Abstract

THE EFFECT OF WORD FAMILIARITY AND TREATMENT APPROACH ON WORD RETRIEVAL SKILLS IN APHASIA

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The purpose of this investigation was to examine the influence of subjective word familiarity on word retrieval ability and responsiveness to short, intensive aphasia treatment. Four native English-speaking participants with chronic aphasia received Phonological Components Analysis (PCA) and Semantic Feature Analysis (SFA) treatments in a crossover design. Each treatment focused on retrieval of familiar and unfamiliar words based on participant self-rating. There has been limited research relative to the influence of subjective familiarity on word retrieval. Furthermore, no studies to date have examined the effect of familiarity on treatments targeting improved word retrieval of individuals with aphasia. Additional information is needed relative to the factors that influence word retrieval as well as how these factors affect an individual's response to treatment. As individuals with aphasia have been observed to respond differently to treatment, it is valuable to examine the variables that may motivate change, such as subjective familiarity.

Both accuracy and reaction time measurements were obtained for all stimuli at baseline and at the beginning of each day of treatment during SFA and PCA treatment protocols for each participant. Probe stimuli were presented throughout each treatment protocol to examine

generalization. The Western-Aphasia Battery Revised and the Test of Adolescent/Adult Word Finding were administered pre-treatment and periodically throughout the experimental protocol.

Subjective familiarity of stimuli influenced word retrieval relative to accuracy and reaction time for two of the four participants. SFA and PCA treatments had varied effects on accuracy and reaction time across participants. Specifically, treatment effectiveness was significantly evident for three of four participants for SFA whereas one participant demonstrated significant changes after PCA treatment. Generalization to untreated stimuli was minimal; only one participant demonstrated significant changes relative to improvement from treatment. Relationship between accuracy and reaction time was observed for one participant relative to familiarity. Specifically, JD demonstrated a direct relationship between accuracy and RT for familiarity with increased accuracy and faster retrieval for familiar stimuli at baseline. However, JD showed an inverse relationship between speed and accuracy for familiar stimuli after both treatment approaches. Two participants (RR, RM) demonstrated a direct relationship between accuracy and RT relative to treatment with increased accuracy and faster retrieval after SFA treatment. IC exhibited a speed-accuracy of retrieval trade-off with increased accuracy accompanied by slower retrieval, specific to SFA treatment. Further understanding of these variables in treatment of word retrieval is needed to determine effectiveness of specific treatments.

Overall, the present findings suggest that subjective familiarity may influence word retrieval skills relative to accuracy and reaction time for some individuals with aphasia. Furthermore, intensive SFA or PCA treatment can yield improvement in word retrieval skills and may result in standardized aphasia test performance in participants with aphasia, regardless of severity, chronicity, or basis of retrieval impairment.

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DEDICATION

For IC, JD, RR, and RM

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I.

REVIEW OF THE LITERATURE

Introduction

In the United States, strokes are the third most common cause of death to citizens over age 45 (Davis, 2007). When death does not result, the impact of a stroke on an individual's brain functioning is not immediately clear, but when the left hemisphere is damaged, aphasia is highly considered as a possible newly acquired disorder. Aphasia will affect an individual's expressive and receptive language abilities. Individuals have trouble expressing ideas during speaking, writing, and gesturing. They also may have difficulties with reading and listening to information as well as recognizing pictures and objects (Rosenbek, LaPointe, & Wertz, 1989). Expressive abilities are often more impaired than receptive abilities. The ability to repeat may remain intact in some aphasic individuals (Davis, 2000; 2007; Goodglass, 1993; Goodglass, Kaplan & Barresi, 2001; Raymer & Gonzalez- Rothi, 2000).

Regardless of the specific type of aphasia, all aphasic individuals are united by the symptom of anomia. Anomia can be described as the inability to find words. This disorder affects an individual's ability to retrieve words, which weakens the overall communication loop between the speaker and the listener. In conversation, an individual with aphasia may often circumlocute or define and describe a target word when he/she cannot retrieve the target word. There are many factors that may influence word retrieval in aphasia. The purpose of the current study was to examine the effect of word familiarity on word retrieval ability and responsiveness to treatment in aphasia. To achieve this goal, this literature review will initially address aphasia and its characteristics. This will be followed by a discussion on theories of word retrieval and issues and factors affecting word retrieval in aphasia. Treatments used to improve word retrieval skills for aphasic patients will then be discussed. The review of the literature will conclude with the summary, rationale, plan of study, and experimental questions for this investigation.

Definition and Characteristics of Aphasia

According to Davis (2007), aphasia is a "selective impairment of the cognitive system specialized for comprehending and formulating language, leaving other cognitive capacities relatively intact" (p. 15). This definition indicates that individuals with aphasia typically have intact intellectual, motor, and sensory abilities. Furthermore, unlike amnesia, an individual with aphasia does not ordinarily have memory, recall or recognition problems, so generally recognition and recall abilities remain unaffected.

Aphasia affects the functioning of an individual's expressive and receptive language abilities. As previously mentioned, expressive abilities are often more impacted than receptive abilities. Within expression, the individual may have trouble speaking, writing, and gesturing. Frequently, the aphasic individual may have difficulty in these areas due to anomia (Davis, 2007; Goodglass, 1993; Thompson & Worall, 2008; Whitworth, Webster, & Howard, 2005). As a result, they may produce unintentional sound or word substitutions known as paraphasias that compensate for difficulty with word retrieval. He/she may also produce nonsense words known as neologisms, speaking in lengthy utterances such as jargon. For example, adults with Wernicke's aphasia often produce jargon in their verbal output. It is typical for jargon speakers to display a press for speech tendency in which they speak before another speaker can take his/her turn in a conversation.

Some individuals may be agrammatic and produce limited output, primarily consisting of content words. Agrammatic speakers, such as those individuals with Broca's aphasia, produce a lot less verbal output than jargon speakers. Their speech is void of function words and bound morphemes, even when reading words from grammatical text.

Aphasic individuals also may have agraphia or trouble retrieving words when writing. These word retrieval errors are known as paragraphias (Davis, 2007; Goodglass, 1993). An aphasic individual's writing abilities often will be more impaired than his/her verbal output. This is why analyzing the writing abilities of a patient with brain damage is valuable in detecting a mild aphasia. However, writing abilities may mirror verbal output (Davis, 2007; Goodglass, 1993; Whitworth, et al., 2005).

Aphasic individuals also have impaired receptive language abilities. He/she may have trouble comprehending auditory information. It is evident a patient is struggling with auditory comprehension when he/she often responds to questions at a slower rate, requests things to be repeated, and/or fails to follow instructions correctly. Relative to visual comprehension, the patient may have trouble reading silently or aloud. This is known as acquired dyslexia (Davis, 2007). The patient may often verbalize words incorrectly, otherwise known as paralexias. Generally, reading is usually more impaired than auditory comprehension.

The most frequently-used classification method for describing types of aphasias is Goodglass's fluent/non-fluent system (Goodglass, 1993). This system divides patients based on extent of verbal output. Specifically, fluency is based on phrase length and words per minute. Wernicke's, conduction, anomic, and transcortical sensory aphasia are all types of fluent aphasias. These aphasic individuals produce longer phrases of five or more connected words and they produce more than 75 words per minute. Fluent aphasic patients also produce speech with no apparent effort, even in the presence of sound, word, or grammatical errors. They typically sound "normal" in terms of their phrase length and intonation. Non-fluent aphasic patients produce limited verbal output, producing utterances containing four or fewer connected words and 50 or fewer words per minute. Unlike fluent aphasic speakers, these speakers expend a lot of effort in the act of speaking and their speech sounds segmented because it typically lacks melodic contour. Non-fluent types of aphasia include Broca's, global, mixed, and transcortical motor aphasia (Davis, 2007; Goodglass, 1993; Goodglass, et al., 2001; Raymer & Gonzalez-Rothi, 2000)

Universally, most aphasic adults have less difficulty producing subpropositional language (ready-made forms for the speaker) including routine greetings, such as "How are you?", "I'm fine", profanities, reciting parts of the alphabet, and counting to ten (Davis, 2007). They have significantly more difficulty using propositional language, which is "a creative formulation of words with specific and appropriate regard to the situation" (Eisenson, 1984, p.6). Hence, their impairment severely affects their ability to communicate at the conversational level, where spontaneous, creative ability is required.

As previously mentioned, the most common symptom of aphasia is anomia or difficulty retrieving words in verbal output. Anomia is a term that refers to 'problem with word finding' or more specifically "impaired access to one's vocabulary" (Goodglass, 1993, p. 77). Many adults with aphasia suffer the tip-of-the-tongue phenomenon (ToT); however, non-brain damaged individuals also experience this phenomenon. An individual knows what they want to say, but they cannot think of the word (Davis, 2007). In fact, some aphasic patients with anomia have been observed to provide the correct auxiliary of the intransitive verb and/or the gender of nouns (Badecker, Miozzo, & Zanuttini, 1995). Other patients have been found to accurately report the number of syllables within the word and/or utterance and whether or not the target form is a compound word (Lambon, Ralph, Sage, & Roberts, 2000). Some other adults with aphasia have been able to report the first letter of the item's name (Nickel, 1992). Barton (1971) found that adults with aphasia were accurate 60% of the time when the examiner instructed them to point to properties of particular words including the target word's syllable number, first letter, or adjective that indicated the size of the word.

Many aphasic adults also resort to the covert/intentional tactic of circumlocution and the unintentional tactic of a commission error. Circumlocution involves defining and/or describing a target word in an effort to clue the speaker in on what he/she is referring to in conversation when he/she cannot think of the target word. When an individual with aphasia makes a circumlocution, this behavior shows that he/she understands the concept of the word by stating descriptors of the word, but he/she cannot retrieve the word itself. When making a commission error, the person with aphasia often unintentionally will produce a paraphasia. Paraphasias refer to any unintended choice in word (Goodglass, 1993). An aphasic adult may produce verbal, semantic, phonemic, or neologistic paraphasias (Goodglass, 1993). The person commits an unrelated verbal paraphasia when he/she labels a "cat" as a "table." He/she is making a semantic paraphasia when they refer to all "four-legged creatures" as "dogs." Sometimes, aphasic patients may produce non-words, called neologisms, such as "goggashle" to identify a "dog" (Davis, 2007; Goodglass, 1993; Goodglass, et al., 2001; Raymer & Gonzalez-Rothi, 2000). Frequently, commission errors are harder to understand than circumlocutions because more information is omitted during this latter error type.

Theories of Word Production

In general, naming problems result from impairments at particular stages of the word production process, whether it be the decoding, storage, selection, retrieval or the encoding stage (Benson & Ardila, 1996; Goodglass, 1993; Whitworth et al., 2005. Caramazza and Berndt (1978) summarize the naming process into three main stages: an encoding stage in which a stimulus and its identifying features are perceived, a central stage consisting of initial mapping of information onto the stimulus's semantic representation/conceptual category followed by secondary mapping of the concept to a specific lexical item/the object's name and finally a production stage that guides the articulation of the correct phonological sequence. Currently, there are several theories that propose there are three main systems that are affected which can help explain the underlying basis for anomia. Morsella and Miozzo (2002) have indicated that anomia results because of impairment or impairments at the semantic, phonological or lexical levels of word production. Semantic and phonological level theories support that anomia occurs at (a) the input level (semantic) or (b) the output level (phonological), respectively. Lexical level theories explain that the grammatical category and frequency of the word affects its retrieval. Discovering the level of impairment is especially difficult to assess because all three levels are stages of the naming process and more than one level may be impaired (Chialant, Costa, & Caramazza, 2002; Davis, 2007; Raymer & Gonzalez-Rothi, 2000).

Semantic Level Deficits

Kay and Ellis (1987) indicated that an impaired semantic system manifests itself by (1) poor performance on semantic tasks, (2) improved naming given correct phonemic cues, (3) increased production of semantic paraphasias given phonemic miscues, (4) absence of 'tip-of-the-tongue' responses, and (5) equal difficulties comprehending words he/she cannot produce (Allport & Funnell, 1981; Allport, 1983; Howard & Orchard-Lisle, 1984). Butterworth (1984), Gainotti, Silveri, Villa, and Miceli (1986), and Nickels and Howard (1994) all reported that their patients with semantic deficits experienced difficulties across all modalities and comprehension and production. Allport (1983, 1984; Allport & Funnell, 1981) and Howard and Orchard-Lisle (1984) also concluded that individuals with semantic deficits had difficulty with comprehending words that they could not produce.

Semantic level theorists advocate that individuals with aphasia suffer from anomia because their semantic memory is negatively impacted. Semantic memory stores concepts, which are the simplest mental representations of classes of actions and objects in the real world (Davis, 2007). Concepts are organized as nodes connected to other nodes that share a semantic relationship (Dell, 1986). The entire collection of nodes and their connections is known as the semantic network.

Figure 1 is a schematic map depicting the simple semantic memory network. In Figure 1, more semantically-related nodes are closer together. For example, fire engines are primarily red so the distance between ‘fire engine’ and ‘red’ is very short. The distance between ‘roses’ and ‘red’ will always be longer because there are more non-red roses than non-red fire trucks. Dell (1986) described a spreading activation-theory of word retrieval in which an activated concept has a base level of node activation, which it sends to nodes connecting to it. Once this activation level reaches the new, destination node, the destination node’s current activation level increases in a process known as summation. All connections are two way, with node A connecting to node b (excitatory, top-down processing) and vice versa (excitatory, bottom-up processing). Strengths of associations vary according to how related concepts are, with stronger associations equated with higher potential activation levels. Activation additionally decays exponentially over time (Dell, 1986).

During lexical access, two steps must occur (Harley & Brown, 1998). First, a node that corresponds to a relevant concept must be retrieved, otherwise known as “lemma access” (Levelt, Roelofs, & Meyer, 1999). Then, the word’s phonological characteristics must be retrieved, which then dictate the phonetic plan that leads to the final production of the word via articulation. Syntactic properties are also attached to lemmas during sentence production.

Incorrect lemma access retrieval could lead to a person saying “knee” for “elbow” (Kittredge, Dell, Verkuilen, & Schwartz, 2008). Incorrect phonological characteristic assignment could lead to a person saying a nonword, such as “dat” for “dog.” Incorrect lemma access and/or phonological retrieval could also result in the production of a completely different word or even a non-word.

Davis (2007) and others (Thompson & Worrall, 2008; Whitworth et al., 2005) have indicated that the lexical system also may be impacted if the semantic system was impaired. This is because the semantic system partially determines the actions of the lexical system. Fromkin’s (1971, 1973) “Utterance Generator Model” and Butterworth’s (1985) “Modern Speech Production Model” all describe the semantic system as preceding the lexical system, with the phonological system occurring last relative to language processing systems involved in word retrieval. The lexical system allows a concept to be suitably named based on specific characteristics of the target object and or action. This system determines the grammatical category of a target word. The lexical system also distinguishes the frequency of word usage, which leads to some concepts being activated more often than others. Patients with anomia tend to produce more commonly used words, signifying that their semantic system is deficient because it is over-generalizing concepts (Goodglass, 1993; Raymer & Gonzalez-Rothi, 2000; Wepman, Bock, Jones, & Van Pelt, 1956). Sometimes, semantic impairments are so severe that no response occurs, not even a semantic error. This is often the result in patients with global aphasia (Howard & Orchard-Lisle, 1984) and semantic dementia (Funnell & Hodges, 1991; Hodges, Patterson, Oxbury, & Funnell, 1992). Semantic deficits may result in varying degrees of grammatical category impairments (Davis, 2007; Goodglass et al., 2001; Raymer & Gonzalez-Rothi, 2000). For instance, an individual may experience more trouble retrieving nouns than

(Davis, 2007, p. 71)

Figure 1

Simple Semantic Memory Network

verbs (Davis, 2007). There are many studies that acknowledge as well as contradict this finding. Basso, Razzano, Faglioni, and Zanobio (1990) and Berndt, Mitchum, Haendiges, and Sandson (1997a) observed patients having more difficulty retrieving verbs or facing equal difficulty across both grammatical categories. Some studies have revealed that aphasic patients' noun and verb retrieval performance varies across written and oral modalities. Caramazza and Hillis' (1991) patient was better at retrieving verbs when asked to say the word versus writing the word. The patient also was better at saying verb and noun homonyms (i.e. to watch/the watch), but when asked to write them, she could only write the nouns correctly.

Category-specific deficits also may occur. These may involve dissociations occurring between animate (living) and inanimate (nonliving) things (Davis, 2007). Similar to nouns and verbs, there is no dominant retrieval pattern regarding the ability to name animate or inanimate items. When Hillis and Caramazza (1991) tested two aphasic patients, they found PS could name 90 percent of inanimate objects and 39 percent of animals, whereas JJ showed the reverse pattern, naming 20 percent of inanimate objects and 91 percent of animals.

There is still debate over whether or not concepts are organized on the basis of living and nonliving things (Funnell & Sheridan, 1992). Some patients have been found to show selective impairments naming objects within both animate and inanimate categories. Patient YOT in Warrington and McCarthy's (1987) study experienced selective impairments within both categories. He was able to name "large, outdoor inanimate objects," (p. 136) despite an initially overwhelming inability to name inanimate objects (Funnell & Sheridan, 1992). In addition, he had difficulty naming body parts, even though his overall ability to name living things seemed relatively intact. Warrington and Shallice (1984) explained the existence of living and nonliving dissociations and the basis of selective impairments by proposing a sensory/functional theory

(SFT). This theory denotes that semantic memory is organized into functional and visual-semantic properties of objects, with nonliving things having more functional-semantic properties and living things having more visual-semantic properties (Davis, 2007). Thus, a patient can have selective impairments within a category of living or nonliving things because a certain object may have fewer properties. A person who struggles more with naming musical instruments, animals, and plants than vehicles, furniture, and tools may have a more impaired visual-semantic system than a functional-semantic system (Caramazza & Shelton, 1998). However, Caramazza and Shelton (1998) do not support this theory. Although they purport that the underlying semantic system is not categorically organized, they propose an alternate theory, referred to as the domain-specific theory, "in which dissociations of semantic categories reflect an amodal conceptual organization of semantic memory" (p. 82). Stewart, Parkin, and Hunkin (1992) showed flaws in the SFT because even when pictures were matched in frequency, familiarity, and visual complexity, no significant category effects resulted. This observation occurred despite there seeming to be an initially more significant impairment for living than nonliving things prior to matching the variables to prevent possible influences that would confound the results. Further support has been found with the patients in Marcella, Capitani, and Caramazza's (2003) study; these individuals had dissociations and/or selective impairments despite possessing equal knowledge of functional and visual-semantic properties.

Phonological Level Deficits

Theories indicating that anomia arises from a phonological level deficit have developed because some patients are able to comprehend the names of object(s), despite their inability to name the object(s). Kay and Ellis (1987) indicated that an impaired phonological system manifests itself via (1) good performance on semantic tasks, (2) lack of naming improvement despite being given correct phonemic cues, (3) no naming improvement given phonemic miscues, (4) 'tip-of-the-tongue' responses, and (5) difficulties reading (requires phonological processing). They reported on one patient, E.S.T., who appeared to have solely phonological deficits (output). Extensive testing revealed that E.S.T. had an intact verbal semantic system, with equal retrieval abilities across all semantic categories of the 260 pictures Snodgrass and Vanderwart (1980) pictures, but an impaired phonological system because he had “no difficulty recognizing or comprehending words he could not produce successfully” (Kay & Ellis, 1987, p. 625). Kay and Ellis (1987) reported that his impaired phonological system resulted in slower word retrieval rates because the phonological activation of target words was delayed.

Despite Kay and Ellis’ (1987) assumptions on E.S.T., they suggested an alternate theory that could serve to explain the root of other anomias. They presented the notion that both an intact semantic and phonological system that results in anomia could occur because there is a “partial disconnection” (p. 626) between the two systems. This disconnection may be thought of in terms of “weak or fluctuating levels of activation between corresponding entries in the semantic system and the phonological lexicon” (Kay & Ellis, 1987, p. 626). High-frequency words naturally have higher levels of activation at rest, so they have a higher chance of being retrieved and produced (Stemberger, 1985). A disconnection will affect lower frequency words more because these words require more activation. A disconnect between the two systems may be apparent when an individual forms a phonological approximation or target-related neologism (Ellis, 1985; Miller & Ellis, 1986). Hadar, Jones, and Mate-Kole (1987) additionally suggested that a disconnection between the semantic and phonological lexical systems was evident in a patient with anomic aphasia who had both “(a) a discrepancy between impaired comprehension and good semantic performance in expressive tasks and (b) an exceptionally high level of benefits from phonemic cues" (p. 515). Thus, it is suggested that the anomia is due to an impaired semantic system, phonological system, or a disconnect between the two systems.

Alternate Theories of Lexical Access in Speech Production

Serial Model Vs. Cascade Model

Both the serial model and the cascade model propose that there are two main stages involved in lexical production: (a) selection of the word's lexical node and its syntactic features and (b) phonological encoding of the word. The two models differ on the sequence of processing. While the serial model argues that selection of a word's lexical node and its syntactic features always precedes phonological encoding of the word, the cascade model argues that "although phonological forms can only be activated after lexical nodes, the activation at the lexical level can flow onto the phonological level before lexical selection has taken place" (Morsella & Miozzo, 2002, p. 555). Thus, cascade models permit lower-level phonological information to affect higher-level lexical processing. This can cause several word forms (phonological) to be activated at once. This is supported by work from Caramazza (1997) and others (Dell, 1986; Harley, 1993; Humphreys, Riddoch & Quinlan, 1988; MacKay, 1987; Stemberger, 1985). Another major difference between the two models is on the issue of phonological activation of the word. While the cascade model presupposes that unselected lexical nodes activate phonological encoding, serial models assume that only selected nodes can activate phonological encoding (Morsella & Miozzo, 2002). Presently, there is evidence that supports both types of models.

The occurrence of phonological, semantic, and mixed speech errors have been shown to support the cascade model. When speech errors are committed, the word may be semantically or phonologically related to the target or intended word. A semantic speech error would include saying “dog” instead of “cat.” A phonological speech error would include saying “cas” instead of “cat.” Mixed errors also can occur. They consist of the production of a word that is both semantically and phonologically related to the target, intended word. For example, an individual may say “rat” instead of “cat” (Morsella & Miozzo, 2002). These mixed errors, according to serial model accounts, have an equal chance of occurring because the serial model advocates that phonologically related errors are “purely incidental,” (Morsella & Miozzo, 2002, p. 556). Dell (1986) and Stemberger (1985) argued that this is not the case. They found that mixed errors occur more frequently than semantic errors alone. Thus, these findings support the cascade model because it proves that phonological activation of an unselected lexical node could occur during word retrieval (Dell, 1986; Stemberger, 1985). More specifically, these mixed errors demonstrate that the phonological activation of a word semantically related to the target word can precede lexical node activation. Another word “pig” which is semantically related to the word “cat” could be activated at the phonological level, but the activation would not be as strong as the word “rat” because it is not as phonologically similar to the target word “cat” (Morsella & Miozzo, 2002).

Levelt, Roelofs, and Meyer (1999) dismissed mixed errors as evidence against the serial model’s existence by reporting that mixed errors occur during post-encoding or speech production editing. When the editor scans for errors, the most semantically and phonologically related words are often overlooked because their high degree of similarity makes them less likely to be counted as errors. Morsella and Miozzo (2002) found support for the cascade model when they concluded that English speakers had an easier time naming a target word (i.e. bed) from a picture paired with a phonologically related picture (i.e. bell), rather than two unrelated pictures (i.e. bed and pin). This ‘facilitation effect’ supports the cascade model because it shows that phonological encoding can occur before lexical node selection. After conducting priming experiments, Pechman and Havinga (1991) found no evidence of activation of competing lemmas, but Peterson and Savoy (1997) found that synonyms simultaneously activate forms.

Researchers have conducted reaction-time experiments to shed more light on the speech production process and its support for the serial or cascade model. Starreveld and La Heij (1995) instructed participants to name a picture and ignore a written word distractor that was shown along with the picture. It was already known that distracters would disrupt picture-naming, but Dyer (1973) and MacLeod (1991) discovered that the relationship between a picture and the word affects the length of picture naming time. Along with an unrelated picture-word pair to obtain the baseline reaction-time measurement (e.g. cat-tree), semantically related pairs (e.g. cat-dog) and phonologically similar pairs (e.g. cat-mat) were used in this experiment to obtain two other reaction time measurements. The results revealed that the semantically related pairs had larger interference effects than the baseline measurement, while phonologically related pairs had significantly reduced interference effects. If these two phenomena abided by the serial model, reasoned Starreveld and La Heij (1995), "a distractor that is both semantically and phonologically related to the target should be additive- that is, no evidence of statistical interaction should be found" (Morsella & Miozzo, 2002, p. 556). On the contrary, Starreveld and La Heij (1995) observed a statistical interaction.

Thus, the above findings provide additional support for the cascade model over the serial model. However, like the speech errors case mentioned previously, other researchers have provided support for the serial model. Contrary to the cascade model, Roelofs, Meyer, and Levelt (1996) pointed out that semantically and phonologically related distracters can conform to the serial model according to certain interpretations assigned to the phonological effects formed from written-word distracters. Overall, Roelofs et al. (1996) designated written words as illegitimate stimuli as a method of deciding between the serial or cascade models of lexical access.

Costa, Caramazza, and Sebastian-Galles (2000) conducted a study involving bilingual individuals that led to supportive evidence of a cascade model of word retrieval. They found that proficient bilingual individuals named cognate pictures faster (*gat-gato 'cat'*) than non-cognate pictures (*taula-mesa 'table'*) in Catalan and Spanish. These observations support the cascade model because cognates are phonologically similar words. Non-cognates sound different. The faster retrieval speed indicates that it is very likely that the common phonemes of both words led to higher activation levels, which explains the faster response times (Costa et al., 2000). The researchers admitted that this finding could fit the serial model if the faster response times could be explained by a frequency effect. In other words, the cognates may occur because the phoneme combinations (i.e. /ga/) could frequently occur in both Catalan and Spanish. If that were the case, then the frequency effect of phonemes would justify the faster response latencies, rather than higher phonological activation effects on the lexical node (i.e. support for cascade model). Both Costa et al. (2000) and Levelt et al. (1999) have not reported on any data showing that the "frequency of phoneme combination affects naming latencies" (Morsella & Miozzo, 2000, p. 557).

Issues and Factors that Affect Word Retrieval in Aphasia

Word retrieval in aphasic individuals has been found to be affected by many factors including the type of task used to assess retrieval, operativity, imageability, visual complexity, lexical category and word length of the word, in addition to familiarity with the word.

Numerous researchers have found that type of task affects the accuracy and rate of word retrieval. Zingeser and Berndt (1988) found that aphasic patients were able to retrieve more nouns in a sentence production task than in a simpler picture naming task. and Breen and Warrington (1994), Manning and Warrington (1996), and Wilshire and McCarthy (2002) also found a discrepancy between scores on a picture naming task and scores on word retrieval in a connected speech context. Manning and Warrington (1996) found that an aphasic patient could name pictures with 89% accuracy, but the aphasic patient only achieved 34% accuracy on a spoken naming to written sentence completion task involving the same nouns. Mayer and Murray (2003) and Pashek and Tompkins (2002) both observed that aphasic participants scored higher on conversational and narrative tasks than picture-naming tasks, both of which assessed word retrieval abilities. It is important to note that confounding variables and not just the speech task need to be considered to make an accurate assessment of the score discrepancy. Both the amount of language processing required to complete each task and the amount of context in a task are two such confounding variables that could explain score discrepancies.

