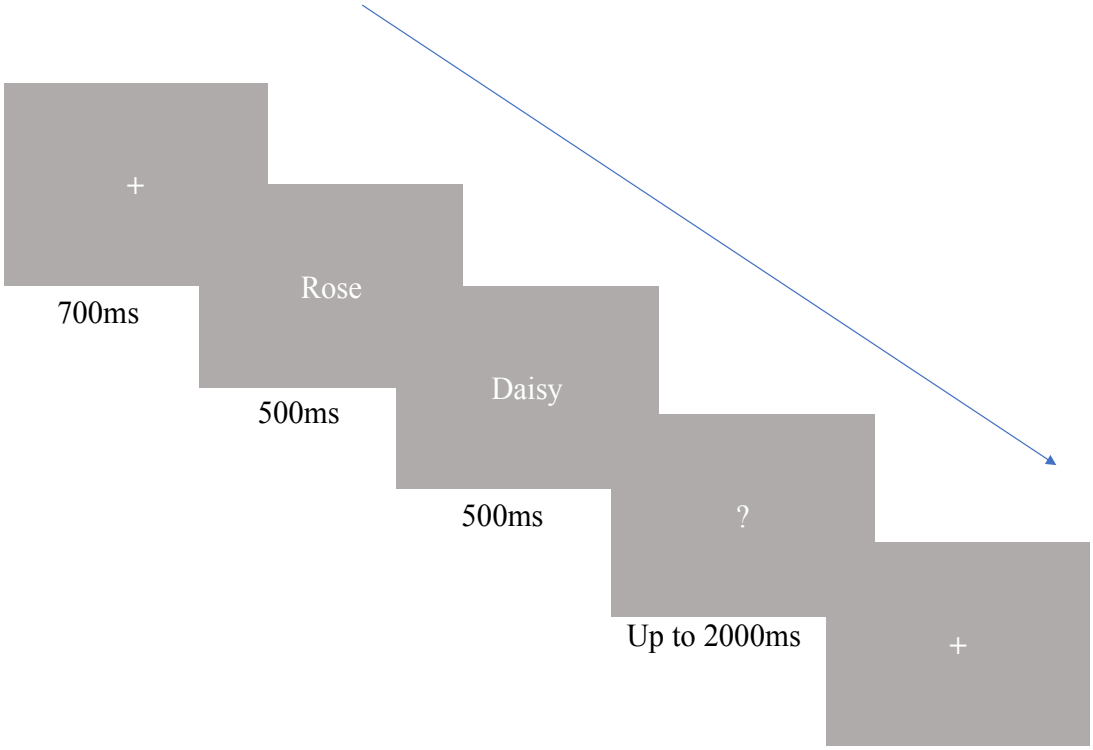

Figure 1. Semantic Relatedness Judgement Task

Data Analysis:

The data analyzed in this study were obtained as part of a larger study. This is a secondary analysis. After the accuracy and reaction time data were collected from this task, they were put into a spreadsheet. The reaction time data were trimmed, removing all incorrect responses. Additionally, 500 ms were added to each reaction time, to represent the reaction time from when the second stimulus started, because the participant was instructed to wait until they saw the question mark before they responded. Based on the recalculated reaction time, any reaction times greater than or less than 2.5 standard deviations away from the mean were removed, in order to remove any outliers in the data. This was done per subject, meaning each subject had their own mean and standard deviation based on their performance.

Once the data were trimmed, they were analyzed using SPSS Statistics software. A 2 by 3 repeated measures ANOVA was completed to look at the main effects of concreteness (abstract versus concrete) and relatedness (association versus similarity versus unrelated), as well as interactions. This was done separately for each group (NTA, PWA). A p-value of .05 was used to determine significance.

Results

Accuracy

Neurotypical Adults (NTA)

The NTA participants scored an average of 89.84% accuracy for concrete words, and 88.68% accuracy for abstract words. The NTA participants scored an average of 90.66% accuracy for words presented in an association condition, 83.03% accuracy for words presented in a similar condition, and 91.68% for words presented in an unrelated condition.