Brookshire (1972) confirmed that presenting easier-to-name items prior to difficult-to-name items also affected the rate and accuracy of word retrieval. Specifically, he found that aphasic patient's naming abilities improved if they were initially presented with easier-to-name items, but their naming abilities deteriorated if they were presented with difficult-to-name items first. Their task performance deteriorated in the latter case as a result of suspected emotional reactions generated from the failure to name the difficult items. This task-related phenomenon is important to consider for any type of aphasic rehabilitation and not just for specific tasks.

Operativity is a variable that describes how often a named object can be manipulated or used in everyday situations (Feyereisen, Van der Borght, & Seron, 1988). Gardner (1973) also defined it as "the extent to which it is possible to act with or upon an object" (Feyereisen et al., 1988, p. 401). For example, scissors, pencils, and books are more operative than clouds, walls, and lungs. Gardner (1974, 1973) showed that aphasic patients had an easier time naming objects that were classified as more operative. However, after Feyereisen et al. (1988) replicated his study, he and his team concluded that AoA and picture familiarity were better predictors of aphasic patients' word naming abilities than operativity.

Imageability has been another variable examined relative to its effect on word retrieval. Words that evoke numerous mental images (i.e. sensory experiences, sounds, pictures) have high imageability (Cortese & Fugett, 2004). Marcel and Patterson (1978) and Richardson (1975) concluded that imageability ratings are semantic in nature. Cortese and Fugett (2004) established imageability norms for 3,000 monosyllabic words by asking thirty-one undergraduates to rate words according to their imageability. Nickels (2005) and Nickels and Howard (1994) found that imageability ratings were related to the occurrence of semantic naming errors, but not phonological naming errors in word retrieval skills of aphasic adults. According to their results, a partially impaired semantic system may lead to more naming errors for pictures with low imageability ratings because the semantic system is internally and externally inefficient at lexeme retrieval. Aphasic patients have been found to show higher accuracy when naming pictures with higher imageability ratings after the confounding effects of other variables were controlled (Nickels & Howard, 1995). Goodglass, Hyde, and Blumstein (1969), Howard (1985), Nickels (1995), Nickels and Howard (1994), and Franklin (1989) showed that aphasic patients have an easier time naming concrete versus abstract words in naming tasks. Strain, Patterson, and Seidenberg (1995) found that high imageability words were retrieved more accurately and faster than low-imageability words.

Visual complexity is another factor that should be addressed when examining word retrieval and naming latencies in aphasia. The visual complexity of a picture may be determined by the amount of detail and intricacy of line in the picture (Snodgrass & Vanderwart, 1980). Snodgrass and Vanderwart (1980) determined that a positive correlation exists between the visual complexity of a picture and its corresponding naming latency. More specifically, the greater the visual complexity of a picture, the longer amount of time it takes to name the picture because it may take longer to identify it, which subsequently slows down the word retrieval process.

Another variable affecting word retrieval ability in aphasia is the lexical category of the word. Unequal retrieval ability across lexical categories has been observed for most aphasic adults. Some aphasic adults can easily retrieve color words, body parts, clothing, and large man-made objects in the room, but their retrieval capacities are limited to those categories (Goodglass, Wingfield, Hyde, & Theurkauf, 1986). In particular, fluent aphasic adults have been found to show relatively intact abilities when naming colors and body parts. Other aphasic individuals have been found to show no signs of anomia except an inability to name vegetables and fruit (Hart, Berndt, & Caramazza, 1985). Warrington and McCarthy's (1983) patient was unable to select pictures of common household objects after their names were spoken; however, she could accurately identify foods, animals, and flowers.

As previously mentioned, verb and noun retrieval difficulties vary among aphasic individuals. Jonkers and Bastiannse (1998) observed aphasic patients who consistently produced nouns better than verbs. In contrast, Berndt, Haendiges, Mitcum, and Sandson's (1997a) patients produced verbs better than nouns. Goldberg and Goldfarb (2005) found that individuals with posterior lesions and subsequent fluent aphasias had greater difficulty with noun naming. Adults with anterior lesions and agrammatic aphasia showed greater difficulty naming verbs. Berndt, et al. (1997a) found that aphasic adults who omit nouns appear to have a more severe word-finding disorder than those who omit verbs. Kohn, Lorch, and Pearson (1989) observed that Broca's aphasic patients with agrammatism typically struggled more with verb retrieval. Similar findings have been reported by Goodglass (1993), Williams and Canter (1987), and Zingeser and Berndt (1990).

Kohn and Miceli (1989) indicated that verbs are harder to retrieve because their presence of morphological marking makes them syntactically more complex than nouns. However, Bates and Chen (1991) provided contradictory evidence, revealing that Chinese agrammatic aphasic patients also were worse at verb retrieval, even though Chinese verbs lack morphological markings. After exploring the role of semantic complexity in verb-retrieval deficits of eight patients with aphasia, Breedin, Saffran, and Schwartz (1998) found no significant difference between action naming and object naming. However, they observed that six of eight aphasic patients struggled more with "light" (auxiliaries) verbs than "heavy" verbs (e.g. walk, eat, sleep).

In Bastiannse's (2008) study of Dutch-speaking aphasic adults and Thompson's (1997) study of English-speaking adults with aphasia, it was found that individuals with Broca's aphasia had more difficulty with verb retrieval during expressive than receptive tasks. Relative to reception, there was no significant difference between verb and noun retrieval. These findings imply that expressive and receptive word retrieval tasks may operate on two different semantic systems. Unlike findings with agrammatic Broca's aphasic adults, adults with purely anomic aphasia have been observed to perform better at naming action pictures with verbs than naming objects with nouns (Goodglass, 1993; Zingeser & Berndt, 1990).

Relative to noun word retrieval difficulties, Bird, Howard and Franklin (2000) proposed that an aphasic person who is more impaired in producing nouns than verbs may have more difficulty naming animate objects than inanimate objects. This may occur because, like nouns animate objects have a high proportion of sensory features (i.e. SFT). These features appear to aid in word retrieval. However, as mentioned previously, alternate theories have been proposed including Caramazza and Shelton's (1998) domain-specific impairment theory. A recent study by Bi, Han, Shu, and Caramazza (2007) revealed contradictory findings, presenting an aphasic patient who struggled more with noun than verb retrieval, but experienced more difficulty retrieving inanimate objects rather than the expected animate objects.

Research has shown that some populations have different degrees of difficulty accessing content versus function words. Examples of content words include nouns, uninflected verbs, adverbs, and adjectives. Content words exist in open classes. Open classes allow novel content words can be easily added to the lexicon. In contrast, function words exist in closed classes, meaning languages do not easily add novel function words to the lexicon, thus a more limited set of words. Examples include pronouns, articles, auxiliary verbs, determiners, quantifiers, conjunctions, prepositions, and grammatical morphemes. Non-brain impaired populations have an easier time accessing function words than content words (Segalowitz & Lane, 2000). In contrast, nonfluent aphasic adults with agrammatism often omit grammatical morphemes, a type of function word. However, most other adults with aphasia struggle with retrieving content words (Davis, 2007) due to individual differences in word familiarity and word predictability.

Word length is another variable that may affect word retrieval, ultimately affecting naming speed. Word length refers to the orthographic length of words. Frederiksen and Kroll (1976) found a positive correlation between the length of the word and its corresponding word-naming latency. Balota, et al. (2004) also showed that shorter words are faster to retrieve and name than longer words. Several studies have confirmed that aphasic patients were less accurate when required to name longer words (Caplan, 1987; Ellis, Miller, & Sin, 1983; Goodglass, Kaplan, Weintraub, & Ackerman, 1976). In contrast, Weekes (1997) concluded that word length affected non-word naming performance, but not real word-naming performance. He indicated that Frederiksen and Kroll (1976) might have found similar results if they controlled for more variables (i.e. orthographic neighborhood size, number of friends, and average grapheme frequency). Coltheart, Rastle, Perry, Langdon, and Ziegler (2001) explained that Weeke's results support a dual-route model of naming. This model essentially indicates that non-word naming takes a sublexical pathway, whereas real word naming takes a more parallel pathway.

Some words also are more rapidly retrieved because the word is usually more familiar to a person. Generally stated, something highly familiar is frequently encountered or seen. Familiarity of a word can develop as the result of several factors. Familiarity is affected by the age of acquisition of the word (AoA), the frequency of the word in the individual's language, and the frequency the individual has personally used and encountered the word (i.e. subjective familiarity) (Davis, 2007; Krackenfels Jones, et al., 2007; Nickels & Howard, 1995; Noble, 1953).

Word frequency refers to the number of times a word appears in a language. Before the advent of the computer, the frequency of each word was generated from the analysis of a few textbooks. Research on the effect of word frequency on naming has revealed that faster naming times are associated with higher word frequency (Oldfield & Wingfield, 1965). Many studies support this phenomenon (Forster & Chambers, 1973; Goodglass, et al., 1969; Howard, Patterson, Franklin, Orchard-Lisle, & Morton, 1985; Humphreys, et al., 1988; Monsell, Doyle, & Haggard, 1989; Oldfield & Wingfield, 1965). This implies that there is a direct relationship between picture-naming accuracy and word frequency. Current research findings on typical adults (Dell, 1990; Laubstein, 1999; Vitevitch, 1997) and aphasic individuals (Gagnon, Schwartz, Martin, Dell, & Saffran, 1997; Gordon, 2002; Schwartz, Wilshire, Gagnon, & Polansky, 2004) have revealed that word frequency solely affects the phonological retrieval of the word and not both the lexeme and phonological retrieval of the word. These conclusions are based on the findings that "high and low-frequency homophones were equally prone to experimentally elicit phonological errors and low-frequency words were more likely than high-frequency words to elicit errors that were phonologically related to the target in both normal and aphasic adults" (Kittredge et al., 2008, p. 464). In contrast, Caramazza, Costa, Miozzo, and Bi (2001) and Jescheniak, Meyer, and Levelt (2003) failed to conclude such findings for homophones. Thus, sole frequency effect on phonological retrieval is suspect. Other researchers have found frequency effects on lexeme retrieval for both studies involving normal and aphasic adults. In a study of naming involving 15 aphasic adults, Nickels and Howard (1994) found that 2 aphasic adults made more semantic errors on low-frequency and low-imageability target words. However, the majority of the adults failed to show any frequency effects during the production of semantic errors, which contradicts what would be normally expected in spoken language production.

The AoA of a word refers to the age at which a word is acquired. AoA of words is typically determined by asking a large pool of participants to rate when he/she thinks he/she acquired a word according to a pre-determined rating scale. Some AoA devised rating scales have been found to be valid (Gilhooly & Gilhooly, 1980; Jorm, 1991; Walley & Metsala, 1990, 1992) and reliable (Gilhooly & Watson, 1981). In a study conducted by Morrison et al. (1995, 1992) that reanalyzed some of Oldfield and Wingfield's (1965) data, she and her colleagues failed to find a relationship between word frequency and naming time; however, they did find that AoA appears to predict picture and word-naming speed. Rochford and Williams (1962) also found that objects that aphasic individuals could name correctly were directly correlated to names that were correctly produced by 80% of the children that participated in their study. When Hirsch and Ellis (1994) examined a single aphasic patient, NP, they found that AoA, rather than word frequency affected speech production, with earlier acquired words associated with faster retrieval times. However, AoA is not always more influential on naming abilities than word frequency. EP, who had semantic disturbance, performed better on naming tasks involving more familiar words. In contrast, Hirsh and Funnell (1995) determined that one aphasic patient who showed no semantic disturbance was able to name pictures faster according to words that were earlier acquired (AoA) vs. words that were more familiar. Thus, Hirsh and Funnell (1995) proposed that AoA affects access to lexical phonological representations, rather than semantic representations. Hence, aphasic patients who struggle more with lexical-phonological processing may name words acquired at an earlier age faster than words that are more familiar to them via word frequency or subjective familiarity. Their study (1995) and others (Brown & Watson, 1987; Gilhooly & Watson, 1981; Hirsh & Ellis, 1994; Morrison & Ellis, 1992) support this proposal.

Subjective familiarity, sometimes referred to as experiential familiarity, is another important variable to consider when assessing a person's familiarity with a word. Subjective familiarity differs from word frequency. Word frequency measurements define how often a word appears in written text. Snodgrass and Vanderwart (1980) defined subjective familiarity as "the degree to which one has come in contact with or thought about a concept" (p. 183). There are many different rating scales that been developed and used to assess subjective familiarity. Snodgrass and Vanderwart (1980) inform each patient to rate items according to "how unusual or unusual the object is in your realm of experience" (p. 183). It is the most personal and individualized familiarity measure and can reflect the individual's performance across many modalities, including, but not limited to spoken and written language and drawing (Funnell & Sheridan, 1992). Gilhooly and Logie (1977) used a scale and had participants rate pictures according to how often they saw, heard, or used a word. These participants rated the pictures based on a 1-7 scale, with 7- 'seen, heard, or used everyday' and 1- 'never seen, heard, or used.' Noble (1953) assessed participant's subjective familiarity of words by asking them to assign a NEVER, RARELY, SOMETIMES, OFTEN, or VERY OFTEN to stimuli in order to describe how often he/she has seen or heard or used a word. In order to establish subjective familiarity norms on 260 pictures, Snodgrass and Vanderwart (1980) asked participants to rate their familiarity with each picture on a 5-point rating scale, with 5 indicating 'very familiar' and 1 indicating 'very unfamiliar.'

Treatment Approaches

The struggle to retrieve words is aided by several treatments including Phonological Components Analysis (PCA) and Semantic Feature Analysis (SFA). Individuals who undergo PCA are instructed to point to a word that rhymes with, shares the first sound with, shares the first sound associate with, shares the final sound with, and shares the number of syllables with the target word. The individuals who undergo SFA are instructed to name the superordinate category, use or function of the target, association, coordinate member of the same category as the target word/picture, location (where one might find the target) and physical properties of the target word. Overall, both approaches help a patient retrieve a target word by requiring the patient to form cues that describe the target word. The motive behind these cue formations is that one or more will eventually lead to the production of the desired output, the target word. The long-term goal of both treatments is to teach an approach the individual can use independently to assist with the accuracy and rate of his/her word retrieval.

Semantically-Based Treatment Protocols

In broad terms, treatments associated with semantics are “meaning-based treatments” (Leonard, Rochon, & Laird, 2008, p. 924). The primary purpose of semantically-based treatment approaches is to help a patient activate concepts associated with words (Davis, 2007). Activating concepts targets work on the semantic level. A unique aspect of this type of therapy is that it does not force patients to produce the target word in therapy. Rather, they can activate concepts engaging the patient in a picture-word matching technique (Davis, 2007; Goodglass, 1993). Working on activating concepts emphasizes the semantic, rather than the lexical system.

Another semantic treatment is known as Semantic Feature Analysis (SFA). Originating from the theory of spreading activation (Collins & Loftus, 1975; Dell, 1986), the focus of this approach is to help the patient produce words that are semantically associated to a target word (Boyle, 2004; Boyle & Coelho, 1995; Coelho, McHugh & Boyle, 2000; Massaro & Tompkins, 1994). A picture is placed at the center of a feature analysis chart. The stimuli may originate from Snodgrass and Vanderwart’s 260 black-and-white (1980), the more recent color line drawings (Rossion & Pourtois, 2004), or can involve any other picture stimuli. Multiple types of conceptual associations/features surround the object. The feature categories may include, but are not limited to: superordinate category, use or function of the target, association, coordinate member of the same category as the target word/picture, location (where one might find the target) and physical properties. An SFA clinician may first ask the patient questions to cue the feature words and then use a sentence completion format. Other cuing protocols have been used with SFA. The clinician records the patient’s responses on the chart for the patient to see. Initially, the burden of cueing is mainly the clinician’s responsibility. However, one of the primary goals of this treatment is to teach patients to independently use feature analysis strategies so he/she can cue themselves to retrieve words.

Phonologically-Based Treatment Approaches

Phonological-based treatment approaches are “word-form based treatments” (Leonard, Rochon, & Laird, 2008, p. 924). According to Davis (2007), phonological treatments rely on lexical cueing. Unlike semantic treatments that focus on the meaning and function of words, phonological treatments focus on the sounds or form of the words. Miceli, Amitrano, Capasso, and Caramazza (1996) presented a treatment protocol that stressed continual drills of the words’ pronunciations through repeating, reading, and picture-naming activities. Additional treatments have involved tasks that require judgment of the initial phonemes and the number of syllables of words in an effort to develop the patient’s phonological awareness (Laine & Martin, 1996; Robson, Marshall, Pring & Chiat, 1998).

Phonological Components Analysis (PCA), also known as Phonological Feature Analysis (PFA) is another treatment protocol that attempts to improve word retrieval skills through methods of cueing the patient. It was originally developed for individuals with traumatic brain injury, but it is also has been used to treat individuals with aphasia (Massaro & Tompkins, 1992; Leonard, Rochon, & Laird, 2008). It is modeled off of the Semantic Feature Analysis treatment approach (Boyle & Coehlo, 1995). As explained by Leonard, et al., 2008), it was developed after SFA because the results of that approach were encouraging and the SFA offers the “principle of choice,” which some (Hickin, Best, Herbert, Howard, & Osborne, 2002) have described as being an important contributor of “producing longer-lasting effects of treatment” (p. 923). In PFA, the patient is asked to name a picture in the center of a chart that helps to cue the target word. Even if the patient is able to name the word, the clinician still asks the patient to identify five phonological components related to the target word including a word that the target rhymes with, first sound, first sound associate, final sound, and the number of syllables. If he/she still cannot spontaneously respond after providing the five phonological components, he/she is asked to select a word from a list (Coelho, McHugh, & Boyle, 2000). Another phoneme-based treatment by Kendall, Rosenbek, Heilman, et al. (2008), involves training participants to form concepts of individual phonemes with the use of visual, proprioceptive, and verbal feedback of the unique articulatory features of each phoneme. Furthermore, this approach trains participants to phonographically and orthographically arrange knowledge through the ability to recognize, distinguish, and manipulate single and multisyllabic words and nonwords composed of previously trained/familiar phonemes.

Research reports have indicated that PCA (a.k.a. PFA) has had a successful impact treating anomia in individuals with aphasia (Best, Herbert, Hickin, Osborne, & Howard, 2002; Boyle, 2004; Boyle & Coehlo, 1995; Conley & Coelho, 2003; Hicken et al., 2002; Wambaugh et al., 2004 & Wambaugh, 2003). In Leonard, et al. (2008), 7 out of 10 of aphasic participants improved their ability to name treated items, with treatment effects maintained at 1 month post follow-up. Using PCA, Rochon, et al. (2006) observed an improvement in naming accuracy from 73% to 96% after treatment for four out of seven participants. Kendall et al. (2008) observed successful results using PFA. After 96 hours of training over a 12 week period for 10 participants, followed by a single-subject, repeated probe design with replication, and a 3 month follow-up of the 10 participants, the positive factors of confrontation naming, improvements in non-word repetition, phonologic production, and generalization to discourse production were found to occur. Additionally, 8 participants who were tested three months post therapy exhibited a mean gain of 9.5 points on the Boston Naming Test and 5.12 points on the Controlled Oral

Word Association Test (Kendall et al., 2008).

Howard, Patterson, Franklin, Orchard-Lisle, and Morton (1985) determined that semantic and phonologically-based treatments were equally effective at facilitating word retrieval in individuals with aphasia, but their ability to generalize outside of therapy was limited. Nickels (2002) concluded similar findings. In several SFA treatment studies, participants have improved naming untreated items (Boyle & Coehlo, 2004; Boyle & Coelho, 1995). Howard (2000) and others argued that no generalization to untreated items should occur for PCA because mapping from semantics to phonology is word-specific, rather than interconnected as words are in the semantic system (Miceli et al., 1996). Three of seven participant's in Leonard, Carol, Rochon, et al.'s (2008) study who displayed generalization to non-PCA treated stimuli suggested that the phonological system could be organized in a format more akin to the semantic system that allows for activation within the lexicon to stimulate further activation of other entries, otherwise known as the interactive activation model (e.g., Foygel & Dell, 2000). Drew and Thompson (1999) reported positive results from the application of a combined treatment versus just semantic treatment alone for individuals with aphasia. In Wambaugh et al. (2001) study, one participant who demonstrated primarily a phonologic naming impairment, responded better to a treatment targeting the semantic level of processing, as opposed to a treatment targeting the phonologic level of processing. Hillis (2001) completed an extensive literature review on naming treatment results, which led to Nickel's (2002) indicating that, "we still cannot predict which therapy will work with which impairment" (p. 959).

Summary and Rationale

Aphasia affects both an individual's receptive and expressive language abilities. Thus, individuals may have trouble speaking, writing, gesturing, reading, listening to information, as well as recognizing pictures and objects. Almost all aphasic individuals will suffer from the symptom of anomia or the inability to retrieve words.

There are many models that attempt to explain how words are retrieved. The exact process of word retrieval is still yet to be defined, which is why numerous theories exist and continue to be proposed. These theories are important relative to uncovering the nature of word retrieval deficits because, while all aphasic adults are united by the symptom of anomia, some individuals may be more impaired at particular stages of the word retrieval process. Different models attempt to explain what causes semantic level deficits, phonological deficits, and overall lexical level deficits.

If the semantic word retrieval level is impaired, but the phonemic level is intact, the individual may perform poorly on semantic tasks such as providing the name of a picture or a description, naming categories, listing items in categories, or telling the use or function of an object. However, the individual will be greatly aided by phonemic cueing. Semantic level theorists reason that semantic memory or their organization of concepts is negatively impacted, which leads to semantic level deficits. Impairments at the semantic system also translate to impairments at the lexical level because the lexical level is included within the semantic system. The lexical level determines the frequency and grammatical category of a word. Thus, aphasic individuals often produce more commonly used words, suggesting that they over-generalize concepts. They also may have unequal abilities retrieving nouns versus verbs.

Serial and cascade models have both been proposed to attempt to more thoroughly explain the way words are selected at the lexical level. Both models propose that the selection of a word's lexical node and its syntactic features, and its phonological encoding, are two major stages of lexical production. There is a multitude of scientific evidence to support both models. Specifically, the serial model argues that phonological encoding always must occur after the selection of a word's lexical node and its syntactic features. In contrast, the cascade model, while in agreement relative to word activation following lexical node selection, it additionally proposes that a word can be activated phonologically before lexical selection has taken place.

There are many variables that may affect word retrieval in aphasia. These include the type of task used to assess retrieval, as well as factors such as operativity, imageability, visual complexity, lexical category, word length, in addition to familiarity with the word. The task may involve providing a name of a picture, providing a name to a description or completing a sentence. Operativity describes how often a named object can be manipulated or used in everyday situations. While aphasic patients have been found to have an easier time naming objects with higher operativity, word familiarity has been found to be a better predictor of naming abilities. Imageability addresses the amount of sensory experiences, sounds, and pictures a word evokes. Aphasic individuals have been found to be more effective at naming pictures with higher imageability overall and are better at retrieving concrete versus abstract words. Visual complexity indicates the degree of detail and intricacy of line in a picture. High visual complexity has been found to increase the time it takes to identify a picture. The lexical category of a word also has been found to affect retrieval, with aphasic individuals naming certain lexical categories better than others.

As mentioned, word familiarity describes how frequently something is encountered or seen. This can be affected by the age of acquisition (AoA) of a word, frequency of a word in the individual’s language, and the frequency with which the individual has personally used and encountered the word. Research has revealed that pictures containing more highly familiar words are named faster than pictures associated with less familiar words. However, it remains unclear how familiarity enhances accuracy and speed of naming for normal or aphasic adults. No research to date has examined how an aphasic individual’s subjective familiarity correlates with their overall naming abilities, or the accuracy with which caregivers detect their aphasic partner’s familiarity with particular words.

Anomia in aphasia has been observed to be greatly aided by treatments such as both Semantic Feature Analysis (SFA) and Phonological Components Analysis (PCA). While SFA relies on activating concepts associated with words, PCA emphasizes lexical cueing that focuses on sounds or forms of words. Both PCA and SFA follow similar procedures because PCA modeled itself after the successful SFA approach. Both treatment approaches also are aimed at teaching aphasic individuals to independently cue themselves to increase their own accuracy and rate of word retrieval. To date, neither treatment has been shown to be generally more effective than the other due to overwhelming evidence that supports both approaches. It has been advocated that those with more semantic-based weakness would be more effectively aided by phonemic, rather than semantic-based cueing methods. However, it is unknown how variables such as word familiarity affect improvement in retrieval skills via either or both treatments.

Research is extremely limited relative to investigations that examine how familiarity of stimuli affects an aphasic individual’s word retrieval skills. Current word retrieval treatments often do not manipulate the familiarity of the stimuli in the study. As familiarity is a variable that affects word retrieval in aphasia, it is imperative to examine how this factor impacts improvement in treatment itself. Furthermore, it is unclear how word familiarity affects word retrieval skills relative to specific treatments such as PCA and SFA, regardless of the basis of the individual's retrieval deficit.

Plan of Study and Experimental Questions

The purpose of the current investigation was to examine the effect of subjective familiarity on an aphasic individual's word retrieval ability and their ability to improve in short, intensive treatment. Four aphasic adults participated. Familiarity in this study was defined as the degree to which a person has come in contact with certain words across any context (auditory, visual). Stimuli were identified as familiar or unfamiliar based on ratings by the participant. Retrieval of the familiar and unfamiliar noun stimuli were addressed by participants receiving crossover treatments of Phonological Components Analysis and Semantic Feature Analysis. Thus, stimulus familiarity and treatment condition will be the independent variables in the investigation. The following experimental questions will be addressed:

1.) Is there an effect of familiarity overall and/or a familiarity effect for a particular treatment type per participant?

2.) Is there an overall treatment effect and/or a treatment effect for a particular treatment type per participant?

3.) Is there an overall generalization effect and/or a generalization effect per treatment type per participant?

4.) Are differences in the *Test of Adolescent/Adult Word Finding* overall raw score over time reflective of changes in treatment performance for each participant?

5.) Are differences on the *Western Aphasia Battery-Revised* Aphasia Quotient over time reflective of changes in treatment performance for each participant?

CHAPTER II.

METHOD

Participants

Four aphasic adults participated in this study. All of the participants were native English speakers, exclusively right-handed, with aphasia being the result of left-hemisphere brain-damage. They all earned at least a high school diploma. All of the participants were at least three months post-onset cerebro-vascular accident (CVA), in order to limit the effects of spontaneous recovery on language. A questionnaire (Refer to Appendix A) requesting the duration and extent of relationship between participant and caregiver (has to be at least 1 year), information on the date of birth, highest education level, profession, gender, race, date of stroke, and treatment history of each participant was completed by the participant and/or caregiver prior to pre-experimental testing. Demographic information on the four participants is in Table 1.

Pre-experimental Testing

All participants underwent a modified hearing screening for older adults at 1000, 2000, and 4000Hz (speech frequencies) at 40dB HL since they were all over the age of 50. If a participant was under the age of 50 at time of testing, he/she would have been administered a routine hearing screening at 25dB HL throughout the speech frequencies. A failed screening would have resulted if the participant did not respond to any one frequency in either ear (Ventry & Weinstein, 1983; 1992), but this was not the case.

All participants passed the screening. All participants were administered the *Test of Adolescent/Adult Word Finding (TAWF)* (German, 1990) (Kertesz, 2007) prior to testing since it was not administered to them within the prior 2 months. JD and RM were additionally administered portions of the *Western Aphasia Battery-Revised (WAB-R)* prior to testing since it

Table 1

Participant Demographic Information

Participant	**Age**	**Gender**	**Years Education**	**Months post-stroke**	**Aphasia Type**
IC	63	Male	17	198	Broca’s
JD	54	Male	13	56	Broca’s
RR	58	Male	20	54	Conduction
RM	64	Female	17	84	Anomic

was not administered to them within the prior 2 months. The WAB-R was administered in order to assess the severity of aphasia. The test provides an Aphasia Quotient (AQ), which determines the type and severity of aphasia, a Language Quotient (LQ), which describes oral and written language functions, and a Cortical Quotient (CQ), which is a score based on the entire test and provides a measure of overall cognitive functioning, verbal and nonverbal deficits, as well as apraxia. The oral/verbal sections of the WAB-R assess spontaneous speech, auditory comprehension, repetition, naming, and word-finding. The nonverbal sections of the test assesses evidence of constructional apraxia, reading, writing, visuospatial and calculation abilities. Only the subtests used to calculate the AQ were administered during each WAB-R testing session in this study. These subtests assessed and simultaneously were named the following: Spontaneous Speech, Auditory Verbal Comprehension, Repetition, and Naming and Word Finding.

The TAWF assesses the nature and degree of expressive word retrieval abilities across various tasks. The tasks include: picture naming nouns, sentence completion, description naming, picture naming verbs, and category naming. Following the administration of the expressive sections of the test, a comprehension subtest was presented to ensure that word retrieval errors on the test are not the result of unfamiliarity with the test stimuli. Use of the comprehension subtest results in a ‘prorated’ set of scores that indicate performance in comparison to other adults in the individual’s age range. Extra verbalizations and gestures during the test also were scored. Latency time is additionally calculated for picture-naming nouns to classify the person as a fast or slow namer. Lastly, the word retrieval error substitution types (i.e. coordinate, circumlocution, initial sound, no response, etc.) are described to determine additional information regarding the participant’s naming abilities.

In order to be eligible for inclusion in the current investigation, the following criteria had to be met: passing the hearing screening and demonstrating an understanding of the concept of familiarity based on the ability to rate pictures using at least one of two familiarity scales. All participants met this criteria.

Experimental Task Stimuli Development

Familiarity Training

As one of the major goals of the investigation was to examine the influence of familiarity on word retrieval, all participants had to understand the concept of familiarity and demonstrate this by their ability to consistently rate their own familiarity with nouns. This was assessed using one of two rating scales: a caregiver-devised familiarity rating scale (adapted from Gilhooly & Hay, 1977; Noble, 1953*)* or a more participant-friendly scale (additionally based on *ASHA FACS*- Frattali, et al., 1995 and *QCL*- Paul et al., 2003). If the patient was unable to abide by the format of the caregiver-devised rating scale, then he/she was required to follow the more participant-friendly rating scale after demonstrating that he/she could rate noun pictures reliably with the use of this scale. The rating scales are discussed in depth in the stimuli development section of this methodology.

During the assessment of the participant's ability to rate pictures based on their familiarity, the clinician showed the participant a picture of a nonsense word depicted by a scribble as well as pictures of real words (abacus, lamb, cheese, soldier). The participant was required to choose which picture was the 'most familiar' from a pair of nouns (scribble picture + lamb picture). Then, the participant had to simultaneously look at the same pair of nouns along with three other words and rate them based on the caregiver or participant-friendly rating scale. The last task required the participant to rate the familiarity of the same five pictures one-at-a-time based on either the caregiver or more participant-friendly scale. Then, the participant repeated the same procedure to demonstrate reliability of their own ratings. Thus, the participant participated in the study if they were able to demonstrate that they understood how to rate items based on their familiarity with the items. If their ratings were found to be contradictory (i.e. a stimuli was marked as highly familiar and unfamiliar), then they were excluded as participants in this study.

Familiarity Rating

The experimental task stimuli and corresponding pictures utilized for this study originated from Rossion and Pourtois (2001), which is a colored adaptation of Snodgrass and Vanderwart's (1980) 260 black-and-white line drawings. These stimuli were used in the current study because they have been standardized for name agreement, image agreement, familiarity, and visual complexity. Stimuli were selected based on the individual's degree of familiarity with each word. A caregiver of the individual with aphasia rated how familiar they thought their significant other was with the 260 picture stimuli prior to their onset of aphasia. All caregivers preferred to rate the pictures using the participant-friendly rating scale (Appendix B), rather than the caregiver-devised familiarity rating scale (Appendix C).

All participants preferred to rate how familiar they were with the 260 stimuli using the more participant-friendly rating scale (adapted from Frattali, et al., 1995 (*ASHA FACS*); Gilhooly & Hay, 1977; Noble, 1953; Paul et al., 2003 (*QCL*)). For this particular scale, the degree of familiarity corresponded to the number of faces, the color of the faces, and the expression on the faces. A larger quantity of faces equated to a more extreme rating of familiarity or unfamiliarity. In general, sad faces represented a lack of familiarity, while happy faces represented some degree of familiarity with the particular noun picture. Both the 'NEVER' and VERY OFTEN' ratings had four faces. The sad faces were red, while the happy faces were black. All of the sad faces: ☹ applied to NEVER and RARELY ratings, while all of the happy faces: ☺ applied to OFTEN and VERY OFTEN ratings. Lastly, both a sad face and a happy face represented a SOMETIMES rating. 1. NEVER 2.RARELY 3.SOMETIMES, 4.OFTEN, and 5.VERY OFTEN= 1.☹ ☹ ☹ ☹ 2. ☹ ☹ 3.☹ ☺ 4.☺☺ 5.☺☺☺☺.

The 260 pictures were displayed on a computer screen that sat no more than one foot away from the participant. Familiarity ratings by participants for all stimuli were recorded and analyzed.

Experimental Materials

After the stimuli were rated, participants were required to name all 260 stimuli on 3 separate occasions. Based on these trials, pictures that a participant failed to name on at least 2 out of three trials were selected as potential treatment and probe stimuli. From these potential treatment and probe stimuli, 80 familiar and 80 unfamiliar stimuli were identified which were specific to each participant. Then, for each participant, the stimuli were randomly divided into two groups of familiar and unfamiliar stimuli, forty stimuli (20 familiar, 20 unfamiliar) for Treatment 1 and forty stimuli (20 familiar, 20 unfamiliar) for Treatment 2. Of the 80 familiar and unfamiliar stimuli for each treatment, 40 (20 familiar, 20 unfamiliar) were identified as treatment stimuli and 40 (20 familiar, 20 unfamiliar) were identified as probes (untreated) for examining generalization at the conclusion of the treatment. Thus, a different set of familiar and unfamiliar treatment and probe picture stimuli were addressed during each treatment phase.

Then, three baseline measures for Treatment 1 (PCA) were taken for RM and RR on 40 randomly chosen familiar and unfamiliar stimuli days nine through eleven. Only one baseline measure was taken for IC and JD for Treatment 1 (SFA) due to experimental error. On days twelve through sixteen, treatment 1 involving the same randomly chosen 40 familiar and unfamiliar pictures occurred. For Treatment 2, three baseline measures were taken for all four participants separately on the other 40 randomly chosen familiar and unfamiliar stimuli days nineteen through twenty-one. On days twenty-two through twenty-six, treatment 2 involving the same randomly chosen 40 familiar and unfamiliar pictures occurred.

All stimuli (familiar and unfamiliar), including treatment and probe stimuli, were additionally named at the end of each treatment session. All stimuli for both Treatment 1 and Treatment 2 for each participant were additionally named one-month post that specific treatment's (1 or 2) baseline 1 testing. A list of stimuli for each participant is in Appendix D.

Experimental Procedures

All of the participants were assigned to either Semantic Feature Analysis (Boyle, 2004) or Phonological Components Analysis (Leonard, Carol, Rochon, et al., 2008) treatment. Participants JD and IC underwent SFA treatment first, followed by PCA treatment, whereas participants RR and RM underwent PCA treatment first, followed by SFA treatment. All participants underwent Treatment Type 1 (either SFA or PCA) for a total of five days. At the end of the treatment, the participants were re-administered the TAWF and the WAB-R AQ subtests to determine any remarkable change in performance based on the standardized tools. Prior to introducing Treatment Type 2 (either SFA or PCA), three baselines were obtained on a different set of 40 familiar and unfamiliar stimuli from the original 80 stimuli mentioned previously for RR and RM, while only 1 SFA baseline was collected for IC and JD due to experimental error. Then, Treatment 2 was implemented over a 5 day period. All participants underwent the same formal re-testing procedures after Treatment 2 that took place after Treatment 1.

SuperLab Pro's (Cedrus Corporation, 2008) tachistoscopic (t-scope) feature was used on a Dell laptop computer (Model #: X12-04660) to determine accuracy and latency of responses for picture naming. SuperLab Pro was utilized to determine and record baseline, treatment performance, and follow-up data measurements for all treatment and probe stimuli. Treatment performance data included number of accurate responses and reaction times for the 40 familiar and unfamiliar stimuli on a daily basis for that particular Treatment condition.

Treatments

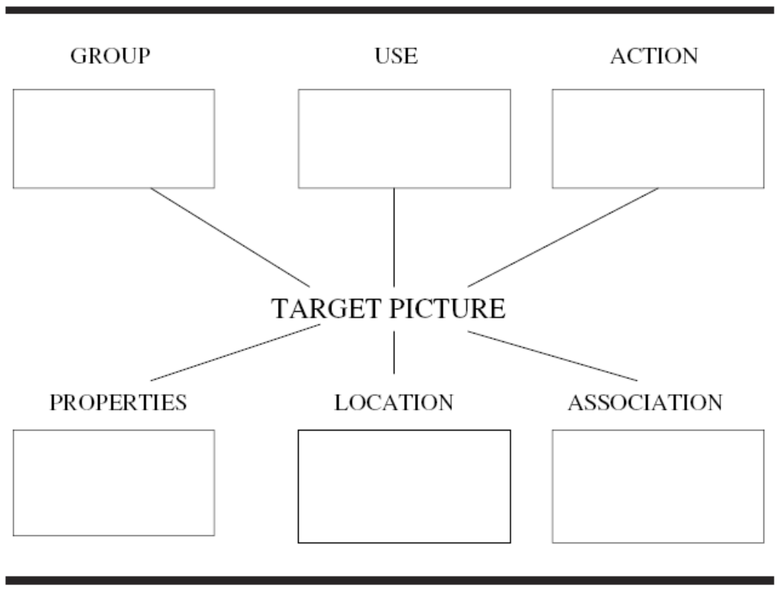
The SFA treatment protocol utilized in the current investigation was similar to Boyle (2004). During the SFA treatment sessions, the clinician showed the participant a picture of the target and asked him/her to name it. She then encouraged them to produce words that were semantically related to the target including words that described its superordinate category, its use, its action, its physical properties, its location, and its association. The clinician elicited these semantic features by asking the participant questions about the word such as, "What does it look like?" for the feature, physical properties, or providing them with sentence-completion cues such as, "It is located ______ for the feature, location. Some of the semantic features were not elicited due to not being appropriate for the target word. For example, the target word apple, as noted by Boyle (2004), might not readily produce an action feature. Some semantic features may elicit more than one word such as the feature, physical properties, which will be encouraged.

During the treatment, the clinician wrote every feature on a chart, similar to what is presented in Figure 2. This chart was written on a large dry erase board so the features can be easily erased in between target words, which will speed up the treatment process. If the participant was unable to produce a feature, the clinician provided an additional cue, recited it orally, and then wrote it on the chart. The clinician encouraged features to be produced for every target word, including words that were produced immediately on initial confrontation naming. This was done in order to utilize the technique as a word retrieval strategy with repeated practice.

The clinician always elicited the features in the following order: superordinate category, use, action, physical properties, location, and association.

If the participant produced a feature out of sequence, then the clinician wrote it in the appropriate feature box and the clinician resumed requesting features in the order above, skipping over the one's that the participant already produced. If the participant retrieved and produced the target word as features were being elicited, the clinician reinforced the success, but still continued to request responses to all features. If the participant failed to retrieve the target word after the listing of its features, the clinician provided the name of the target word, asked the participant to repeat it, and then reviewed all of its features. In this review, the clinician additionally encouraged the participant to speak in sentences and include the word in a sentence with each of the features enabling more opportunities to say the word and practice saying the features aloud. Treatment accuracy was based on percentage of pictures the participant was able to name at the end of each treatment session during the timed naming-reaction time test. This enabled the ability to assess whether the SFA technique was improving a participant's initial confrontation naming ability over time.

The PCA treatment protocol was similar to Leonard, Carol, Rochon, et al. (2008). During the PCA treatment sessions, the clinician showed the participant a picture of the target and asked him/her to name it. She then encouraged them to produce words that were phonologically related to the target including what it rhymes with, its first sound, its first sound associate, its final sound, and the number of syllables it has. The clinician elicited these features by asking the participant a question such as, "What does this rhyme with?" for the feature, "rhyme".



(Boyle, 2004)

Figure 2

Semantic Feature Analysis Treatment Model

As with the SFA treatment protocol, the clinician wrote every feature on a chart, similar to what is displayed in Figure 3.

Similar to the SFA treatment protocol, this chart also was presented on a large dry erase board so the features could be easily erased in between target words, which sped up the treatment process. If the participant was unable to produce a feature, the clinician provided a pre-determined, alternate cue, recited it orally, and then wrote it on the chart. The clinician encouraged features to be produced for every target word, including words that were produced immediately upon initial confrontation naming. This was done in order to encourage use of the technique as a word retrieval strategy with repeated practice.

The clinician elicited the features in the following order: rhymes with, first sound, first sound associate, final sound, and number of syllables. If the participant produced a feature out of sequence, then the clinician wrote it in the appropriate feature box and the clinician resumed requesting features in the order above, skipping over features that the participant already produced. If the participant retrieved and produced the target word as features were being elicited, the clinician reinforced the success, but still continued to request responses to all features.

If the participant could not spontaneously produce a response to the features requested, he/she was asked to choose from an array of two responses, none of which were the target word. If the participant retrieved and produced the target word as features were being elicited, the clinician reinforced the success, but still continued to request responses to features. If the participant failed to retrieve the target word after the listing of its features, the clinician provided the name of the target word, asked the participant to repeat it, and then reviewed all of its features. Treatment accuracy was based on percentage of pictures the participant was able to

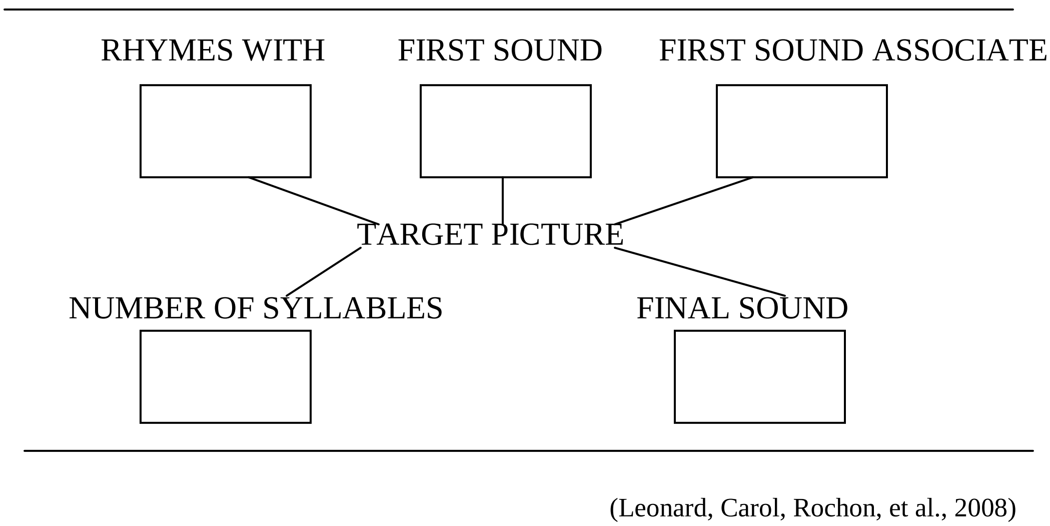


Figure 3

Phonological Components Analysis Treatment Model name at the end of each treatment session during the timed naming-reaction time test. This enabled ability to assess whether the PCA technique was improving a participant's initial confrontation naming ability over time.

General Testing Procedures

The investigation was approved by the Institutional Review Board (IRB) at East Carolina University (Appendix E). Prior to any pre-experimental testing or experimental treatment, participants and caregivers signed an informed consent form, a sample of which is in Appendix F. The informed consent form explained the purposes, requirements, and time commitment of the investigation.

All pre-experimental and experimental testing and treatment procedures occurred either at the East Carolina University Speech, Language, and Hearing Clinic, and RR and RM's home. Each participant was tested and underwent treatment individually by the examiner, in a quiet, well lit environment free of visual, auditory, and other distractions. The examiner sat across from the participant during all pre-experimental and experimental testing and treatment tasks. A Sony ICD-P620 digital audio recorder was used to tape-record all pre-experimental and experimental tasks.

The order of the testing procedures was as follows:

PRE-EXPERIMENTAL TASK AND STIMULI DEVELOPMENT

Day 1: 1) Questionnaire 2) Audiological Screening 3) WAB-R 4) TAWF;

Day 2: 1) Participant Informal Familiarity Rating and Reliability Assessment

Day 3: Participant Rating & Naming of 260 Stimuli

Day 5: Participant Rating & Naming of 260 Stimuli

Day 7: Participant Rating & Naming of 260 Stimuli

TREATMENT

Day 9: Treatment 1: Baseline: 20 familiar (10 T, 10 P), 20 unfamiliar (10 T, 10 P)

Day 10: Treatment 1: Baseline: 20 familiar (10 T, 10 P), 20 unfamiliar (10 T, 10 P)

Day 11: Treatment 1: Baseline: 20 familiar (10 T, 10 P), 40 unfamiliar (10 T, 10 P)

Day 12-16: Treatment Type 1 Begins (A-B: SFA; C-D PCA); 40 stimuli (20 fam., 20 unfam.)

Day 17: 1) TAWF administered 2) WAB-R administered; 40 stimuli (probes, treatment)

Day 19: Treatment 2: Baseline: 20 familiar (10 T, 10 P), 20 unfamiliar (10 T, 10 P)

Day 20: Treatment 2: Baseline: 20 familiar (10 T, 10 P), 20 unfamiliar (10 T, 10 P)

Day 21: Treatment 2: Baseline: 20 familiar (10 T, 10 P), 20 unfamiliar (10 T, 10 P)

Day 22-26: Treatment Type 2 Begins (C-D: SFA; A-B: PCA); 40 stimuli (20 fam., 20 unfam.)

Day 27: 1) TAWF administered; 2) WAB-R administered; 40 stimuli (probes, treatment)

MAINTENANCE and GENERALIZATION

Day 47: Treatment 1 Stimuli Re-Naming (40 total stimuli, including treatment and probes)

Day 57: Treatment 2 Stimuli Re-Naming (40 total stimuli, including treatment and probes)

CHAPTER III.

RESULTS

The purpose of the current study was to examine the effects of subjective word familiarity on word retrieval ability and responsiveness to short, intensive treatment in aphasia. To accomplish this, four native-English speaking participants with chronic aphasia, underwent individual treatment using two treatment approaches, Semantic Feature Analysis (SFA) or Phonological Components Analysis (PCA). In each treatment, the focus was on the retrieval of familiar and unfamiliar words based on participant self-rating. Each participant underwent two main phases in the experiment: a familiarity rating phase and a treatment phase. Two participants underwent SFA treatment first, followed by PCA and the other two participants received PCA treatment first, followed by SFA. Both accuracy and reaction time measurements were obtained for all stimuli for baseline testing and at the beginning of each day of treatment during both treatment protocols for each participant. The *TAWF* and *WAB-R AQ* were administered at the beginning and at the end of each treatment protocol for each participant.

The influence of familiarity, treatment, and performance on standardized tests over time was considered in analyzing the results. For accuracy analyses, Fisher's Exact tests were conducted for familiarity analyses whereas the McNemar tests were conducted to examine treatment and generalization effects. For statistical reaction time analyses, independent sample t-tests were conducted on familiarity data; paired sample t-tests were conducted on generalization data. Descriptive statistics including number of stimuli (n), mean performance (M), range of performance including minimum and maximum values, and standard deviations (SD) were calculated for all analyses.

Familiarity

The first experimental question addressed the overall influence of familiarity and the effect of familiarity of stimuli on baseline and treatment performance. Specifically, the first analysis involved examination of whether there was an effect of familiarity relative to baseline stimuli for accuracy and reaction time for each participant. Accuracy data in percentages for familiar and unfamiliar stimuli for each participant at baseline are presented in Figure 4. IC and JD had 160 accuracy values at baseline (80 familiar and 80 unfamiliar), whereas RR and RM had 240 (120 familiar and 120 unfamiliar) accuracy values at baseline. There were fewer total stimuli for IC and JD because only one baseline measure was collected for each participant preceding SFA treatment. Three baseline measures were collected prior to PCA treatment for IC and JD and prior to each treatment for all other participants.

Fisher's Exact Tests were conducted on the accuracy data relative to differences between familiar and unfamiliar stimuli. For the application of Fisher's Exact Tests, the participant is treated as the population, meaning that inferences pertain only to this participant. In comparing familiar to unfamiliar words, two populations are being compared: one population is the responses to familiar words and the other is the population of responses to unfamiliar words. For each population, the responses fall into one of two categories: correct or incorrect. Interest here is in comparing the proportion of correct responses in these two populations. Responses here are obtained at baseline. As the participant is aphasic and has received no treatment as yet in the investigation, it is reasonable to assume the responses are independent. Furthermore, it is assumed that the proportion of correct responses is the same for all familiar words as is the proportion of correct responses for all unfamiliar words. In other words, the probability of a correct response may depend on whether the word is familiar or unfamiliar, but it does not depend on the particular word. This second assumption may be less plausible than that of independence.

All tests were conducted at 5% significance level. The results revealed marginally significant findings for JD ($p=.055$) and significant findings for RR ($p= .005$), with significantly greater accuracy for familiar than unfamiliar stimuli. No significant findings were observed for RM or IC ($p >.05$). Accuracy data at baseline for each participant is in Appendix G.

RT data at baseline for the familiar and unfamiliar stimuli for each participant are presented in Figure 5. Independent sample t-tests conducted on these data for each participant revealed significant findings for JD (CI= -1.13 to -.308 seconds; $t= -3.456$; $p=.001$) with significantly faster retrieval for familiar versus unfamiliar words, and significant findings for RM (CI= .235 to 1.20 seconds; $t = 2.923$; $p= .004$); however, for RM, retrieval was significantly faster for unfamiliar than familiar words. No significant findings were observed for RR or IC ($p >.05$). RT data at baseline for each participant is in Appendix H.

The relationship between accuracy and RT at baseline relative to familiarity was examined for each participant. IC, RR and RM had 200 reaction time measurements (100 familiar and 100 unfamiliar). JD had 180 reaction time measurements (90 familiar and 90 unfamiliar) due to missing data on Day 3 of PCA treatment as the result of instrumental error. Data are presented in Figures 6, 7, 8, and 9 for IC, JD, RR, and RM, respectively. These data indicate that IC was fastest for correctly retrieved, familiar stimuli and slowest for incorrectly retrieved, unfamiliar stimuli. Both JD and RR were fastest for correctly retrieved, familiar stimuli whereas RM was fastest for correctly retrieved, unfamiliar stimuli. JD, RR, and RM were slowest for incorrectly named, familiar stimuli.