The NTA participants were 92.24% accurate (range 67.50% – 100.00%) on words presented in the concrete association condition. NTA participants were 82.89% accurate (range 45.00% – 100.00%) on words presented in the concrete similarity condition. NTA participants were 92.11% accurate (range 61.25% – 98.75%) on words presented in the concrete unrelated condition.

The NTA participants were 89.08% accurate (range 65.00% – 100.00%) on words presented in the abstract association condition. The abstract similarity condition was 83.16% accurate (range 67.50% – 95.00%). NTA participants were 91.25% accurate (range 42.5% – 100.00%) on words presented in the abstract unrelated condition. Table 3 shows the mean accuracy percentages for the NTA participants.

Table 3. Neurotypical Adults Accuracy

	CONCRETE	ABSTRACT
ASSOCIATION	92.24% (9.79%)	89.08% (10.48%)
SIMILARITY	82.89% (19.35%)	83.16% (9.57%)
UNRELATED	92.11% (8.65%)	91.25% (12.46%)

There was no significant main effect of concreteness (F (1,18) = .62 p = .44). However, there was a significant main effect of relatedness (F (2, 18) = 6.48 $p < .05$). Pairwise comparisons using the Sidak method for multiple comparisons revealed a significant difference between the association and similarity conditions of relatedness ($p < .05$). There was also a significant difference between the similarity and unrelated conditions of relatedness ($p < .05$). All other comparisons were not significant (ps > .05). There was a not a significant interaction of concreteness by relatedness (F (2, 18) = .39 p = .54).

Neurotypical Adults Minus Participant #30

Participant number 30 was subtracted from the data, as they were an outlier, and might be affecting the data. When participant number 30 was subtracted from the data, the accuracy in each condition increased. The NTA participants were 93.61% accurate (range 70.00% – 100.00%) on words presented in the concrete association condition. NTA participants were 83.47% accurate (range 45.00% – 100.00%) on words presented in the concrete similarity condition. NTA participants were 93.82% accurate (range 80.00% – 98.75%) on words presented in the concrete unrelated condition.

With participant number 30 removed from the data, the mean of words presented in the abstract association condition was 90.42% (range 70.00% – 100.00%). The abstract similarity condition was 84.03% accurate (range 67.50% – 95.00%). The abstract unrelated condition was 93.96% accurate (range 83.75% – 100.00%). Table 4 shows the mean accuracy percentages for the NTA participants, minus participant number 30's data.

Table 4. Neurotypical Adults Minus Participant #30 Accuracy

	CONCRETE	ABSTRACT
ASSOCIATION	93.61% (7.96%)	90.42% (8.96%)
SIMILARITY	83.47% (19.74%)	84.03 % (9.04%)
UNRELATED	93.82% (4.49%)	93.96% (4.10%)

With these data removed, the results of the ANOVA did not significantly change.

Persons with Aphasia (PWA)

Overall, the PWA participants scored an average of 81.88% accuracy for concrete words, and 69.02% accuracy for abstract words. The NTA participants scored an average of 80.54% accuracy for words presented in an association condition, 78.39% accuracy for words presented in a similar condition, and 71.43% for words presented in an unrelated condition.

The PWA participants were 85% accurate (range 55.00% – 100.00%) on words presented in the concrete association condition. PWA participants were 88.93% accurate (range 62.50% – 100.00%) on words presented in the concrete similarity condition. PWA participants were 76.79% accurate (range 3.75% – 97.50%) on words presented in the concrete unrelated condition.

The PWA participants were 76.07% accurate (range 32.50% – 95.00%) on words presented in the abstract association condition. The abstract similarity condition was 67.86% accurate (range 40.00% – 87.5%). PWA participants were 66.07% accurate (range 6.25% – 96.25%) on words presented in the abstract unrelated condition. Table 5 shows the mean accuracy percentages for the PWA participants.

Table 5. Persons with Aphasia Accuracy

	CONCRETE	ABSTRACT
ASSOCIATION	85.00% (15.75%)	76.07% (20.81%)
SIMILARITY	88.93% (13.45%)	67.86% (18.45%)
UNRELATED	76.79% (32.89%)	66.07% (30.85%)

There was a significant main effect of concreteness (F (1,6) = 81.95 p < .001). There was not a significant main effect of relatedness (F (2, 6) = 1.07 p = .34). Pairwise comparisons using the Sidak method for multiple comparisons revealed no significant differences between any conditions of relatedness (p > .05). There was a not a significant interaction of concreteness by relatedness (F (2, 6) = 1.49, p = .27).