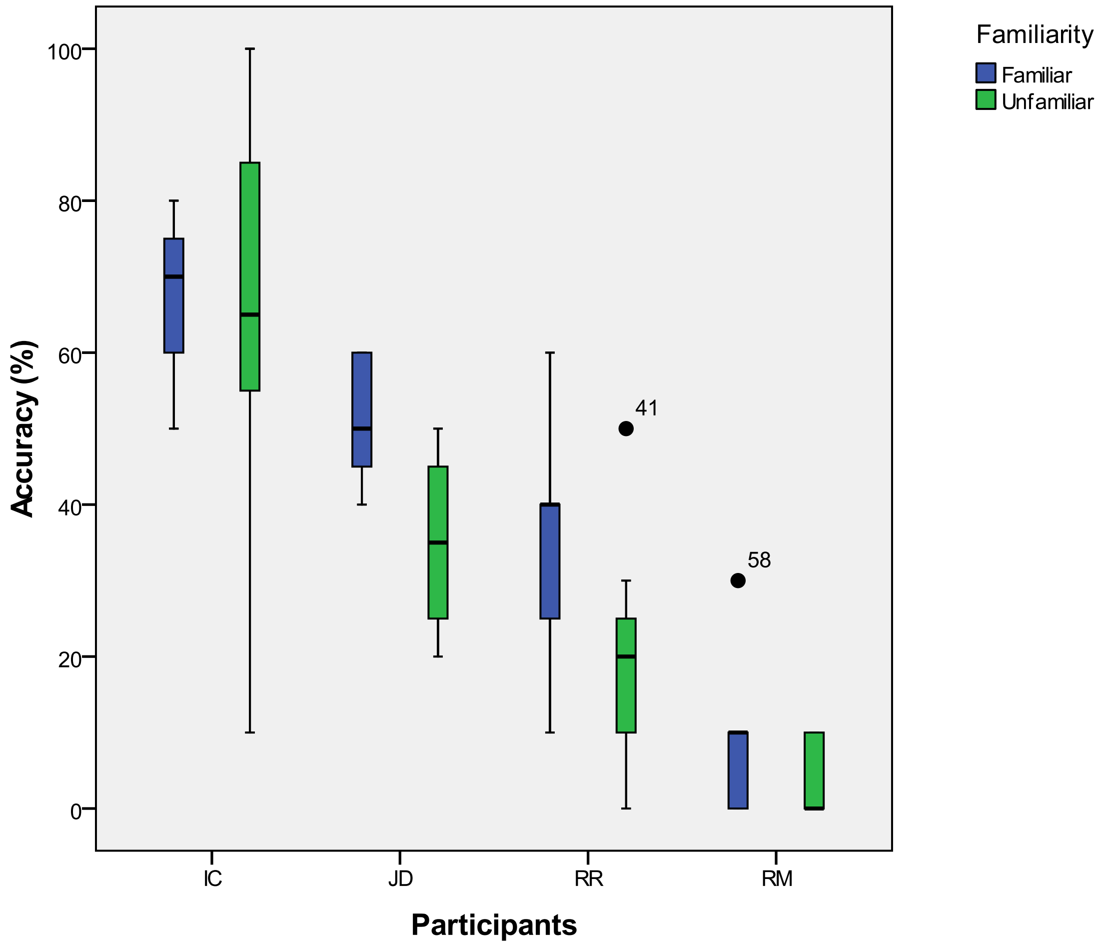


Figure 4

All Participants Accuracy: Familiarity Effect on Word Retrieval at Baseline Regardless of Treatment Approach

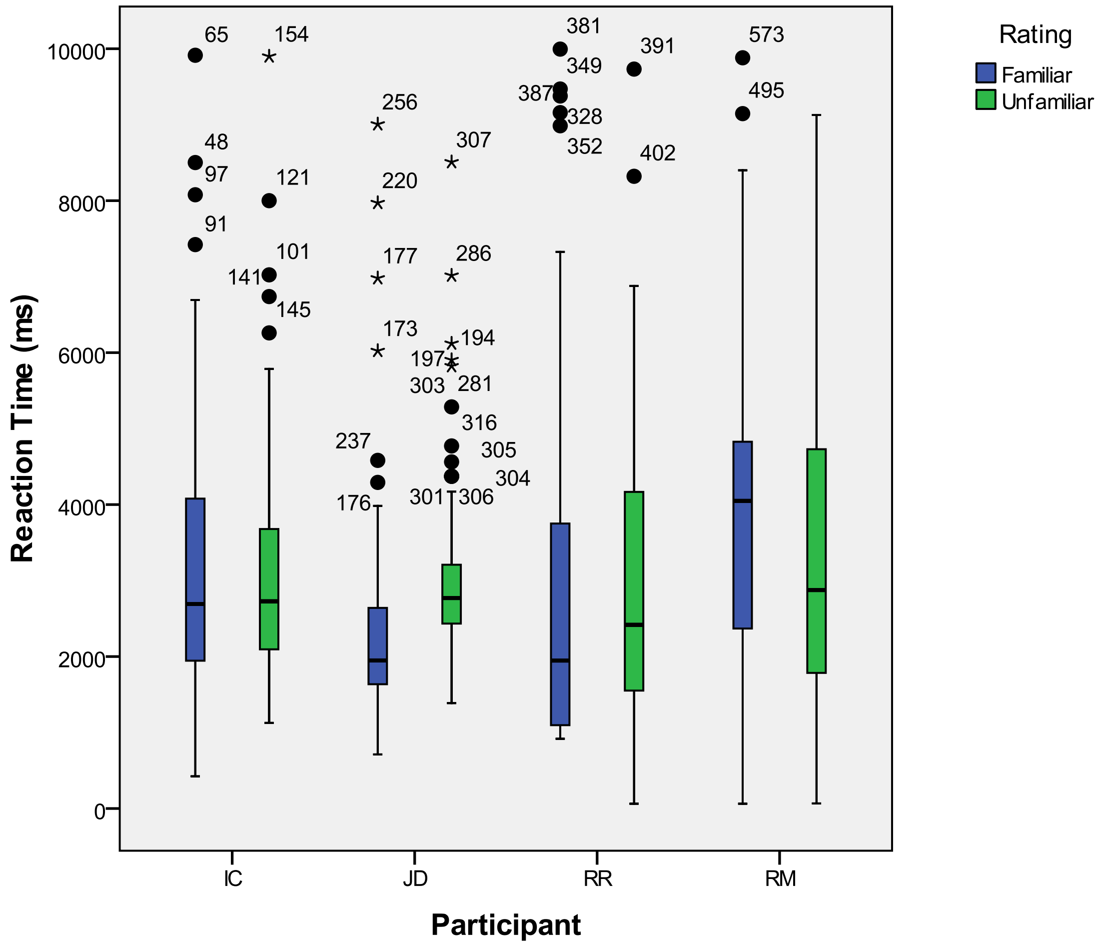


Figure 5

All Participants Reaction Time: Familiarity Effect on Word Retrieval at Baseline

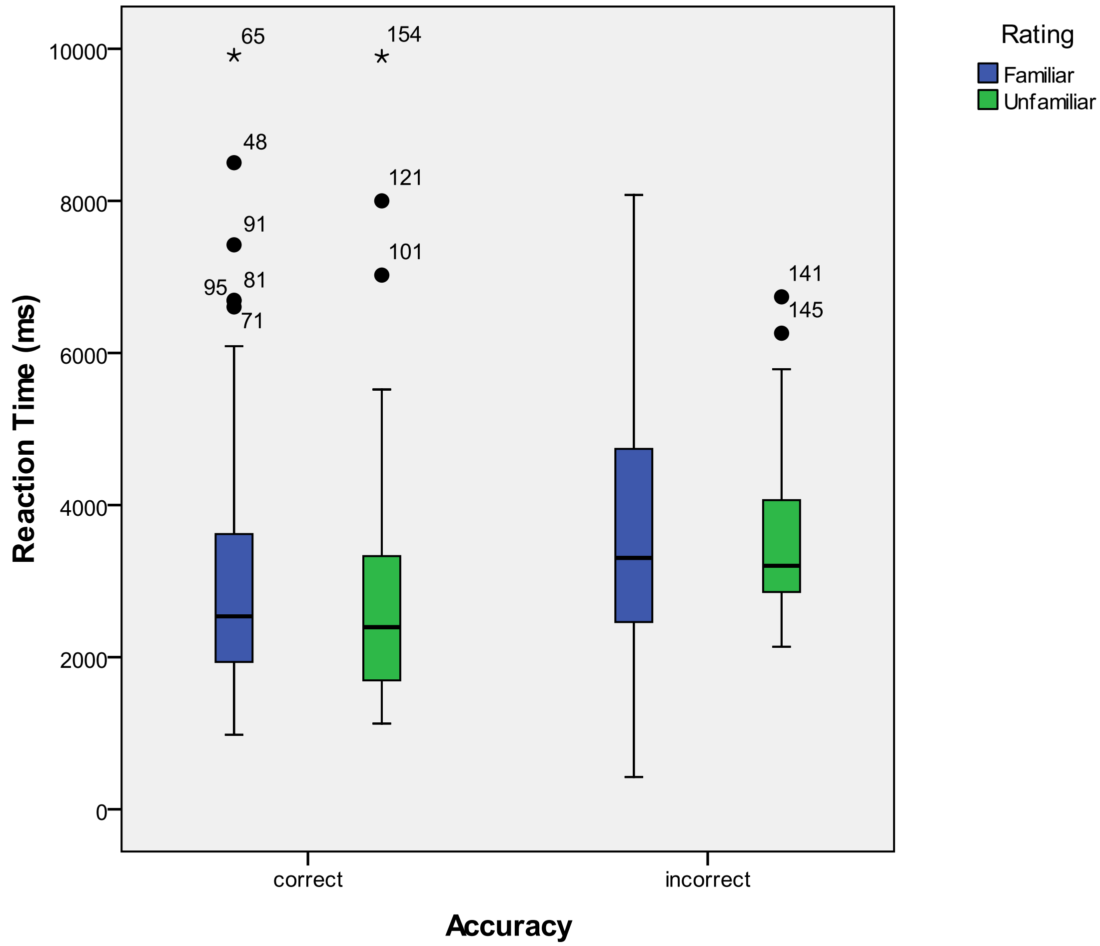


Figure 6

IC: Familiarity at Baseline: Relationship Between Reaction Time and Accuracy

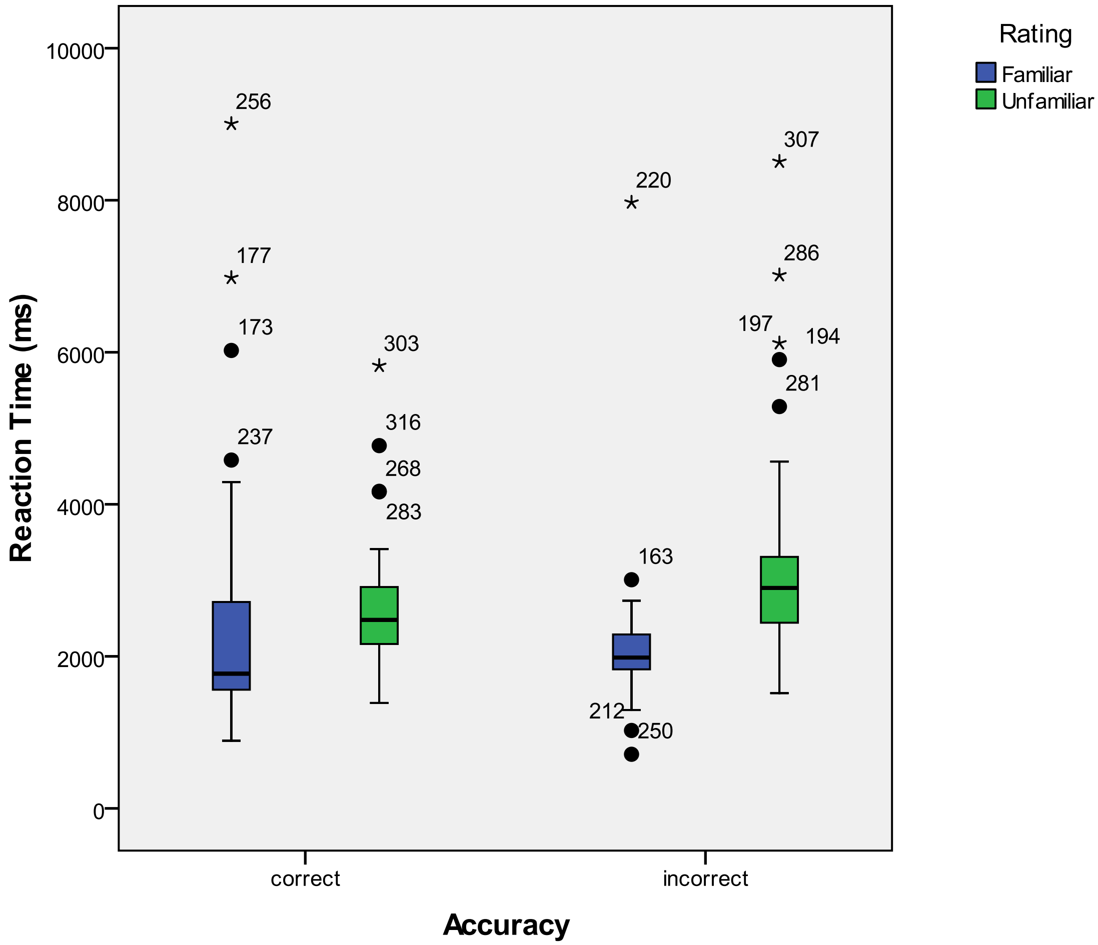


Figure 7

JD: Familiarity at Baseline: Relationship Between Reaction Time and Accuracy

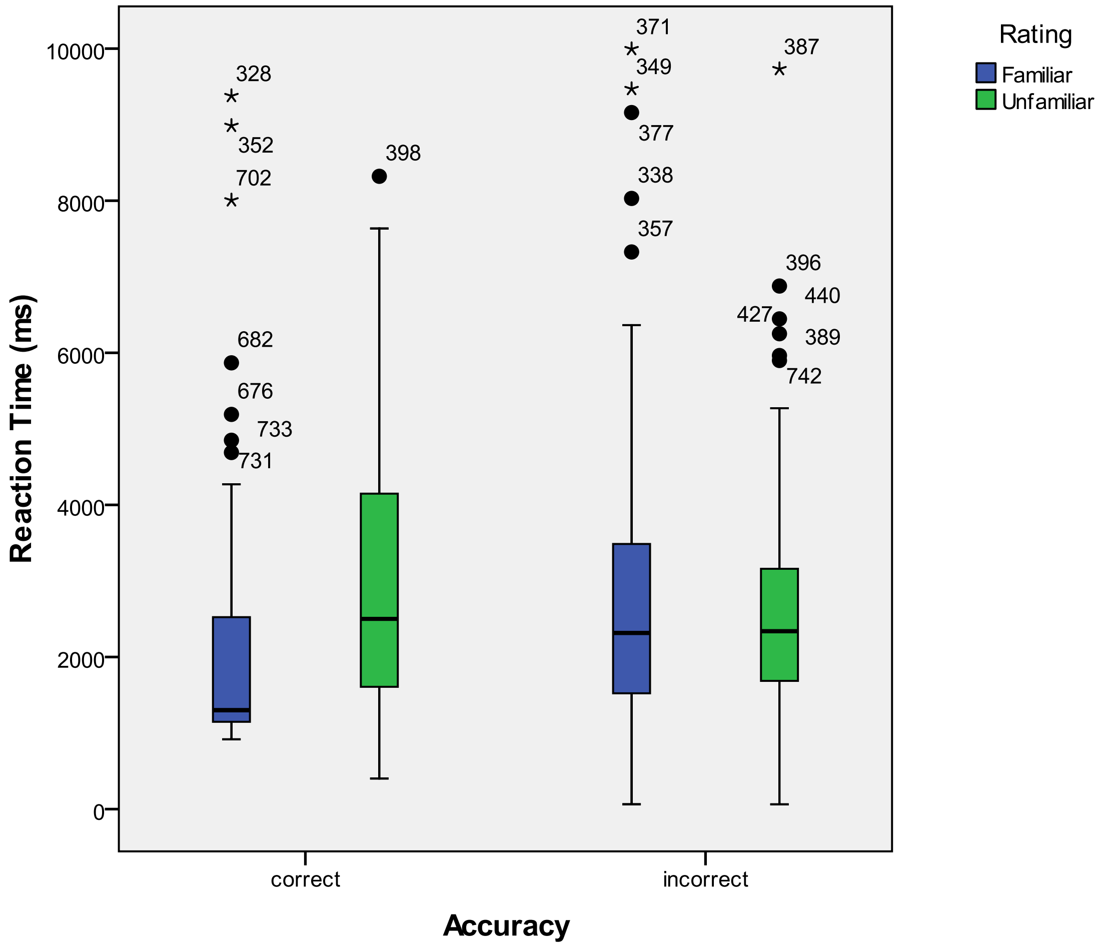


Figure 8

RR: Familiarity at Baseline: Relationship Between Reaction Time and Accuracy

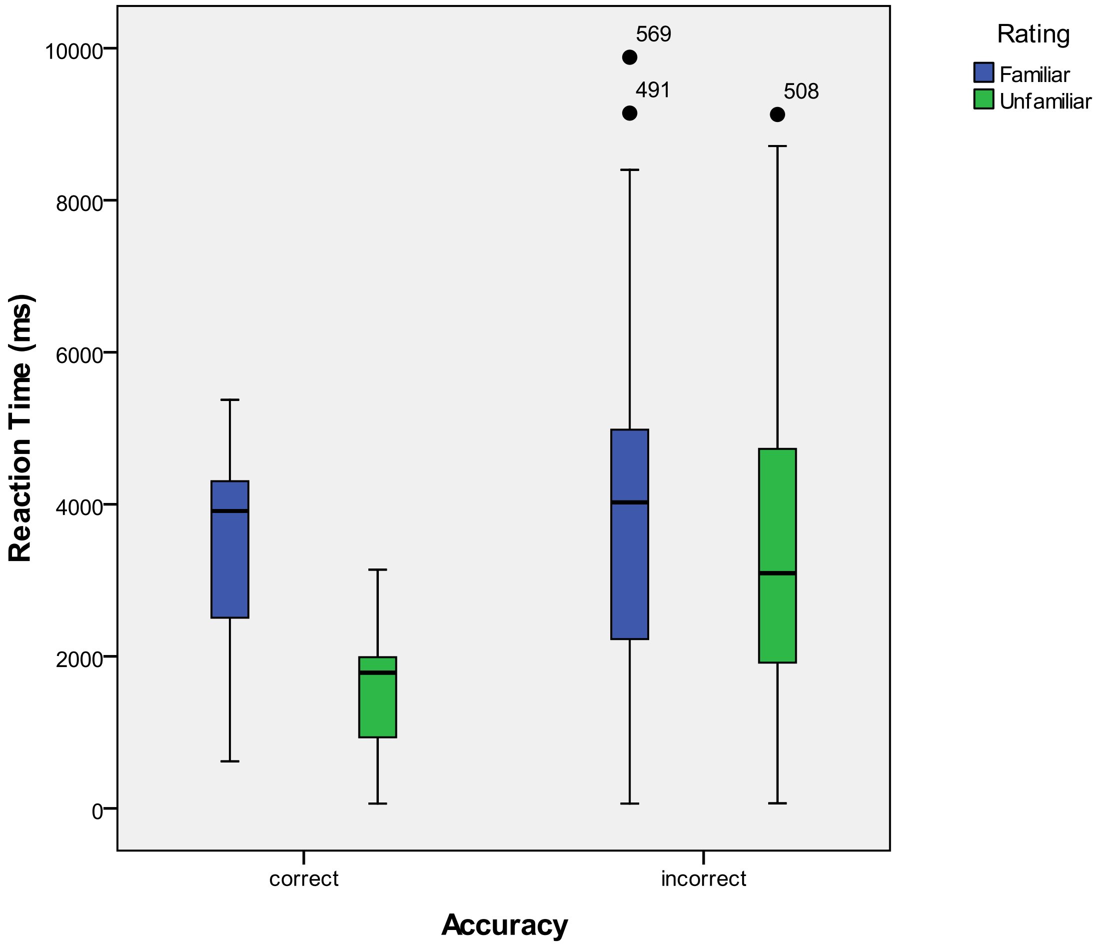


Figure 9

RM: Familiarity at Baseline: Relationship Between Reaction Time and Accuracy

The next analysis addressed whether there was a familiarity effect for a particular treatment type per participant. In this analysis, accuracy for familiar and unfamiliar words was compared in each treatment. Each participant had 100 accuracy values (50 familiar and 50 unfamiliar). Fisher's Exact Tests were conducted on the accuracy data relative to differences between familiar and unfamiliar stimuli for the two treatment types for each participant. Results revealed no significant findings for either treatment type for any participant ($p > .05$). Figures displaying the influence of familiarity on accuracy, regardless of treated or probe stimuli across baseline and treatments for each participant are presented in Figures 10 (IC), 11 (JD), 12 (RR), and 13 (RM). Mean accuracy data throughout each treatment approach for each participant are presented in Appendix I.

The effectiveness of each treatment type relative to stimulus familiarity also was examined for each participant. Mean accuracy performance at baseline was compared to accuracy at the last day of each treatment for familiar and unfamiliar stimuli for each participant. These data are presented in Table 2. Due to a limited number of data points, statistical analyses were not conducted. As can be observed, some remarkable performance increases are apparent for both familiar and unfamiliar stimuli, specific to particular participants as well as the specific treatment. JD showed noticeable increases in word retrieval for familiar stimuli in both treatments whereas RM showed increases in word retrieval for unfamiliar stimuli in SFA only.

RT results for familiar and unfamiliar stimuli per treatment type for each participant are presented in Figures 14, 15, 16, and 17. In this analysis, reaction time for familiar and unfamiliar words was compared in each treatment. Each participant had 100 reaction time measurements (50 familiar and 50 unfamiliar) for each treatment, with the exception of JD who had 80 reaction time measurements for PCA treatment (40 familiar and 40 unfamiliar). JD's missing data resulted from instrumental error on Day 3. Independent sample t-tests were conducted on reaction times between familiar and unfamiliar stimuli per treatment type for each participant. The results revealed significant findings for IC (CI= -1.39 to -56.5 seconds); (t *(df=88.4)* = -2.155; p=.034) for SFA. IC was significantly slower for unfamiliar than familiar stimuli during SFA; no significant findings were observed for PCA (p >.05). IC showed more variability for unfamiliar stimuli during SFA treatment whereas he showed more variability for familiar stimuli during PCA treatment. Significant findings were observed for RM for both SFA (CI=.080 to 1.93 seconds; t *(df*=80.5*)* = 2.163; p=.034) and PCA (CI=.188 to 1.65 seconds; t *(df*=97.8*)* = 2.492; p= .014). RM was significantly slower for familiar than unfamiliar stimuli during both treatments. No significant findings were observed for familiarity for either JD or RR (p >.05) during either treatment type. RT data through both treatment types for each participant are presented in Appendix J. Figures displaying the influence of familiarity on RT per treatment type for each participant are presented in Figures 18 (SFA) and 19 (PCA) for IC, 20 (SFA) and 21 (PCA) for JD, 22 (PCA) and 23 (SFA) for RR, and 24 (PCA) and 25 (SFA) for RM. Note that Figure 24 and 25 are not missing values; incomplete displays are due to RM's consistent 0% performance.

The effectiveness of each treatment type relative to stimulus familiarity also was examined for each participant. Mean reaction time performance at baseline was compared to RT at the last day of each treatment for familiar and unfamiliar stimuli for each participant. These data are presented in Table 3. Due to a limited number of data points, statistical analyses were not conducted. As can be seen, some remarkable changes in speed of retrieval are evident relative to both familiar and unfamiliar stimuli. IC showed a noticeable decrease in RT for

Table 2. *Treatment Effectiveness Relative to Accuracy (%) of Retrieval of Familiar and Unfamiliar Stimuli*

Participant And Testing Period	SFA Baseline	SFA Day 5 (Post-Tx)	PCA Baseline	PCA Day 5 (Post-Tx)
<u>IC</u>				
Familiar	70	100	63	70
Unfamiliar	20	80	90	90
<u>JD</u>				
Familiar	50	90	43	60
Unfamiliar	50	50	40	70
<u>RR</u>				
Familiar	27	60	30	60
Unfamiliar	33	70	10	50
<u>RM</u>				
Familiar	18	20	3	0
Unfamiliar	7	40	7	0

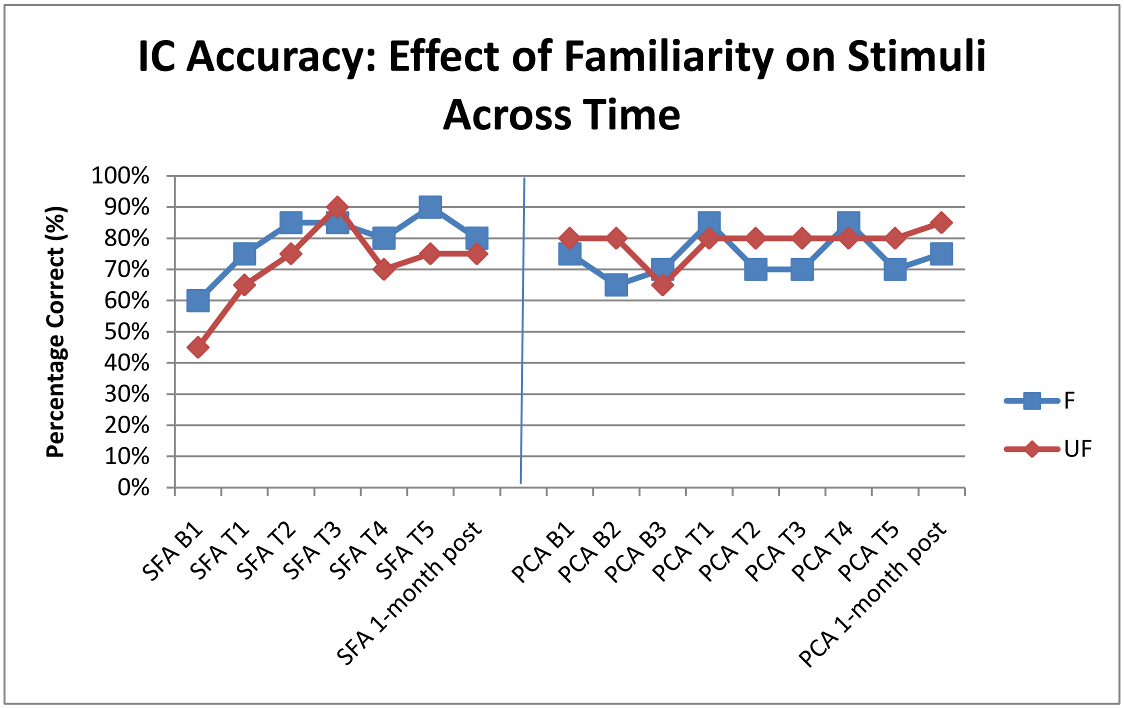

IC Accuracy: Effect of Familiarity on Stimuli Across Time
Percentage Correct (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
SFA B1
SFA T1
SFA T2
SFA T3
SFA T4
SFA T5
SFA 1-month post
PCA B1
PCA B2
PCA B3
PCA T1
PCA T2
PCA T3
PCA T4
PCA T5
PCA 1-month post
F
UF

Figure 10

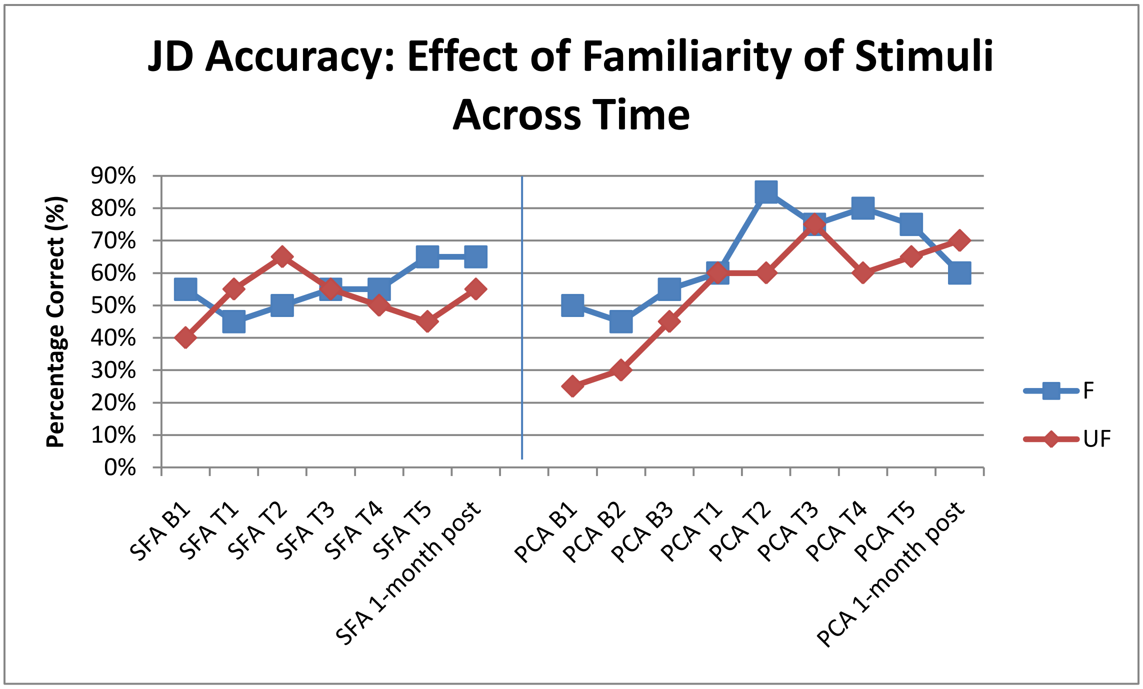

JD Accuracy: Effect of Familiarity of Stimuli Across Time
Percentage Correct (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
SFA B1
SFA T1
SFA T2
SFA T3
SFA T4
SFA T5
SFA 1-month post
PCA B1
PCA B2
PCA B3
PCA T1
PCA T2
PCA T3
PCA T4
PCA T5
PCA 1-month post
F
UF

Figure 11

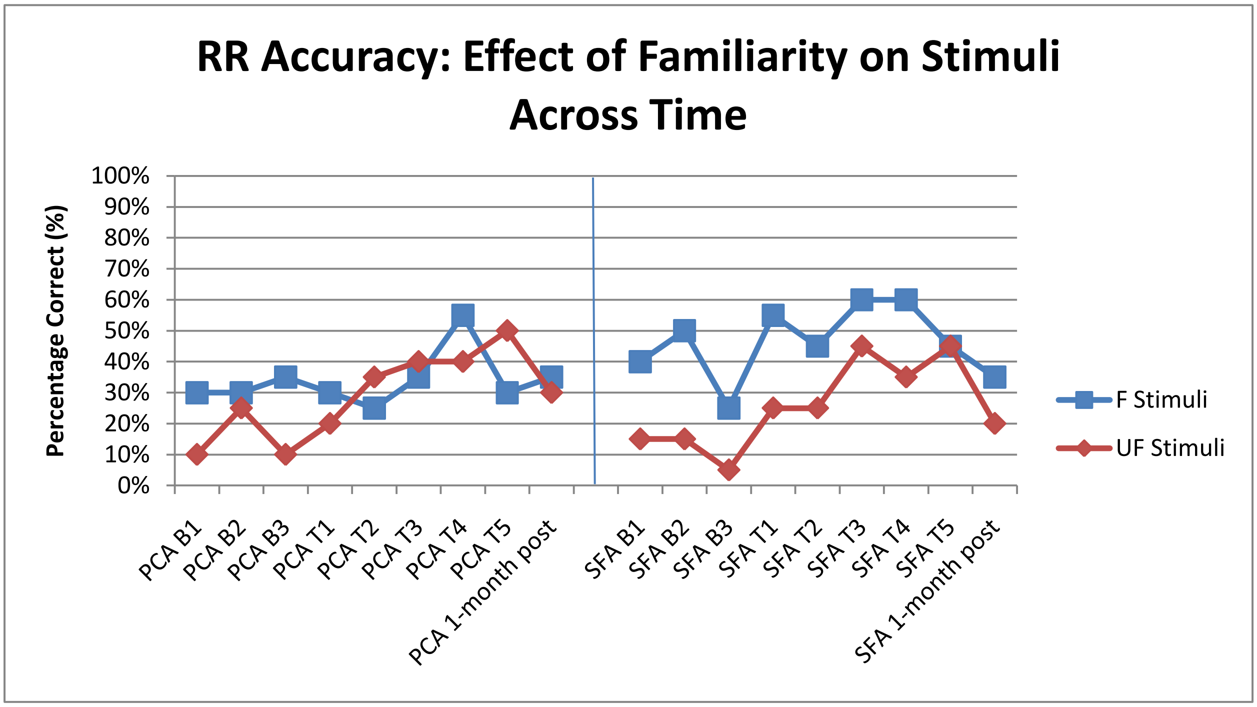

RR Accuracy: Effect of Familiarity on Stimuli Across Time
Percentage Correct (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
PCA B1
PCA B2
PCA B3
PCA T1
PCA T2
PCA T3
PCA T4
PCA T5
PCA 1-month post
SFA B1
SFA B2
SFA B3
SFA T1
SFA T2
SFA T3
SFA T4
SFA T5
SFA 1-month post
F Stimuli
UF Stimuli

Figure 12

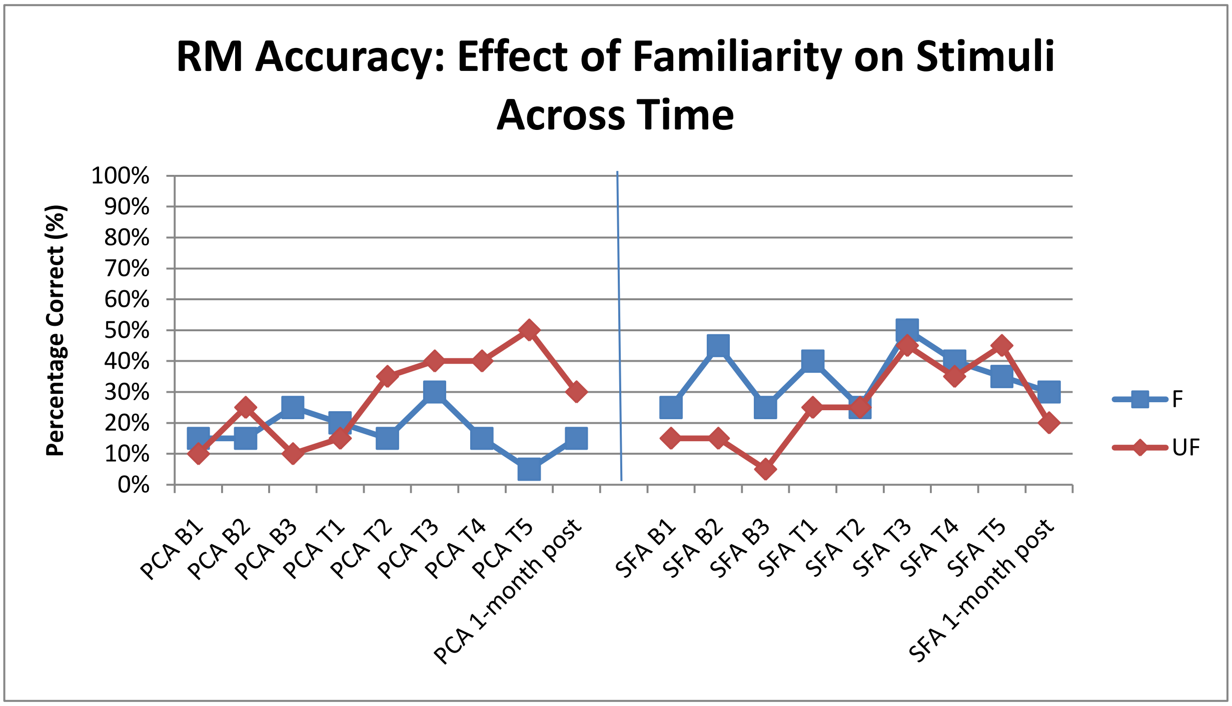

RM Accuracy: Effect of Familiarity on Stimuli Across Time
Percentage Correct (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
PCA B1
PCA B2
PCA B3
PCA T1
PCA T2
PCA T3
PCA T4
PCA T5
PCA 1-month post
SFA B1
SFA B2
SFA B3
SFA T1
SFA T2
SFA T3
SFA T4
SFA T5
SFA 1-month post
F
UF