Reaction Time

Neurotypical Adults

In the concrete association condition, there was a mean reaction time of 902.37 ms (range 651.94 – 1194.38 ms; SD = 163.04 ms). In the concrete similarity condition, there was a mean reaction time of 892.55 ms (range 672.11 – 1211.91 ms; SD = 136.94 ms). In the concrete unrelated condition, there was a mean reaction time of 949.49 ms (range 729.73 – 1282.83 ms; SD = 160.19 ms).

In the abstract association condition, there was a mean reaction time of 954.20 ms (range 707.95 – 1260.28 ms; SD = 170.66 ms). In the abstract similarity condition, there was a mean reaction time of 968.56 ms (range 726.14 – 1425.24 ms; SD = 193.20 ms). In the abstract unrelated condition, there was a mean reaction time of 988.43 ms (range 740.81 – 1314.61 ms; SD = 165.32 ms).

The NTA participants had a significant main effect of concreteness (F (1,18) = 19.41, p < .001). The NTA participants did not have a significant main effect of relatedness (F (2,18) = 3.05, p = .06). Pairwise comparisons using the Sidak method for multiple comparisons revealed no significant differences between any conditions of relatedness (p > .05). There was not a significant interaction of concreteness by relatedness (F (2,18) = 1.10, p = .34).

Neurotypical Adults Minus Participant #30

In the concrete association condition, there was a mean reaction time of 894.52 ms (range 651.94 – 1194.38 ms; SD = 164.03 ms). In the concrete similarity condition, there was a mean reaction time of 887.53 ms (range 672.11 – 1211.91 ms; SD = 139.10 ms). In the concrete

unrelated condition, there was a mean reaction time of 951.00 ms (range 729.73 – 1282.83 ms; SD = 164.70 ms).

In the abstract association condition, there was a mean reaction time of 957.39 ms (range 707.95 – 1260.28 ms; SD = 175.03 ms). In the abstract similarity condition, there was a mean reaction time of 966.30 ms (range 726.14 – 1425.24 ms; SD = 198.54 ms). In the abstract unrelated condition, there was a mean reaction time of 989.12 ms (range 740.81 – 1314.61 ms; SD = 170.08 ms).

The minimum and maximum reaction times were not affected by removing participant number 30 from the data.

With participant number 30 subtracted from the data, the NTA participants not only had a significant main effect of concreteness (F (1,17) = 22.86, p <. 001), but also a significant main effect of relatedness (F (2,17) = 3.43, p < .05). Pairwise comparisons using the Sidak method for multiple comparisons revealed a significant difference between the association and unrelated conditions of relatedness (p < .05). All other comparisons were not significant (p > .05). There was not a significant interaction of concreteness and relatedness (F (2,17) = 1.31, p = .28).

Persons with Aphasia

In the concrete association condition, there was a mean reaction time of 1096.96 ms (range 869.81 – 1475.05 ms; SD = 219.80 ms). In the concrete similarity condition, there was a mean reaction time of 1090.99 ms (range 796.85 – 1525.20 ms; SD = 282.71 ms). In the concrete unrelated condition, there was a mean reaction time of 1292.66 ms (range 908.40 – 1990.33 ms; SD = 367.99 ms).

In the abstract association condition, there was a mean reaction time of 1164.82 ms (range 968.59 – 1419.05 ms; SD = 183.18 ms). In the abstract similarity condition, there was a mean reaction time of 1238.39 ms (range 930.93 – 1634.13 ms; SD = 266.87 ms). In the abstract unrelated condition, there was a mean reaction time of 1361.94 ms (range 1005.55 – 1716.21 ms; SD = 289.97 ms).