Figure 13

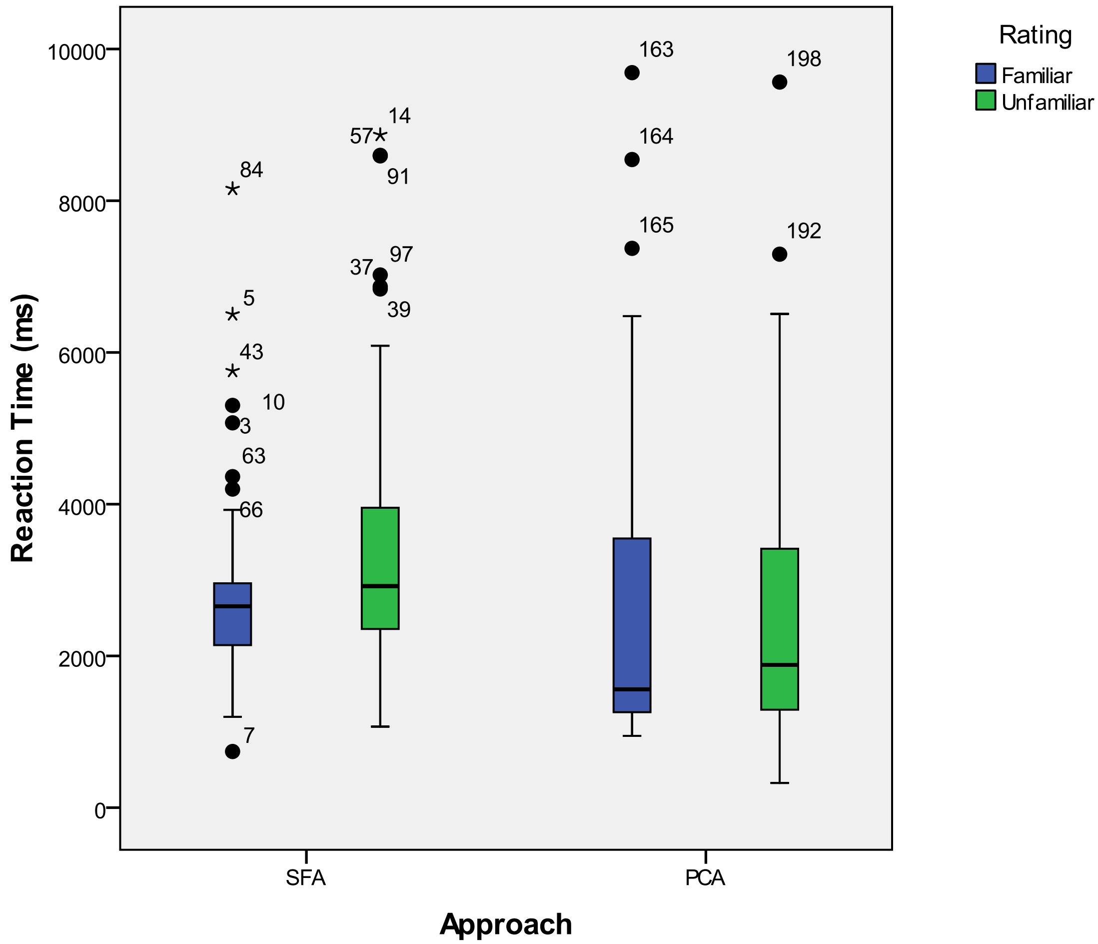


Figure 14

IC Reaction Time: Effect of Familiarity for Treated Stimuli

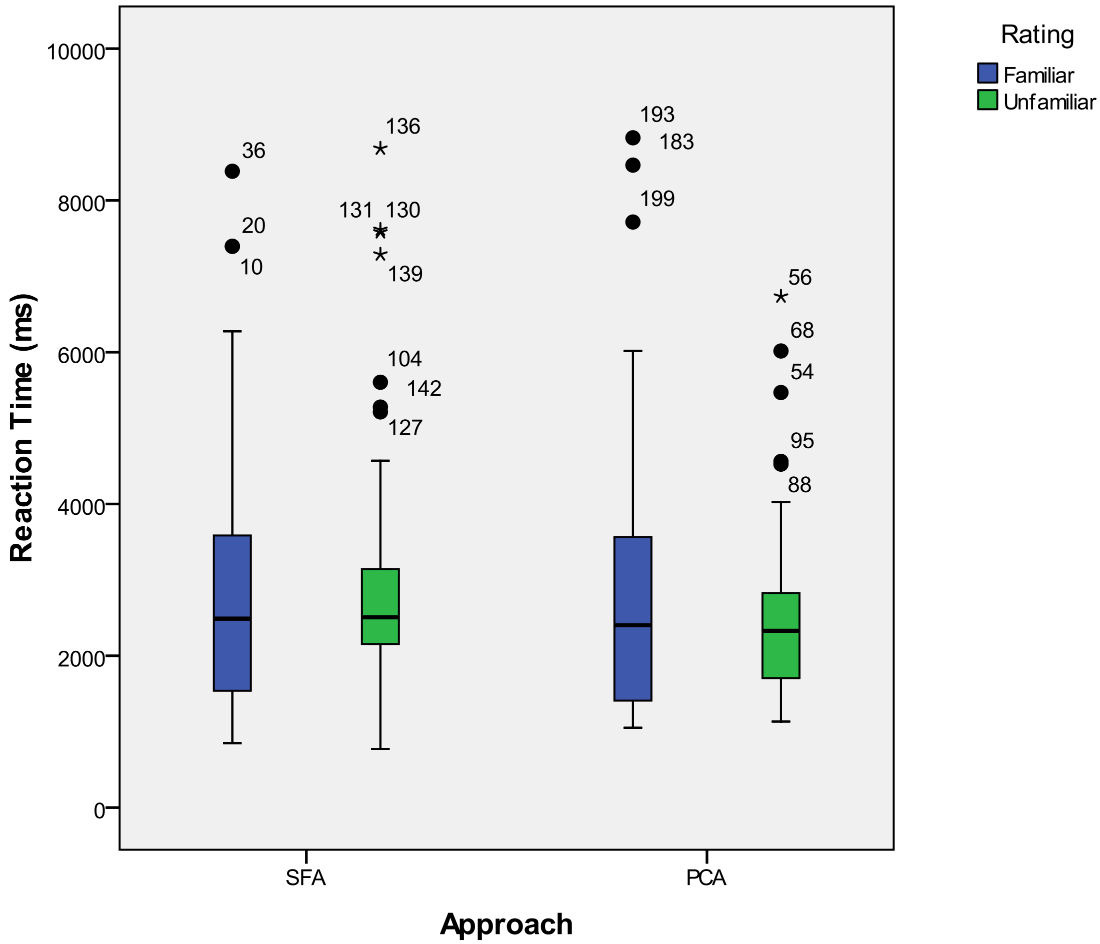


Figure 15

JD Reaction Time: Effect of Familiarity for Treated Stimuli

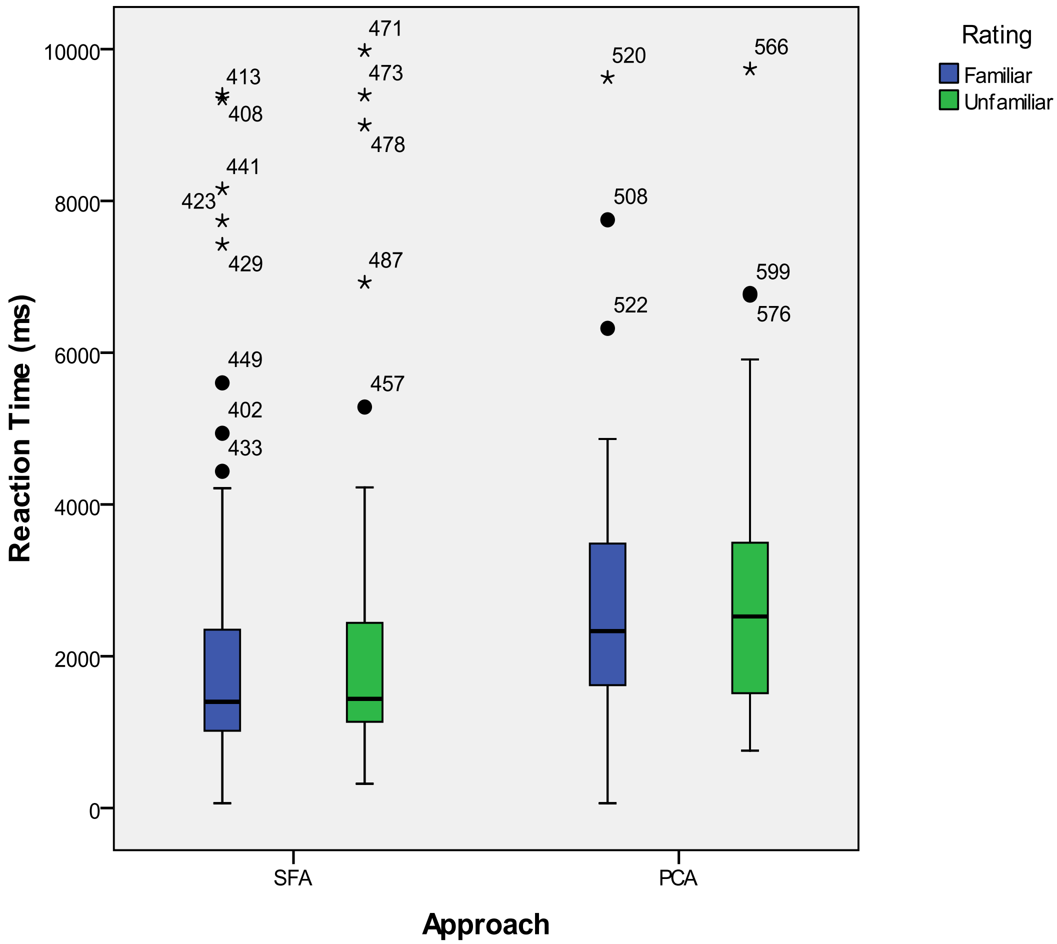


Figure 16

RR Reaction Time: Effect of Familiarity for Treated Stimuli

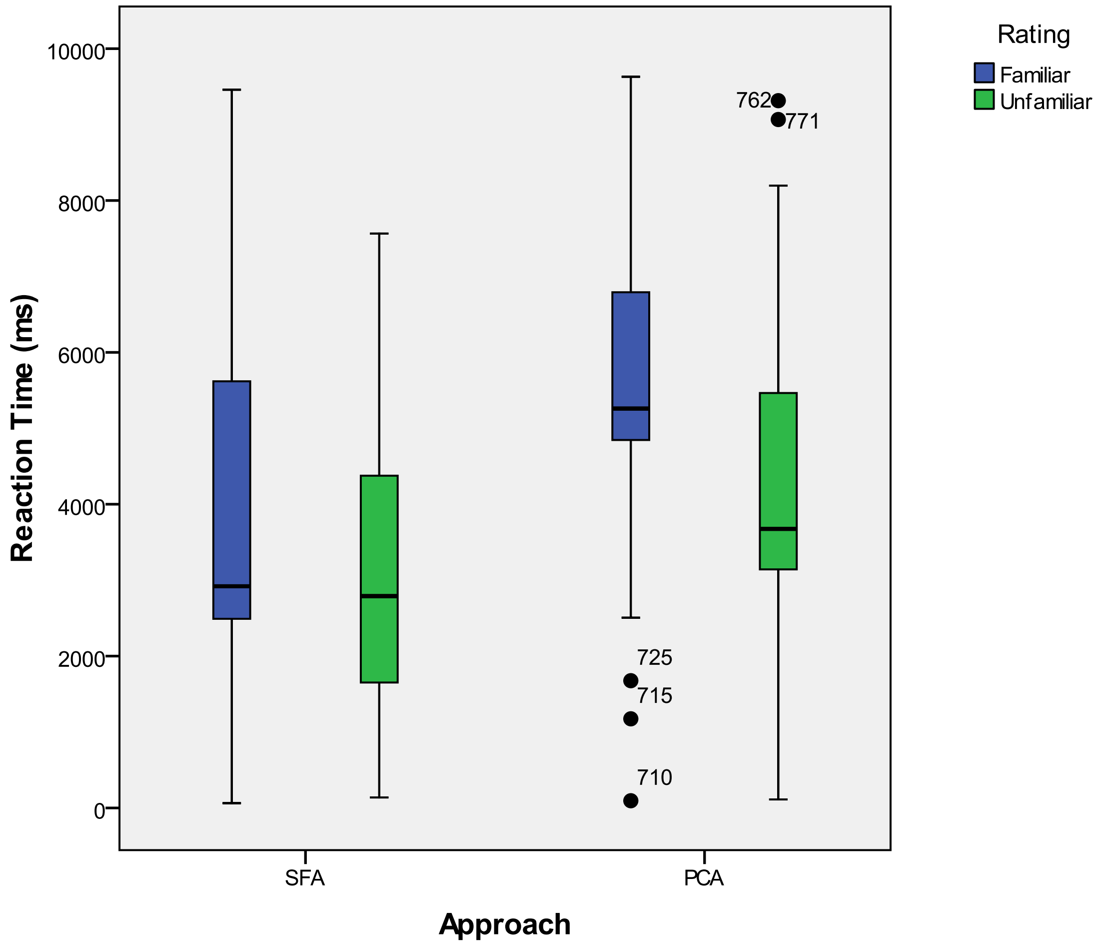


Figure 17

RM Reaction Time: Effect of Familiarity for Treated Stimuli

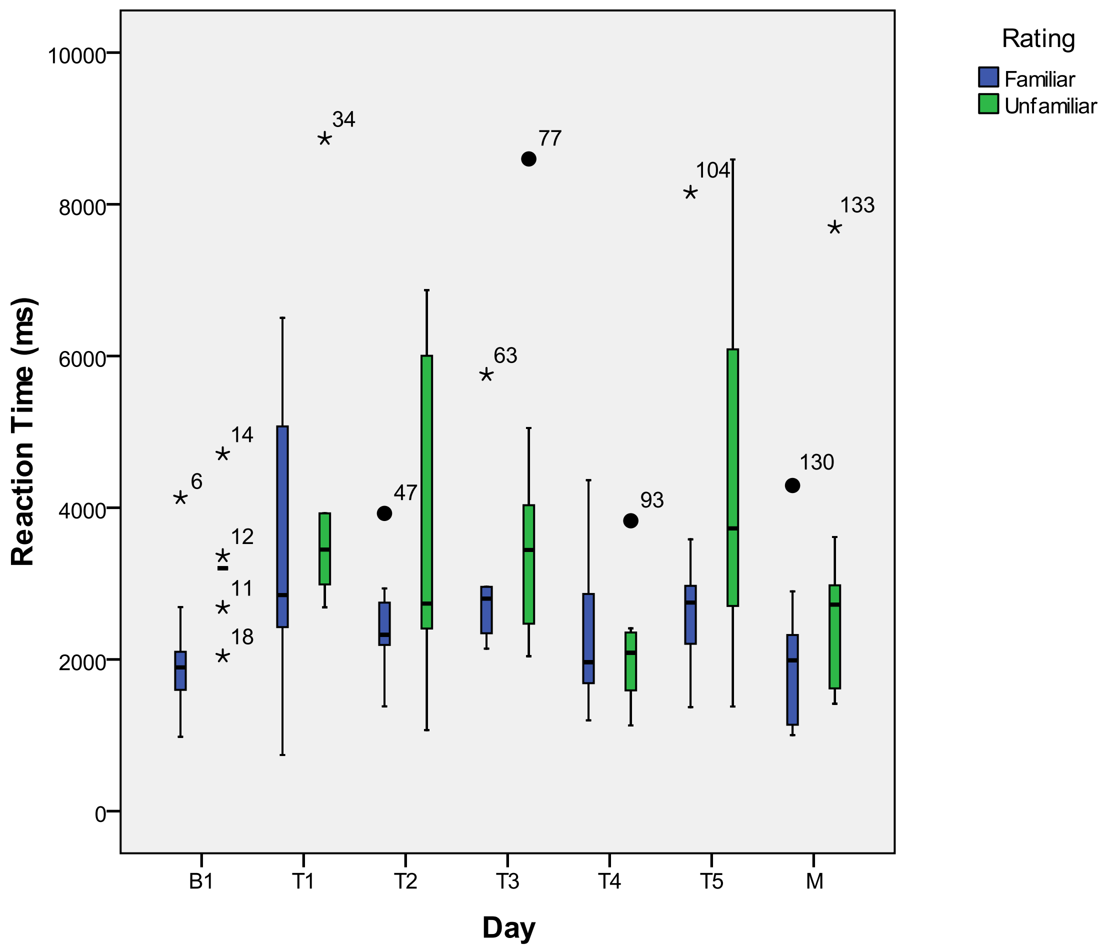


Figure 18

IC: SFA Reaction Time: Effect of Familiarity on Treated Stimuli Across Time

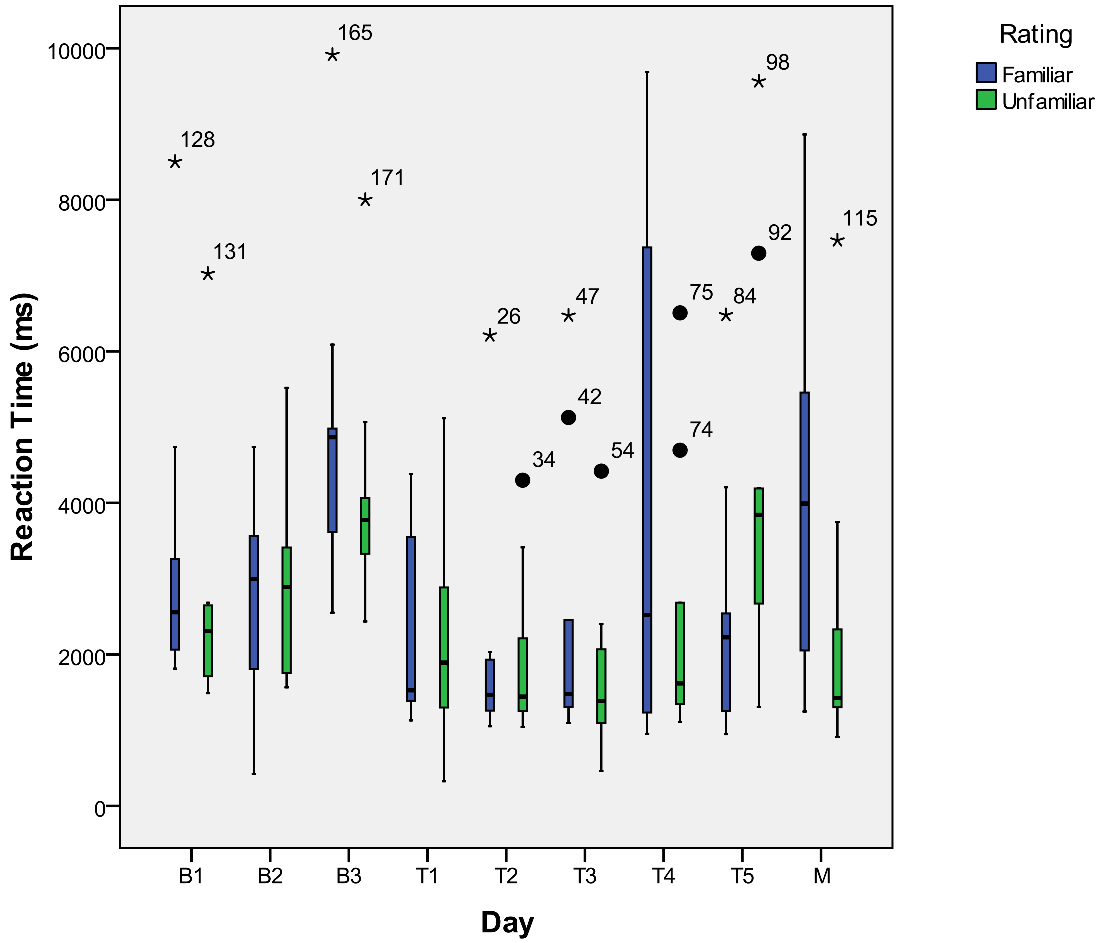


Figure 19

IC: PCA Reaction Time: Effect of Familiarity on Treated Stimuli Across Time

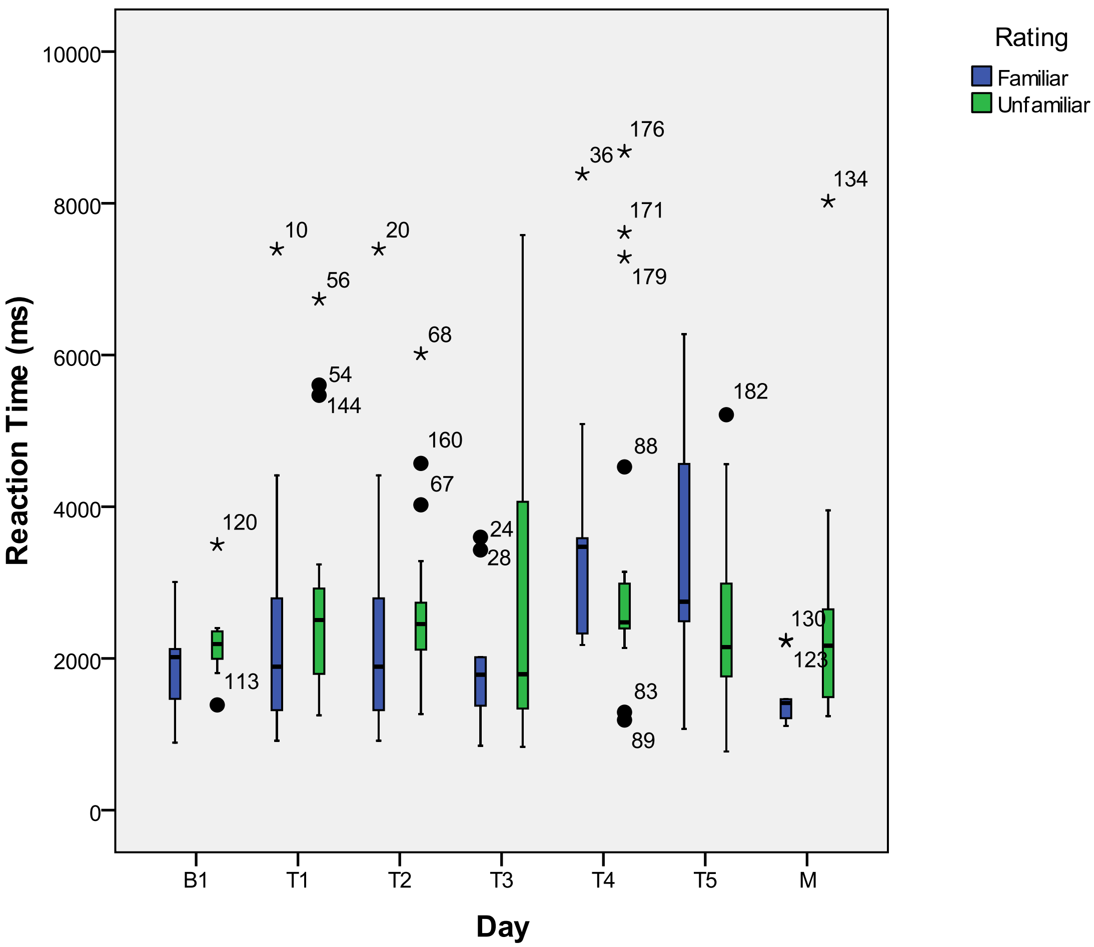


Figure 20

JD: SFA Reaction Time: Effect of Familiarity on Treated Stimuli Across Time

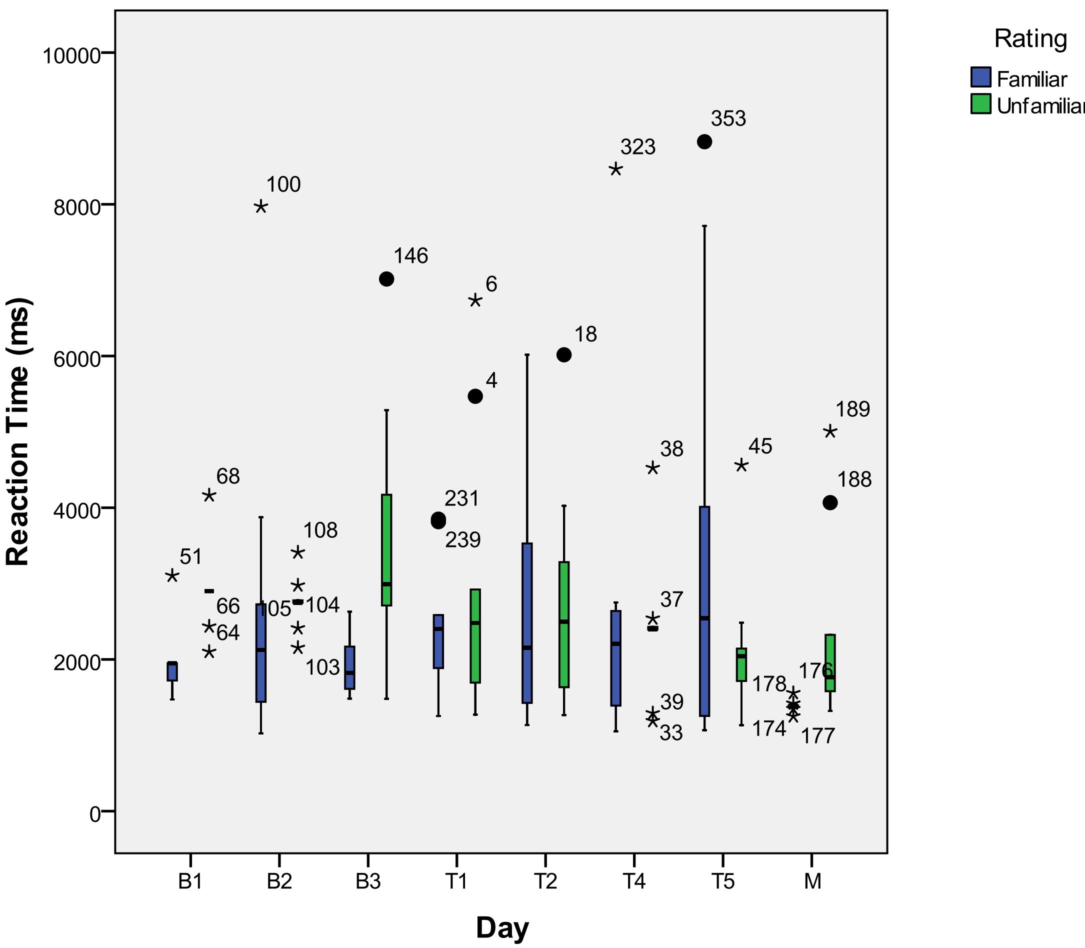


Figure 21

JD: PCA Reaction Time: Effect of Familiarity on Treated Stimuli Across Time

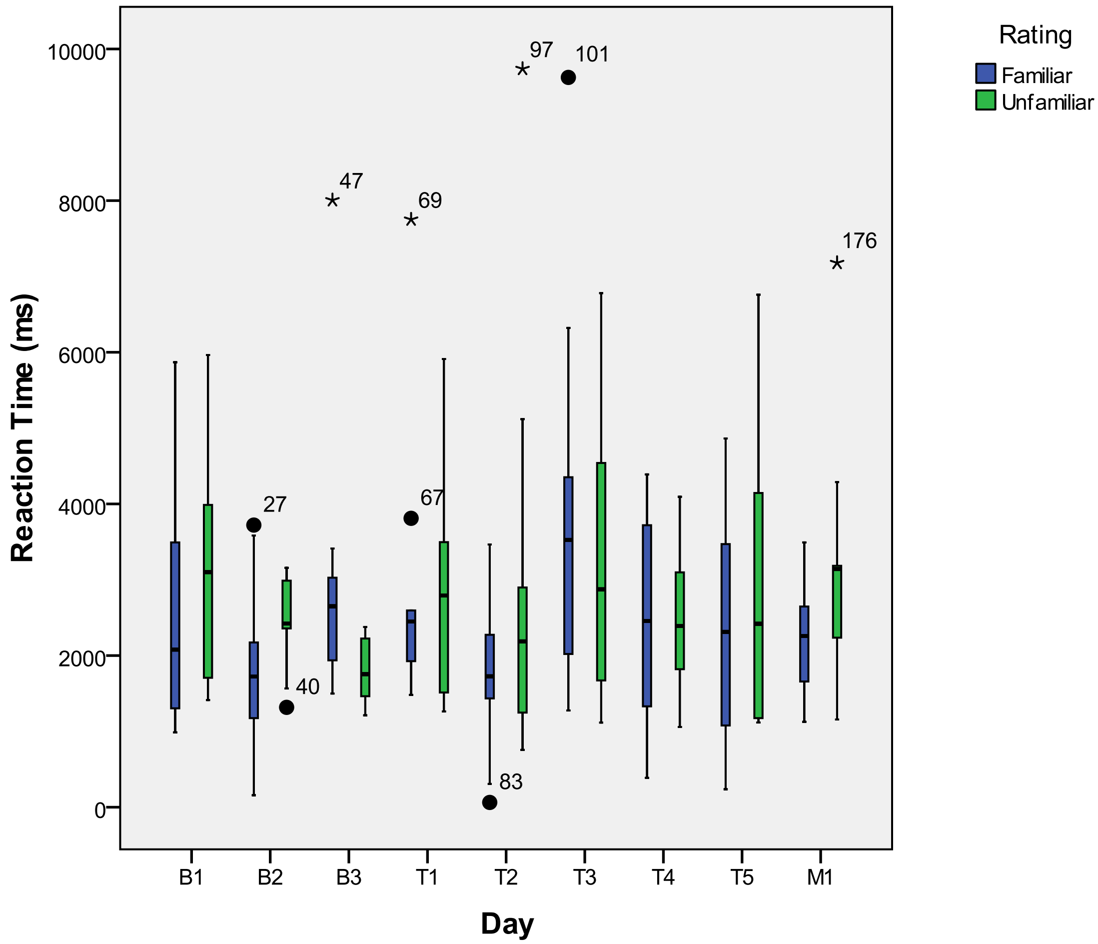


Figure 22

RR: PCA Reaction Time: Effect of Familiarity on Treated Stimuli Across Time

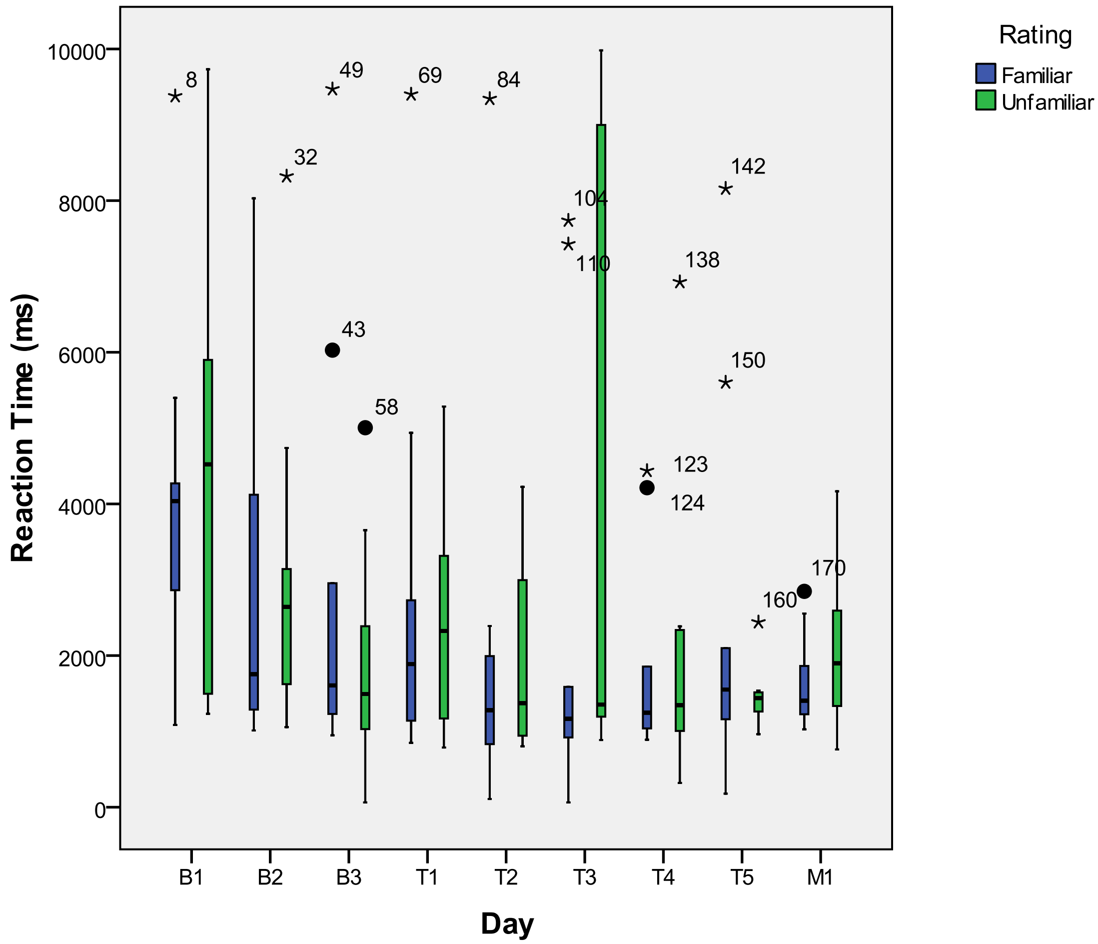


Figure 23

RR: SFA Reaction Time: Effect of Familiarity on Treated Stimuli Across Time

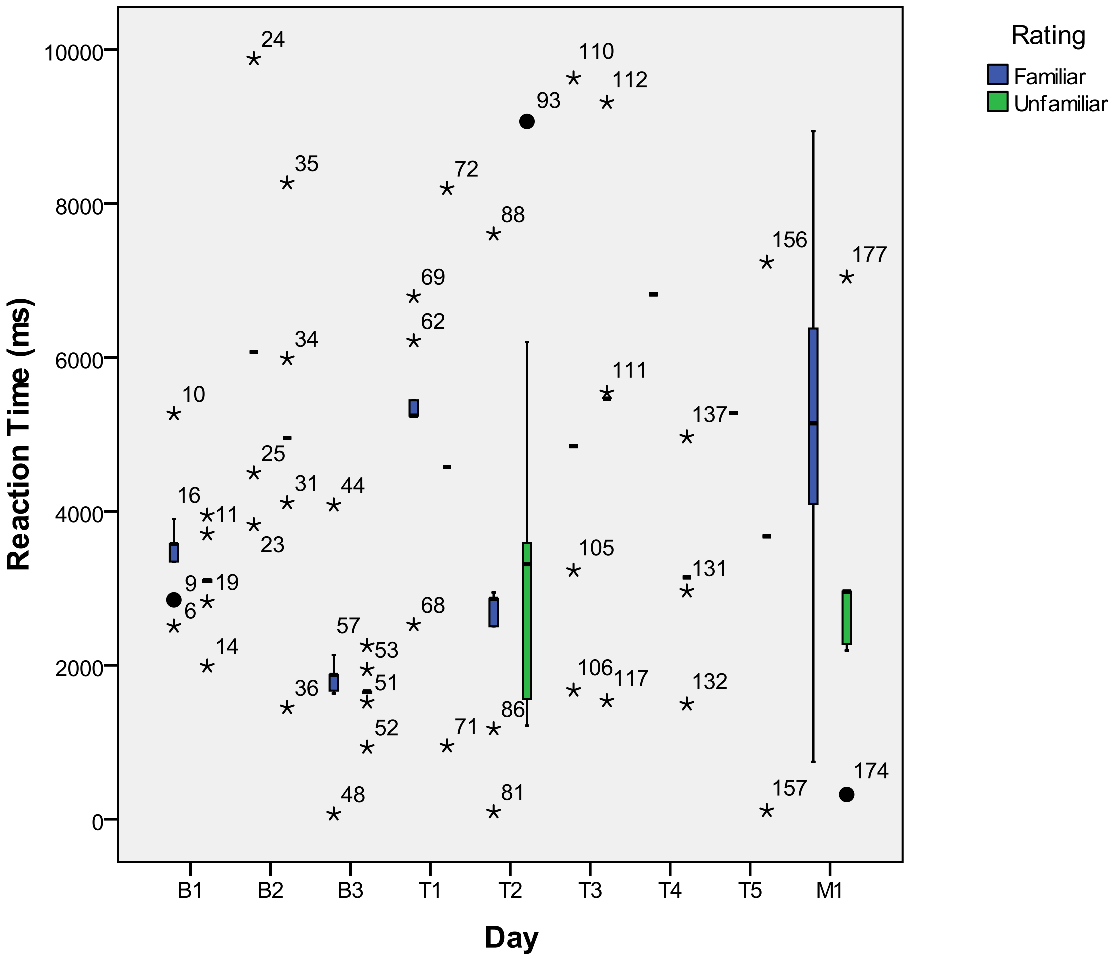


Figure 24

RM: PCA Reaction Time: Effect of Familiarity on Treated Stimuli Across Time

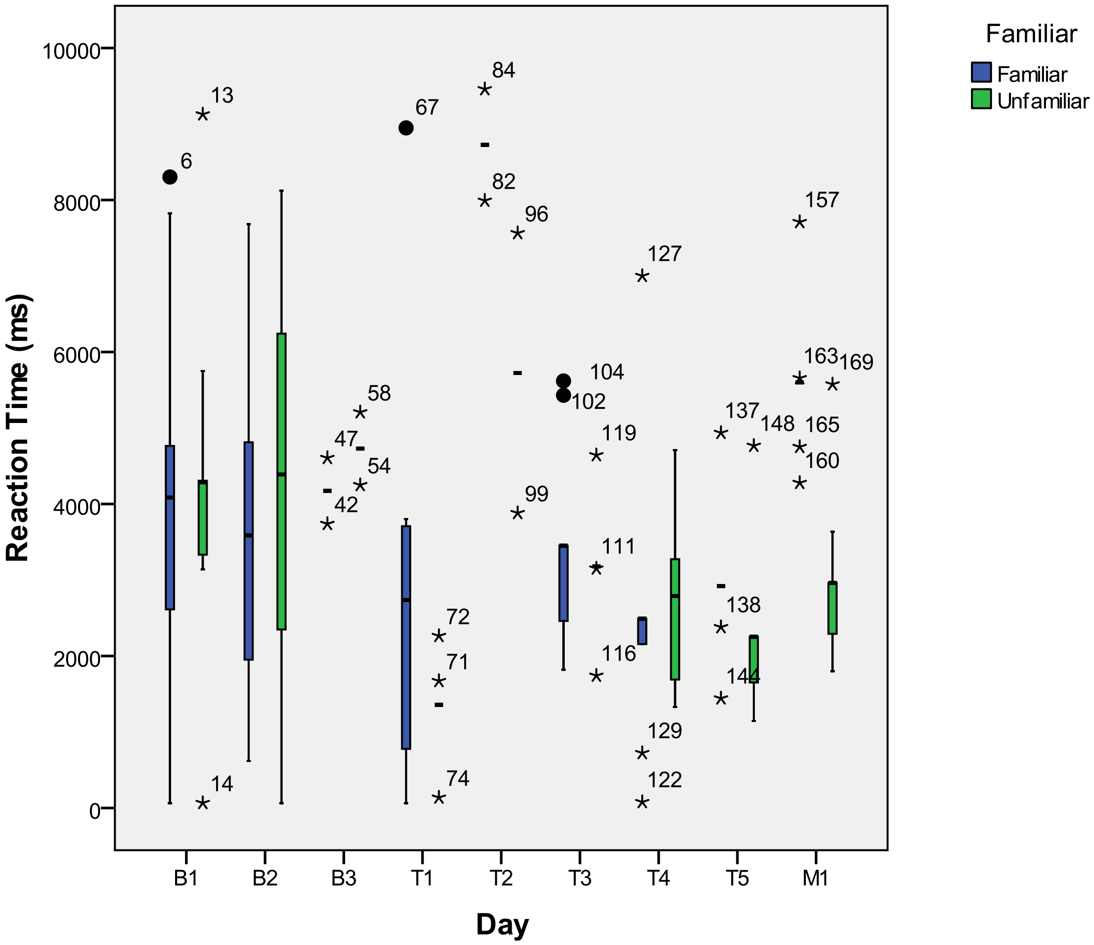


Figure 25

RM: SFA Reaction Time: Effect of Familiarity on Treated Stimuli Across Time

Table 3. *Treatment Effectiveness Relative to Reaction Time (ms) of Familiar and Unfamiliar Stimuli*				
Participant And Testing Period	SFA Baseline	SFA Day 5 (Post-Tx)	PCA Baseline	PCA Day 5 (Post-Tx)
<u>IC</u>				
Familiar	2056	3045	3644	2541
Unfamiliar	3202	4346	3324	4190
<u>JD</u>				
Familiar	2017	3597	2206	3426
Unfamiliar	2235	3024	3042	2143
<u>RR</u>				
Familiar	2521	2465	3242	2446
Unfamiliar	2419	2919	3069	1458
<u>RM</u>				
Familiar	3840	5277	4266	2920
Unfamiliar	3241	3675	3323	2253

familiar stimuli after PCA treatment which was not observed after SFA, whereas JD showed noticeable increases in RT for familiar stimuli in both treatments.

The relationship between accuracy and RT for treated stimuli relative to familiarity for the two treatment types was examined for each participant. All participants had 100 reaction time measurements for each treatment (50 familiar and 50 unfamiliar), with the exception of JD who had 80 reaction time measurements (40 familiar and 40 unfamiliar) for PCA treatment. JD's missing data resulted from instrumental error on Day 3. These data are presented in Figures 26, 27, 28, and 29 for IC, JD, RR, and RM, respectively. IC produced correct responses faster than incorrect responses for SFA; however, for PCA, he correctly retrieved familiar stimuli more slowly than misnaming unfamiliar stimuli. For JD, correct responses were produced faster than incorrect responses for both treatment approaches. Relative to SFA, JD was fastest at correctly producing unfamiliar stimuli and slowest at misnaming of unfamiliar stimuli. For RR, correct responses were produced faster than incorrect responses for PCA, but slower than incorrect responses for SFA. During PCA, RR was fastest at correctly producing familiar stimuli but for SFA, RR was fastest at misnaming of unfamiliar stimuli. RM was fastest at correct retrieval of unfamiliar stimuli and slowest at correct retrieval of familiar stimuli during PCA treatment.

<u>Treatment Effects</u>

The second experimental question addressed the effect of treatment overall and the effect of treatment for a particular treatment type per participant. Figures exhibiting stimulus accuracy for treatment stimuli regardless of familiarity across time for each participant are presented in Figures 30, 31, 32, and 33 for IC, JD, RR, and RM, respectively. The influence of familiarity and treatment on accuracy across baseline and treatments for each participant are presented in Figures 34, 35, 36, and 37.

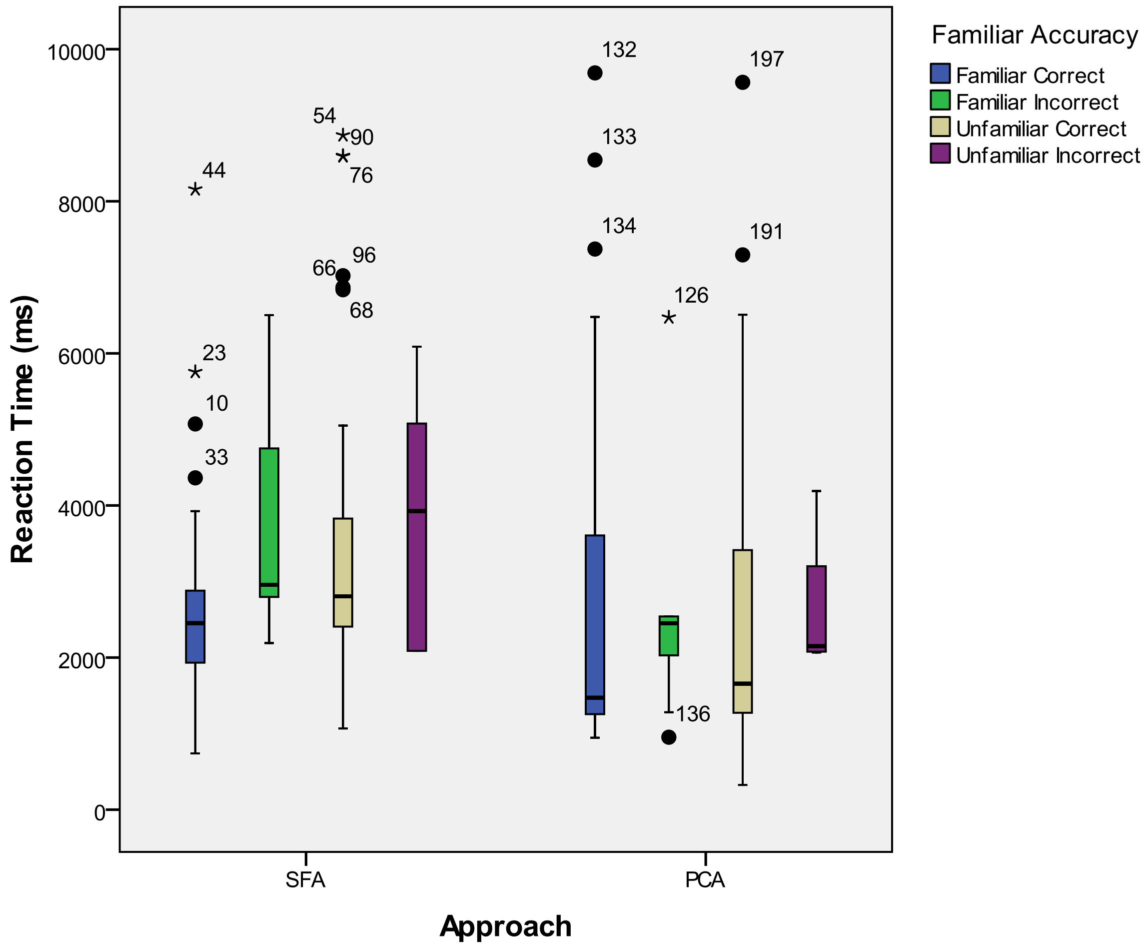


Figure 26

IC: Effect of Familiarity on Treated Stimuli: Relationship Between Reaction Time and Accuracy for SFA and PCA