The PWA participants had a significant main effect of concreteness (F (1,6) = 6.23, p < .05). The PWA participants had a significant main effect of relatedness (F (2,6) = 10.76, p < .01). Pairwise comparisons using the Sidak method for multiple comparisons revealed a significant difference between the association and unrelated conditions of relatedness (p < .05). There was also a significant difference between the similarity and unrelated conditions of relatedness (p < .05). All other comparisons were not significant (p >.05). There was not a significant interaction of concreteness by relatedness (F (2,6) = 1.90, p =.22).

Discussion

Neurotypical Adults

On average, the NTA participants scored a higher accuracy percentage for concrete words than for abstract words, exhibiting the expected concreteness effect. However, when the stimuli were separated into their experimental conditions, NTA participants had the highest accuracy for words presented in the concrete association condition, and the lowest accuracy for words in the concrete similarity condition. This finding is the reverse of what I predicted and does not support the hypothesis that concrete words are organized primarily by their similarity to other concepts, and not their association. This could be due to the broad range in accuracy percentages in the concrete similarity condition. There was a range of 55%, with a standard

deviation of 19.35%. The outliers involved could have affected the overall mean accuracy, leading to the unpredicted result.

For abstract words, NTA participants were most accurate in the unrelated condition and lowest in the similarity condition. The association condition was more accurate than the similarity condition, which provides evidence to support the hypothesis, which predicted abstract words to perform with higher accuracy in the association condition. The unrelated condition performed the most accurate for abstract words. This could be due to a broad range in accuracy percentages in the abstract association and unrelated conditions. There was a range of 55%, with a standard deviation of 10.48%. Additionally, the abstract unrelated condition had a broad range in accuracy percentages, with a range of 57.5%, with a standard deviation of 12.46%. The outliers involved could have affected the overall mean accuracy, leading to the unpredicted result. The broad range of accuracy scores in general could be due to participant familiarity with the stimuli, as well as possible guessing of the correct answer.

In terms of accuracy, there was no significant main concreteness effect found; however, there was a significant main relatedness effect. Importantly, there was no significant effect of concreteness by relatedness. This interaction would have supported the hypothesis if this was a significant effect, and concrete words were more accurate and faster in the similarity condition, and abstract words were more accurate and faster in the association condition.

Not having a significant main concreteness effect means that concrete words were not more accurate than abstract words. This could be due to the potential outliers in the accuracy data mentioned above. A significant main relatedness effect means that the association condition was more accurate than the similarity condition, regardless of word type. Thus, this finding does not support the hypothesis.

In terms of reaction time, unlike the accuracy data, NTA participant data exhibited the expected concreteness effect in that concrete words were recognized quicker than abstract words. There was also a significant main relatedness effect found when an outlier was removed. However, there were no significant interaction effects of condition by relatedness. This suggests that although there was a difference in the word type (abstract or concrete) and the condition the words were presented in (association, similarity, or unrelated), there was not a preference for abstract words in the association condition and for concrete words in the similarity condition. This finding does not support the hypothesis.

Persons with Aphasia

On average, the PWA participants scored a higher accuracy percentage for concrete words than abstract words, exhibiting the expected concreteness effect. This effect was shown to be statistically significant. When the stimuli were separated into their experimental conditions, PWA participants had the highest accuracy for words presented in the concrete similarity condition, and in the abstract association condition. This pattern was predicted by the hypothesis. However, there was not a significant main effect of relatedness, and there was not a significant interaction of concreteness by relatedness. This lack of significance for the expected pattern means that the hypothesis was not supported. It is important to note that PWA participant number 7 had accuracy percentages that were outliers in the data. However, by removing the data, the significance of concreteness, relatedness, or concreteness by relatedness was not affected.

In terms of reaction time, the PWA participant data showed a significant main concreteness effect and a significant main relatedness effect, but no interaction. The significant main concreteness effect confirms the expected concreteness effect. A significant main

relatedness effect suggests there was a significant difference in the reaction time of different conditions. There was a significant difference between the association and unrelated conditions and a significant different between the similarity and unrelated conditions. This does not have any implications towards support for the hypothesis. The lack of an interaction means that concrete words were not more accurate or faster as a result of being in the similarity condition, and abstract words were not more accurate or faster as a result of being in the association condition.

In general, there was more variability in the PWA data. There were broader ranges and greater standard deviations, compared to the NTA data. This could be due to the participants having different types of aphasia. It could also be due to the participants being in different stages of their recovery. A third possibility is that it could have been due to unfamiliarity of the stimuli, which could have resulted in guessing the correct answer, with varying speeds.

The hypothesis of this paper was based on the Differential Representation Theory. Based on the lack of support of the hypothesis of this paper, the Differential Representation Theory was not supported by the findings of this paper. This may be due to some limitations within the study itself.

Within this study there are potential limitations that could have produced less than ideal results. One limitation is that in the task of the study, the participants had to wait to respond until they saw the question mark. The reaction times collected, therefore, are not true reaction times. Another limitation is the task used. The desired results for this study were found in a study by Crutch et al. (2009). The Crutch et al. (2009) study used an odd-one-out task, instead of a semantic judgement task. This task difference could have affected the outcomes. A third limitation of this study could possibly be the wide range of participants. The age range for the

NTA participants was a span of 46 years, and the age range for PWA participants was 27 years. That is a broad age range to be comparing individuals on a cognitive task. Another limitation that could have affected the results of this study is the number of participants. There were 19 NTA participants and 7 PWA participants. This is not enough participants to be powerful enough to overcome the outliers and broad ranges found in the data. An example of this from the study is looking at the accuracy percentages with NTA participant number 30 being subtracted from the data. Accuracy percentages increased in all conditions of relatedness, which is evidence for how outliers can be affecting the data.

A factor to be considered within this study is the differences of the accuracy and reaction time data between each of the two participant groups (NTA and PWA). It is important to consider because for NTA, reaction time is a more accurate representation of their performance. NTA participants would be expected to not have difficulty with accuracy in the semantic judgement relatedness task. Therefore, the time of their response is a more valid indicator of performance. For PWA participants, accuracy is a better representation of their performance. PWA participants may need a longer time to process the stimuli, in order to answer accurately. Having slower reaction times does not suggest that it has to do with concreteness and relatedness. Cognitively, extra time may be necessary for the PWA participants to answer most accurately. Therefore, we should rely more on the accuracy data when making a conclusion for PWA participants.

Conclusion

In conclusion, the NTA participants and the PWA participants differed in their results of the study, both in accuracy and reaction time. NTA participants had greater accuracy in concrete and abstract words, and all conditions of relatedness than PWA participants. NTA participants also had faster reaction times compared to PWA participants. While there were group differences, it is important to consider that NTA participant results should be more focused on the reaction times, and PWA participant results should be more focused on the accuracy. Comparing the two groups of participants may not yield an accurate conception of the results, as cognitively, these two groups are different. In all participants there were not any significant interactions between concreteness and relatedness. This finding was unexpected and does not support the Differential Representation Theory which states that concrete words and abstract words are organized differently within the semantic space, with concrete words being organized by similarity and abstract words being organized by association. Future work should include looking at how semantic organization is affected by the type of aphasia an individual has. Looking for differences in performance across a semantic relatedness judgement task by type of aphasia would be interesting to see if the area of the brain affected causes differences, which could be applied to speech therapy interventions.

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ACADEMIC VITA

Allison Thatcher
allisonthatcher96@gmail.com

Education

The Pennsylvania State University, Schreyer Honors College
B.S. Communication Sciences and Disorders, College of Health and Human Development
Minors: Gerontology and Human Development and Family Studies
Graduating Spring 2018

Research & Academic Experience

Undergraduate Research Assistant, Adult Neuroplasticity Laboratory
Department of Communication Sciences and Disorders
Spring 2016-Present
Advisor: Dr. Chaleece Sandberg

Teaching Assistant, Acoustic Principles in Communication Sciences and Disorders
Department of Communication Sciences and Disorders
Fall 2017

Teaching Assistant, Anatomy and Physiology for Speech and Hearing
Department of Communications
Spring 2017

Tutor for Student Athletes
Morgan Academic Center
Spring 2016-Present

Honors & Awards

Schreyer Honors Scholar
Fall 2016-Present

Health and Human Development Honor Society
Fall 2015-Present

National Society of Collegiate Scholars
Fall 2015-Present

Dean's List
Fall 2014-Present