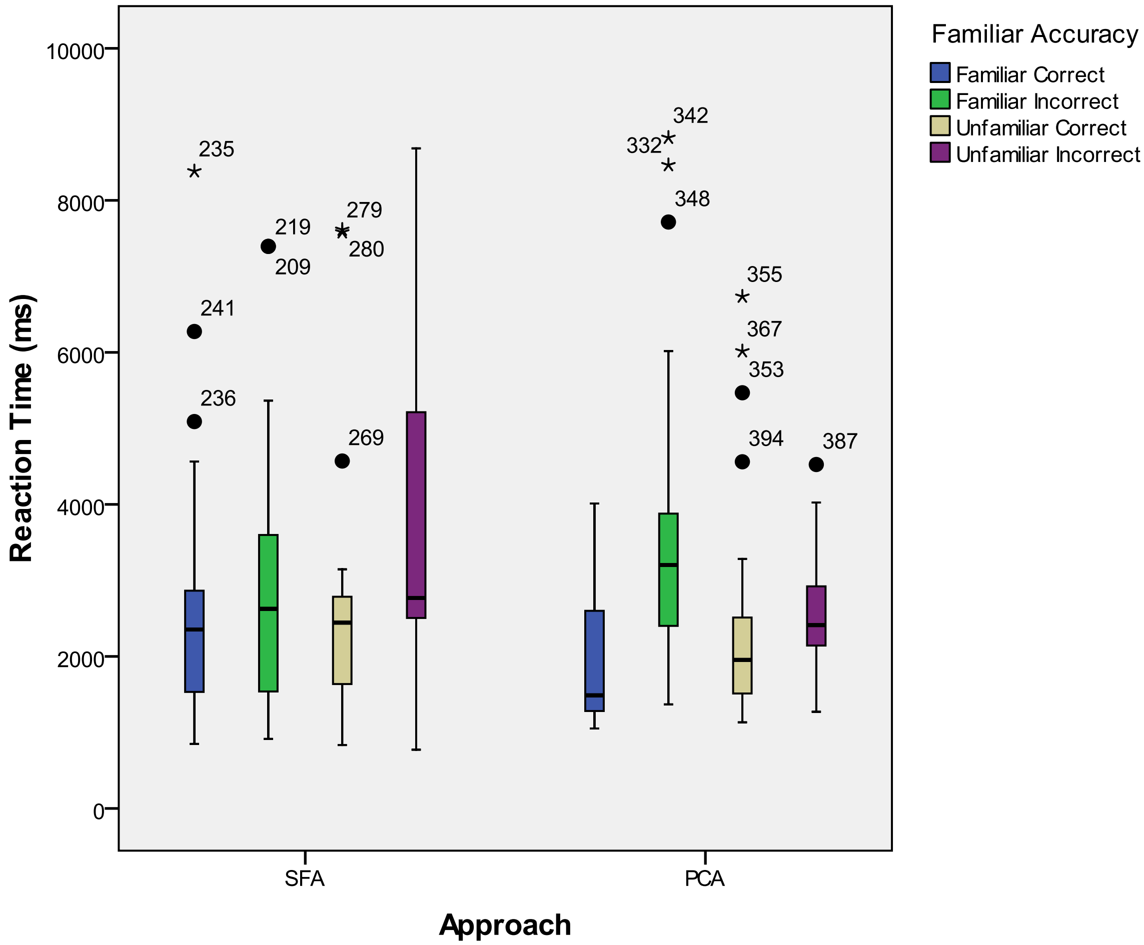


Figure 27

JD: Effect of Familiarity on Treated Stimuli: Relationship Between Reaction Time and Accuracy for SFA and PCA

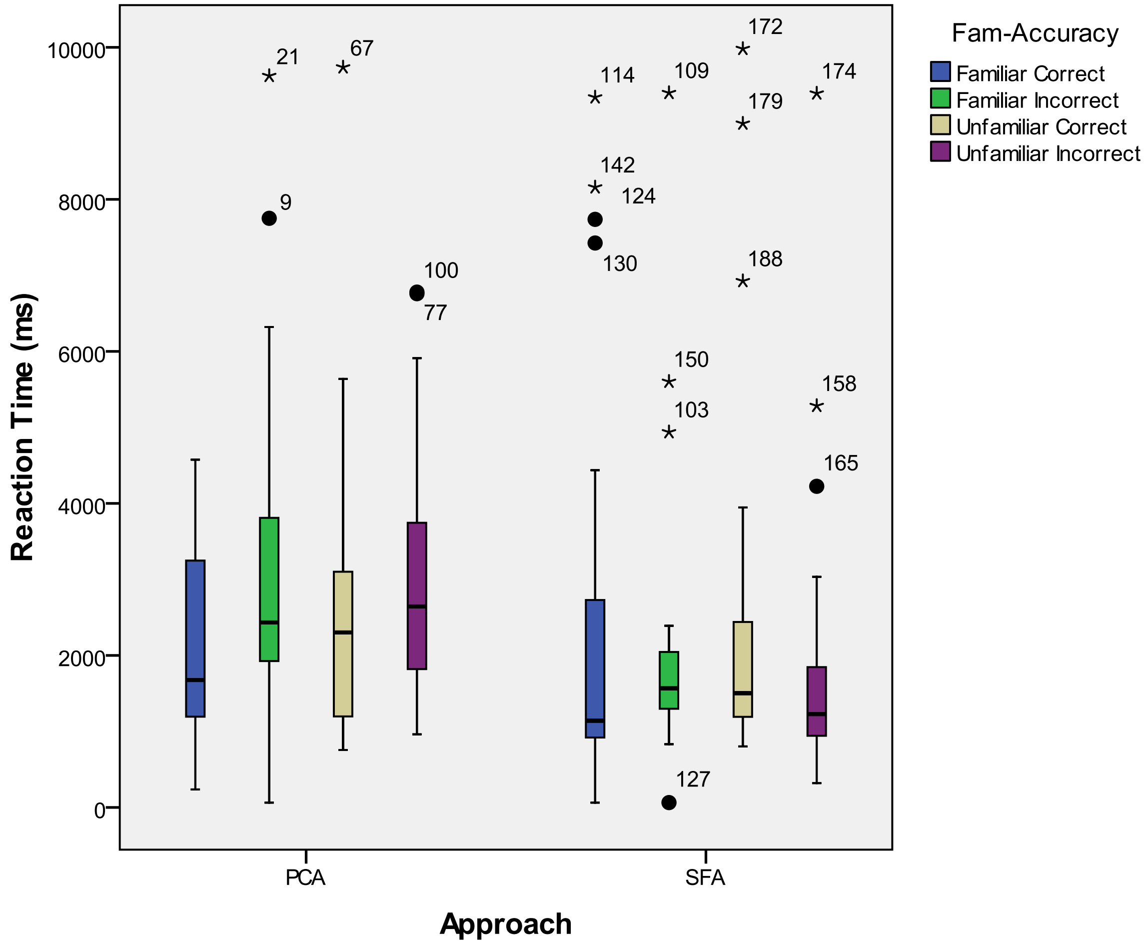


Figure 28

RR: Effect of Familiarity on Treated Stimuli: Relationship Between Reaction Time and Accuracy for SFA and PCA

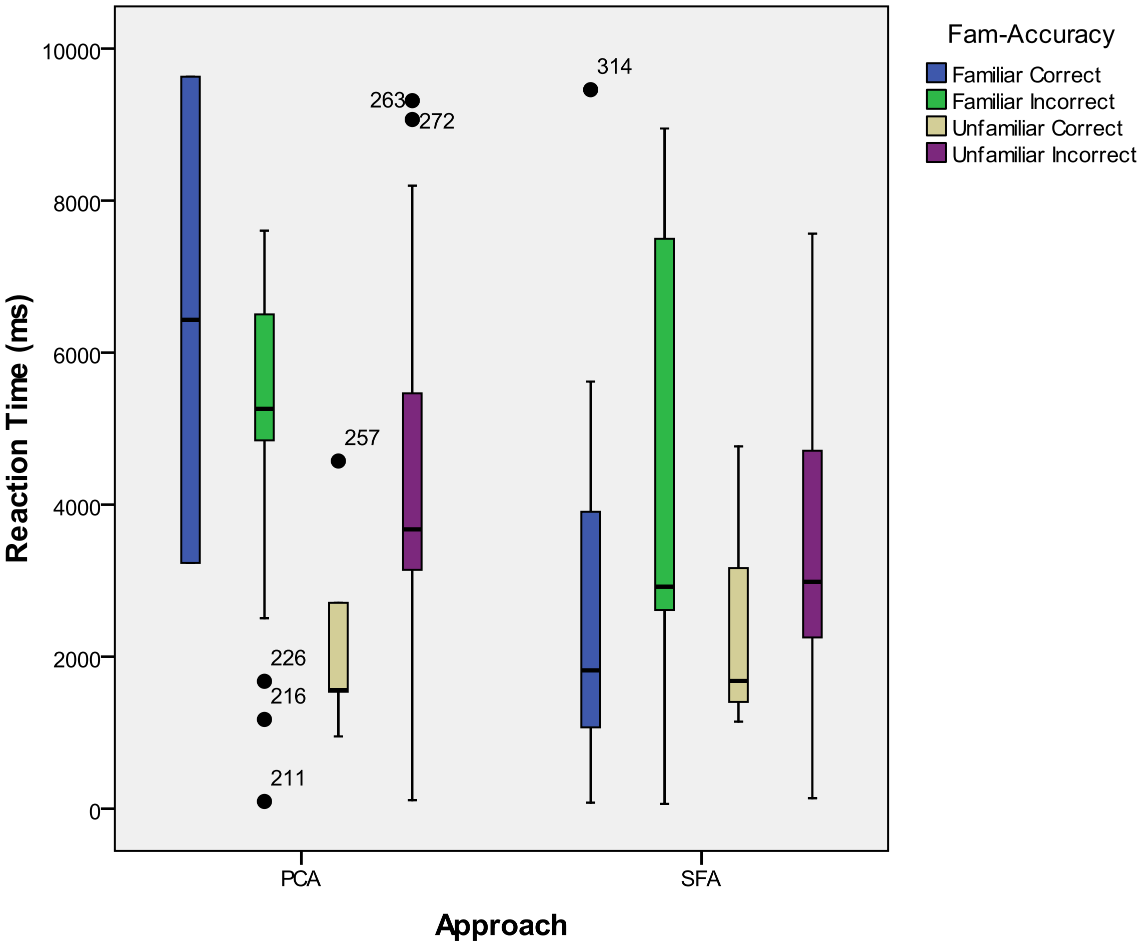


Figure 29

RM: Effect of Familiarity on Treated Stimuli: Relationship Between Reaction Time and Accuracy for SFA and PCA

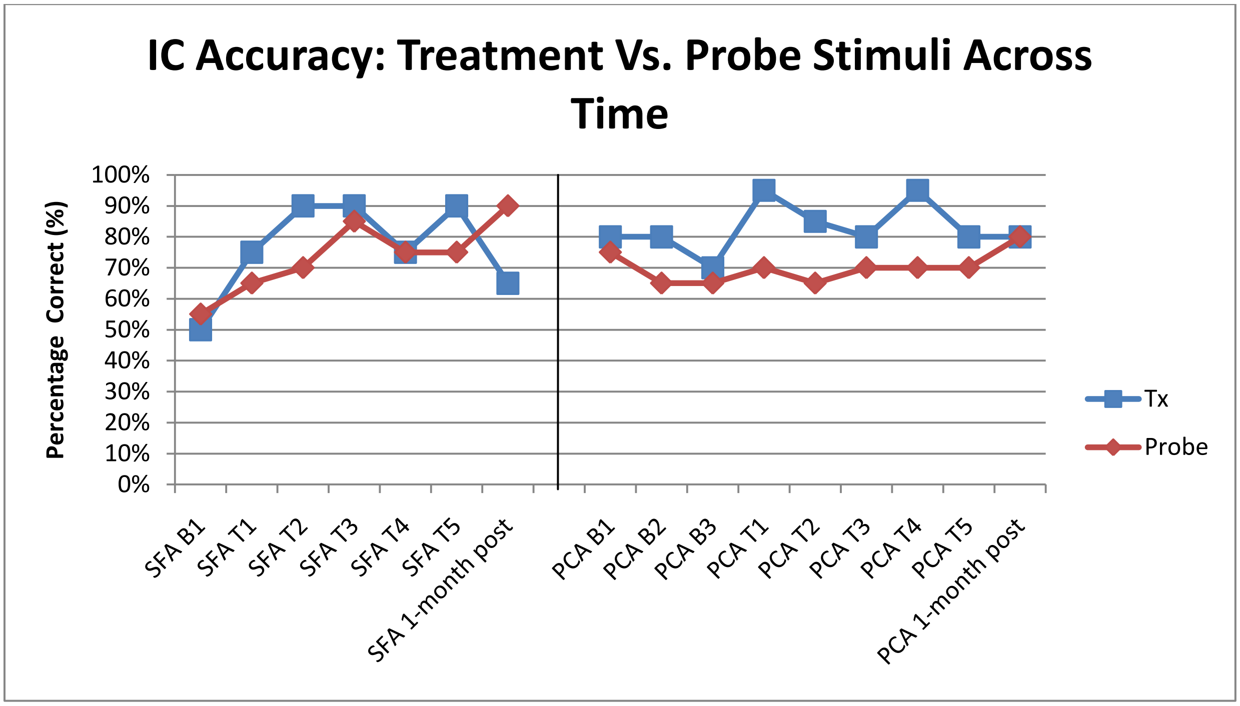

IC Accuracy: Treatment Vs. Probe Stimuli Across Time
Percentage Correct (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
SFA B1
SFA T1
SFA T2
SFA T3
SFA T4
SFA T5
SFA 1-month post
PCA B1
PCA B2
PCA B3
PCA T1
PCA T2
PCA T3
PCA T4
PCA T5
PCA 1-month post
Tx
Probe

Figure 30

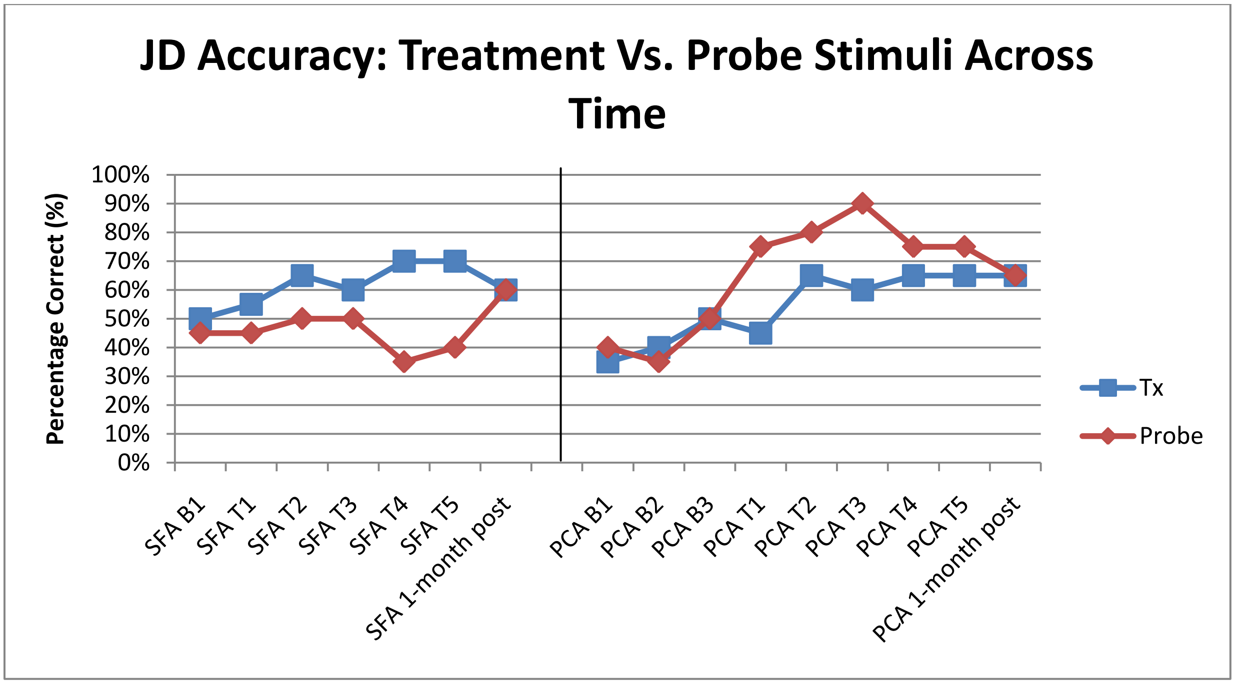

JD Accuracy: Treatment Vs. Probe Stimuli Across Time
Percentage Correct (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
SFA B1
SFA T1
SFA T2
SFA T3
SFA T4
SFA T5
SFA 1-month post
PCA B1
PCA B2
PCA B3
PCA T1
PCA T2
PCA T3
PCA T4
PCA T5
PCA 1-month post
Tx
Probe

Figure 31

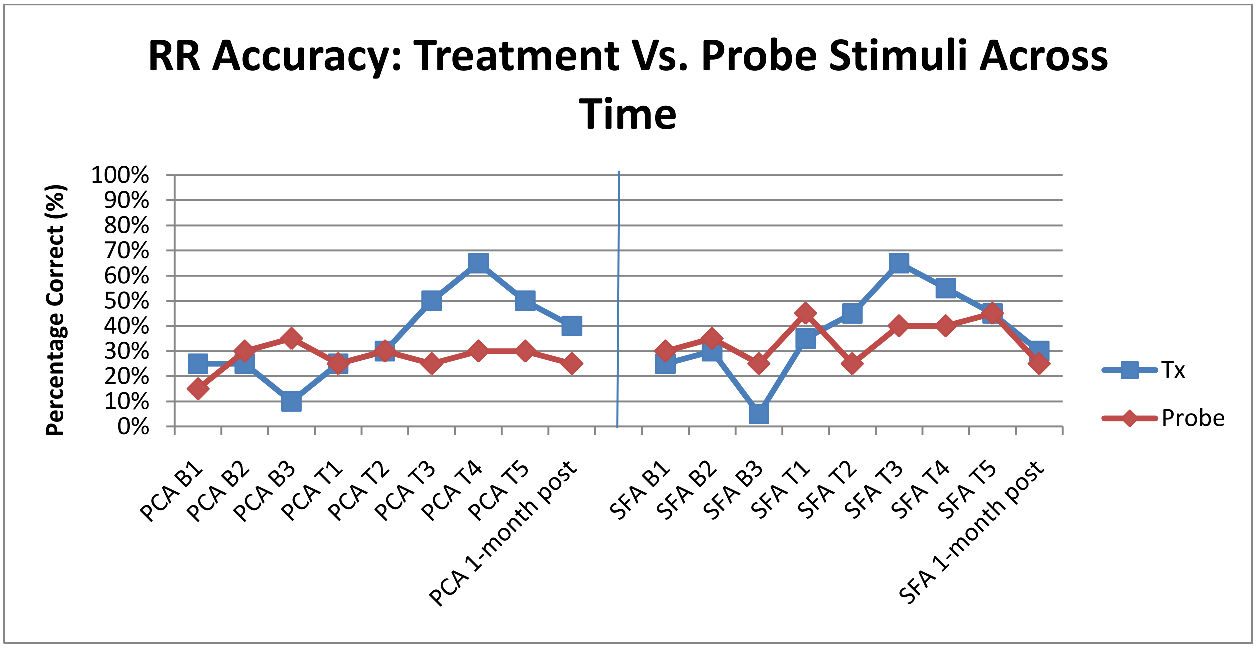

RR Accuracy: Treatment Vs. Probe Stimuli Across Time
Percentage Correct (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
PCA B1
PCA B2
PCA B3
PCA T1
PCA T2
PCA T3
PCA T4
PCA T5
PCA 1-month post
SFA B1
SFA B2
SFA B3
SFA T1
SFA T2
SFA T3
SFA T4
SFA T5
SFA 1-month post
Tx
Probe

Figure 32

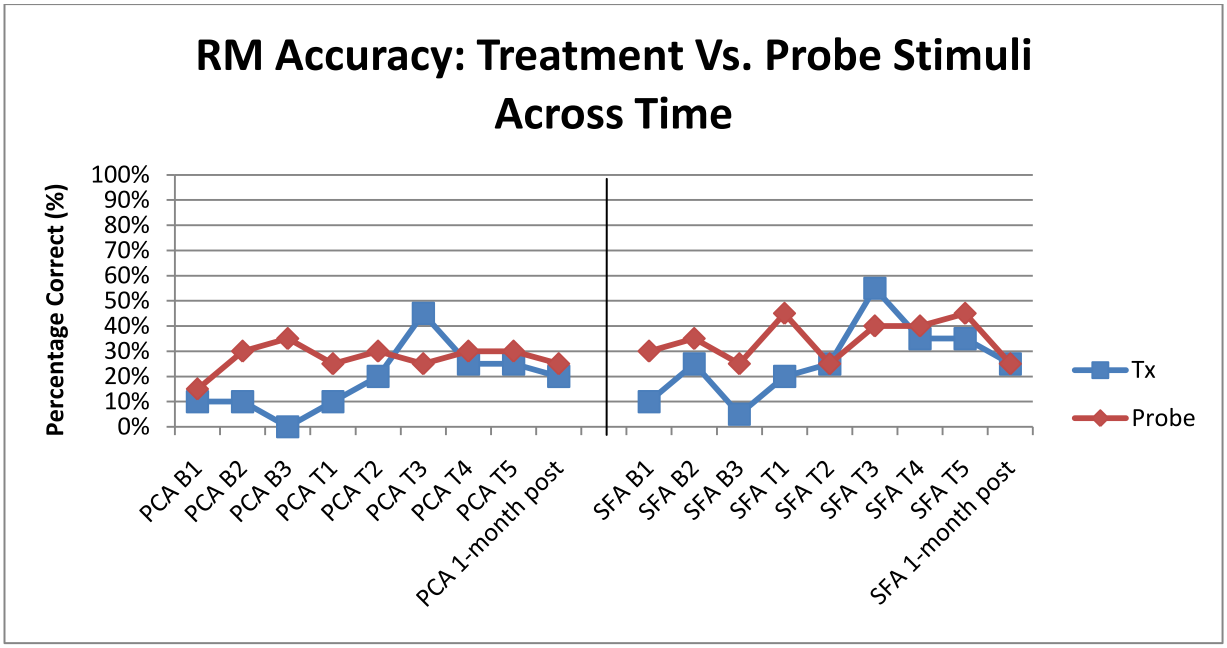

RM Accuracy: Treatment Vs. Probe Stimuli Across Time
Percentage Correct (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
PCA B1
PCA B2
PCA B3
PCA T1
PCA T2
PCA T3
PCA T4
PCA T5
PCA 1-month post
SFA B1
SFA B2
SFA B3
SFA T1
SFA T2
SFA T3
SFA T4
SFA T5
SFA 1-month post
Tx
Probe

Figure 33

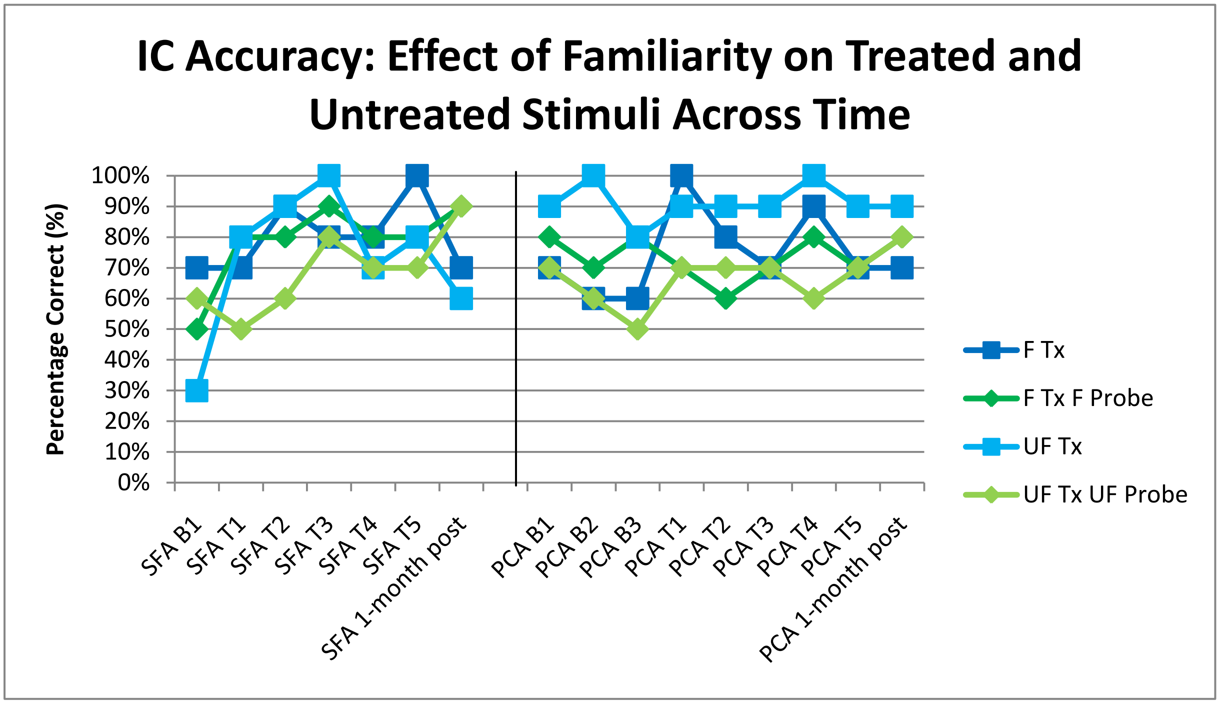

IC Accuracy: Effect of Familiarity on Treated and Untreated Stimuli Across Time
Percentage Correct (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
SFA B1
SFA T1
SFA T2
SFA T3
SFA T4
SFA T5
SFA 1-month post
PCA B1
PCA B2
PCA B3
PCA T1
PCA T2
PCA T3
PCA T4
PCA T5
PCA 1-month post
F Tx
F Tx F Probe
UF Tx
UF Tx UF Probe

Figure 34

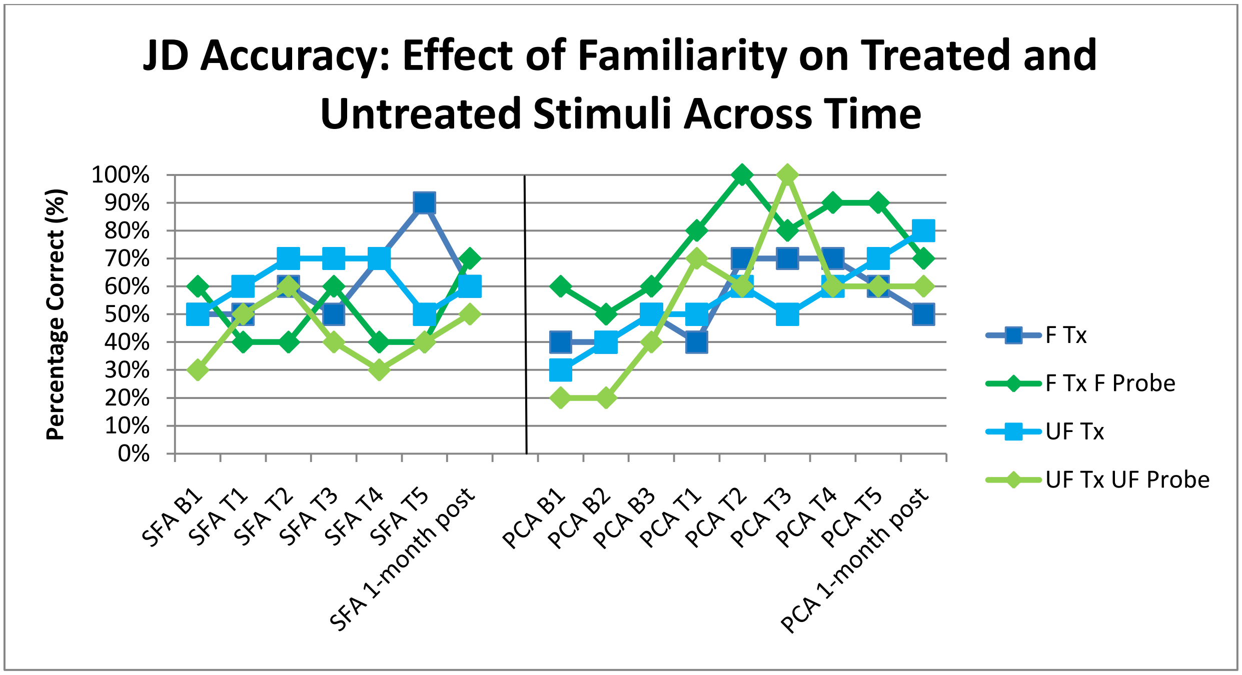

JD Accuracy: Effect of Familiarity on Treated and Untreated Stimuli Across Time
Percentage Correct (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
SFA B1
SFA T1
SFA T2
SFA T3
SFA T4
SFA T5
SFA 1-month post
PCA B1
PCA B2
PCA B3
PCA T1
PCA T2
PCA T3
PCA T4
PCA T5
PCA 1-month post
F Tx
F Tx F Probe
UF Tx
UF Tx UF Probe

Figure 35

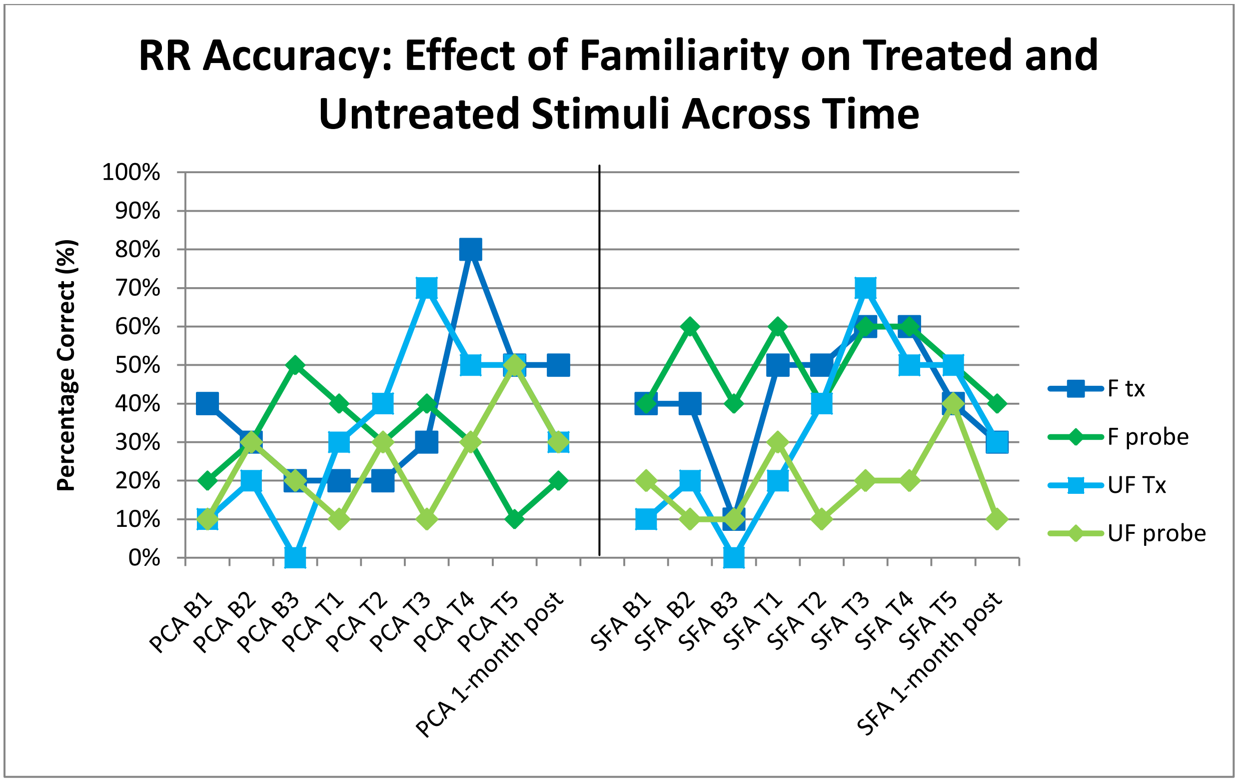

RR Accuracy: Effect of Familiarity on Treated and Untreated Stimuli Across Time
Percentage Correct (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
PCA B1
PCA B2
PCA B3
PCA T1
PCA T2
PCA T3
PCA T4
PCA T5
PCA 1-month post
SFA B1
SFA B2
SFA B3
SFA T1
SFA T2
SFA T3
SFA T4
SFA T5
SFA 1-month post
F tx
F probe
UF Tx
UF probe

Figure 36

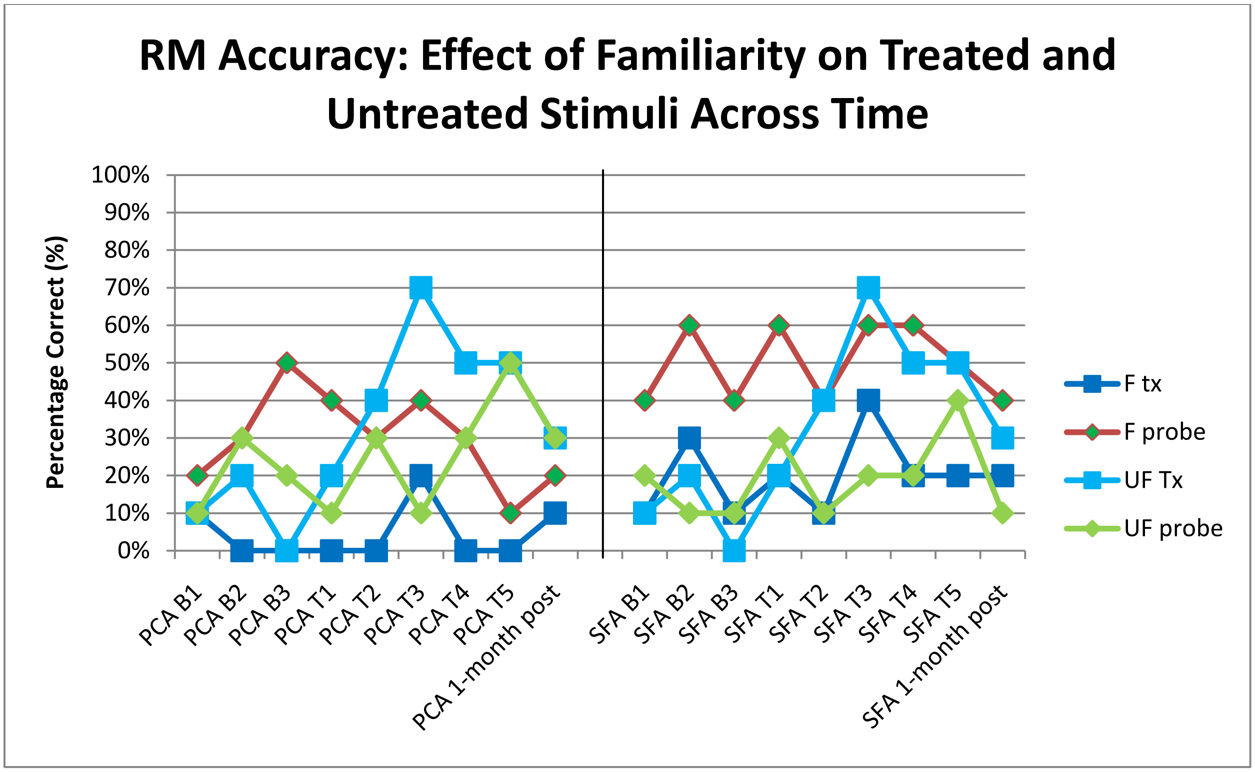

RM Accuracy: Effect of Familiarity on Treated and Untreated Stimuli Across Time
Percentage Correct (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
PCA B1
PCA B2
PCA B3
PCA T1
PCA T2
PCA T3
PCA T4
PCA T5
PCA 1-month post
SFA B1
SFA B2
SFA B3
SFA T1
SFA T2
SFA T3
SFA T4
SFA T5
SFA 1-month post
F tx
F probe
UF Tx
UF probe

Figure 37

McNemar's Tests were conducted to determine treatment effects relative to accuracy on SFA and PCA treatments independently for each participant. All tests were conducted at a 5% significance level. Stimuli were different across treatments for each participant.

For each treatment (SFA or PCA), accuracy measures were obtained for eighty stimuli (40 familiar, 40 unfamiliar). For each treatment type, baseline performance was compared to performance accuracy on day 5 of each treatment type. Results revealed significant findings for IC for SFA treatment (p=.008) with significantly increased accuracy of word retrieval after treatment. There were no significant findings relative to PCA treatment (p >.05). Significant findings were observed for RR after both PCA (p=.0312) and SFA treatments (p=.0312) with significantly increased accuracy after treatment. For RM, significant findings were observed for SFA treatment (p=.0312); accuracy performance was significantly increased after treatment. However, there were no significant findings for PCA treatment (p >.05). No significant findings were observed for JD for either treatment (p >.05). All significant findings were of practical as well as clinical significance. Accuracy data for treated stimuli for each participant is in Appendix K.

RT data relative to treatment performance of treated stimuli, regardless of familiarity, are presented separately for both treatment approaches across time for each participant in Figures 38 (SFA) and 39 (PCA) for IC, 40 (SFA) and 41 (PCA) for JD, 42 (PCA) and 43 (SFA) for RR, and 44 (PCA) and 45 (SFA) for RM. Paired sample t-tests were conducted on the RT data to determine treatment effects on SFA and PCA independently for each participant. For each treatment type, baseline RT performance was compared to RT performance on day 5 of each treatment type. Twenty stimuli (10 familiar and 10 unfamiliar) were compared for each participant. The results revealed significant findings for IC relative to SFA (CI= -2.12 to -.0130 seconds; t *(df=19)* = -2.119; p= .048), with a significant effect of slower retrieval after this treatment; no significant findings were observed for PCA (p >.05). Results revealed significant findings for JD relative to SFA (CI= -1.62 to -.344 seconds; t *(df=19)* = -3.220; p= .005), also presenting with a significant effect of slower retrieval after this treatment; no significant findings were observed for PCA (p >.05). RR showed significantly faster retrieval after SFA treatment (CI= .327 to 2.38 seconds; t *(df=19)* = 2.760; p= .012) with no significant findings for PCA (p >.05). RM also exhibited significantly faster retrieval after SFA treatment (CI= -1.67 to -.203 seconds; t *(df=19)* = 4.606; p= .000), but showed significantly slower retrieval after PCA treatment (CI= -1.67 to -.203 seconds; t *(df=19)* = -2.673; p= .015). RT data for treated stimuli for each participant are in Appendix L.

<u>Generalization Effects</u>

The third experimental question addressed the overall generalization of treatment effects and generalization regarding a particular treatment type per participant. Data reflecting stimulus accuracy for generalization (probe), regardless of familiarity, as well as addressing the effect of familiarity across time for each participant are on Figures 30 and 34 (IC), 31 and 35 (JD), 32 and 36 (RR), and 33 and 37 (RM).

McNemar's Tests were conducted to determine generalization effects relative to accuracy on SFA and PCA independently for each participant. For each treatment type, baseline performance was compared to probe performance accuracy on day 5 of each treatment. Twenty stimuli (10 familiar and 10 unfamiliar) were compared for each participant. Results revealed significant generalization findings only for JD relative to SFA (p= .0391), with significantly greater accuracy on probe stimuli after treatment. No significant findings were observed for PCA (p >.05) and no significant results were found for IC, RR, or RM for either treatment (p >.05). Accuracy data for probe performance for each participant is in Appendix M.

Data reflecting stimulus RT relative to generalization (probe), regardless of familiarity, are presented separately for both treatment approaches across time for each participant, on Figures 38 (SFA) and 39 (PCA) for IC, 40 (SFA) and 41 (PCA) for JD, 42 (PCA) and 43 (SFA) for RR, and 44 (PCA) and 45 (SFA) for RM. Paired samples t-tests were conducted on the RT data to determine generalization effects on SFA and PCA independently for each participant. For each treatment type, baseline RT performance was compared to RT performance for probe stimuli on day 5 of each treatment. Twenty stimuli (10 familiar and 10 unfamiliar) were compared for each participant. All tests were set at a 5% significance level. Significant generalization effects relative to RT were found for IC (CI= 009 to 1.56 seconds; t *(df=19)* = 2.118; p= 048.), JD (CI= .688 to 1.70 seconds; t *(df=19)* = 4.940 ; p=.000) and RM (CI= -2.94 to -.160 seconds; t *(df=19)* = -2.335; p=.031) after PCA treatment only. IC and JD showed significantly faster retrieval after PCA treatment, whereas RM showed significantly slower retrieval after PCA treatment. There were no significant generalization effects for RR relative to PCA (p >.05). No significant generalization findings were observed for SFA for any participant (p >.05). RT relative to probe data for both treatments for each participant are in Appendix N.

Standardized Test Performance

The fourth experimental question addressed whether performance differences on the *Western Aphasia Battery-Revised (WAB-R)* Aphasia Quotient (*AQ*) over time were reflective of changes in treatment performance for each participant. Table 4 is a display of *WAB-R* performance for each participant, showing a participant’s performance prior to treatment, after treatment type 1, and after treatment type 2. Thus, the *WAB-R* was administered to each

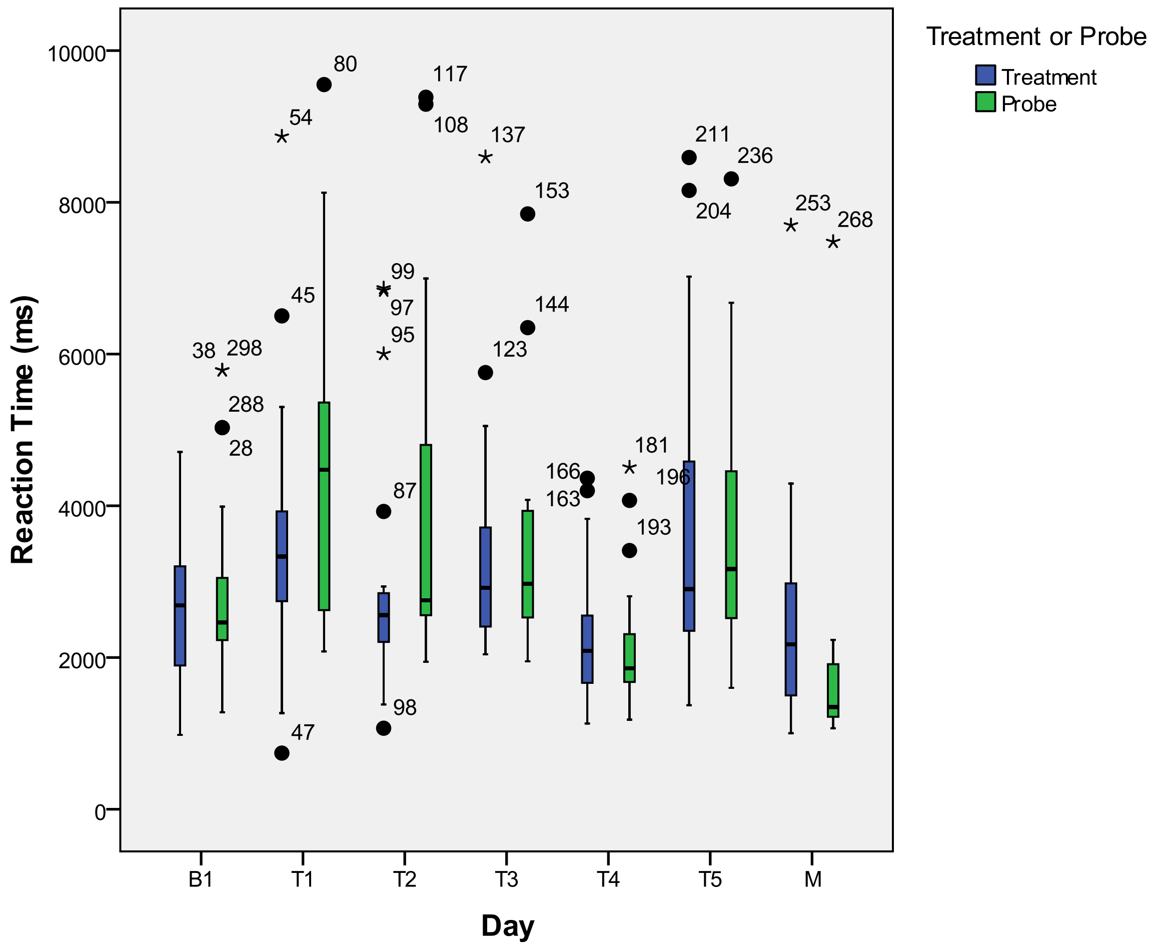


Figure 38

IC: SFA Reaction Time: Treatment Vs. Probe Stimuli Across Time

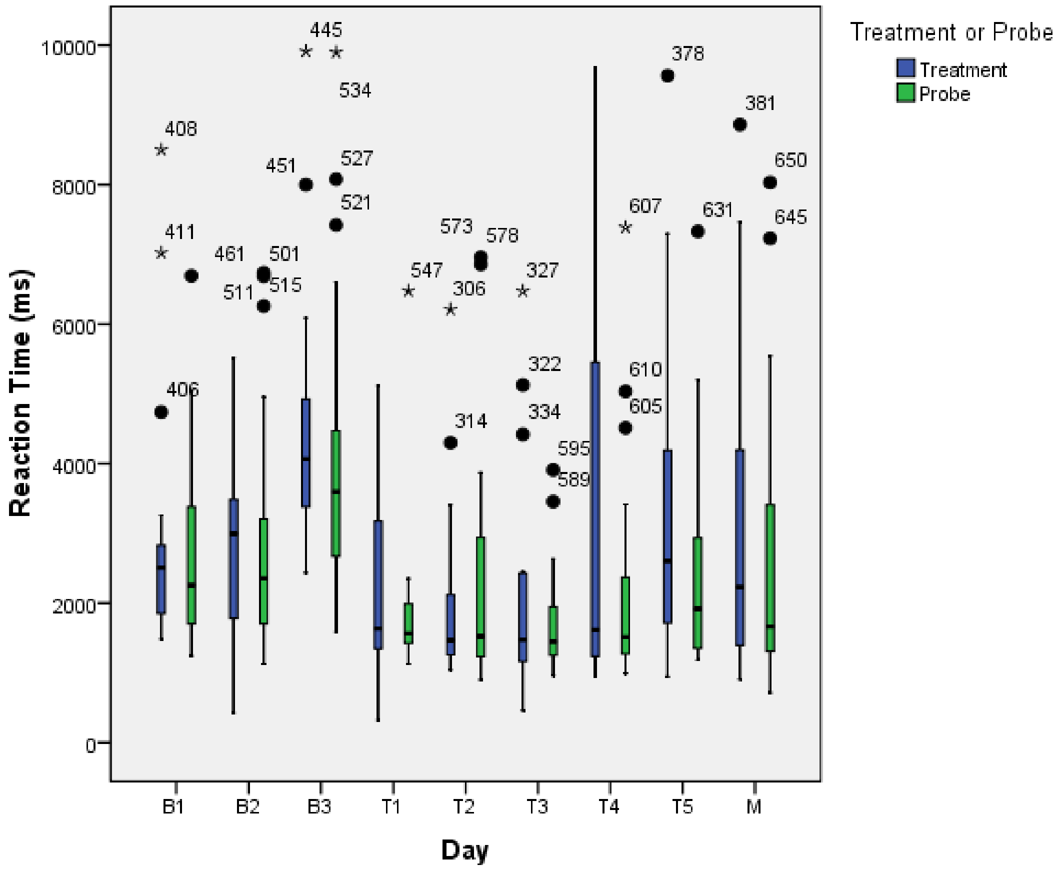


Figure 39

IC: PCA Reaction Time: Treatment Vs. Probe Stimuli Across Time

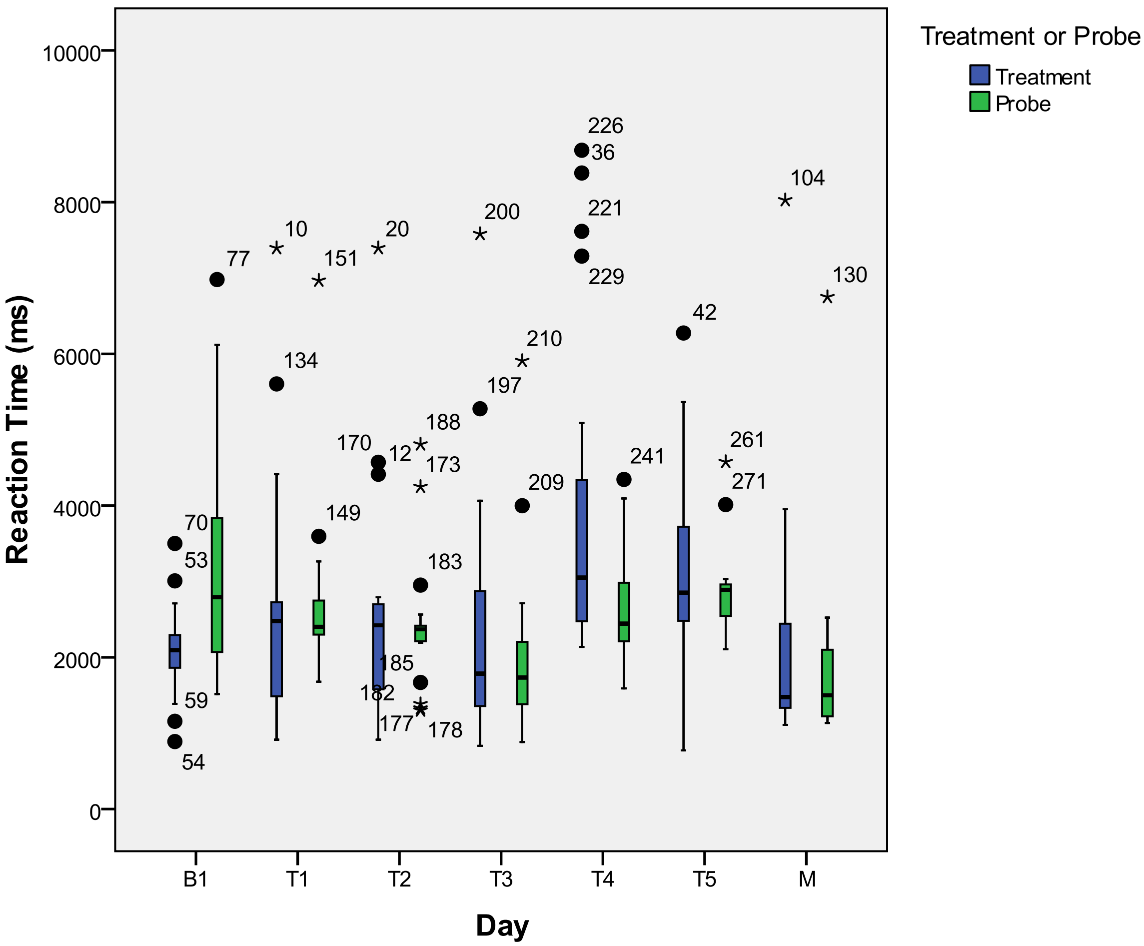


Figure 40

JD: SFA Reaction Time: Treatment Vs. Probe Stimuli Across Time

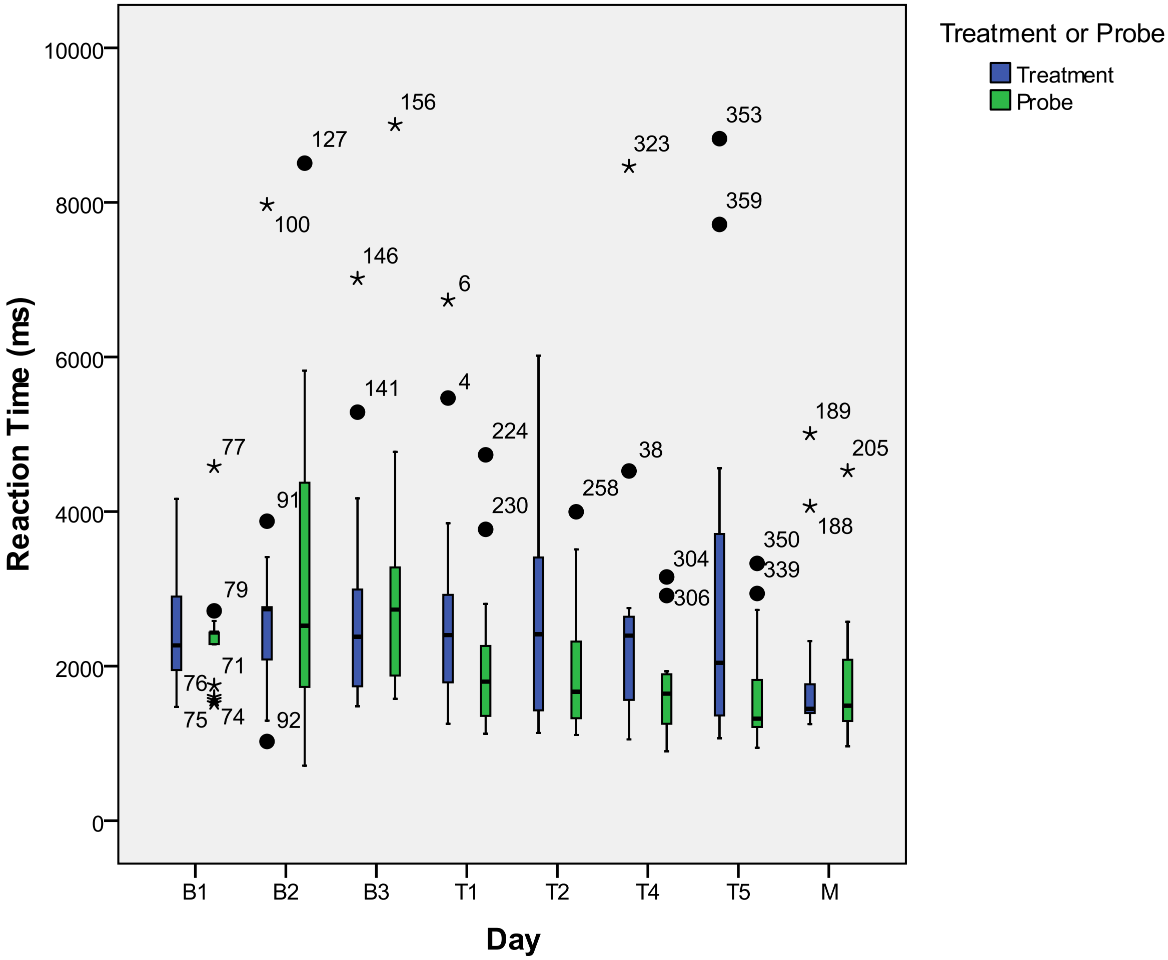


Figure 41

JD: PCA Reaction Time: Treatment Vs. Probe Stimuli Across Time

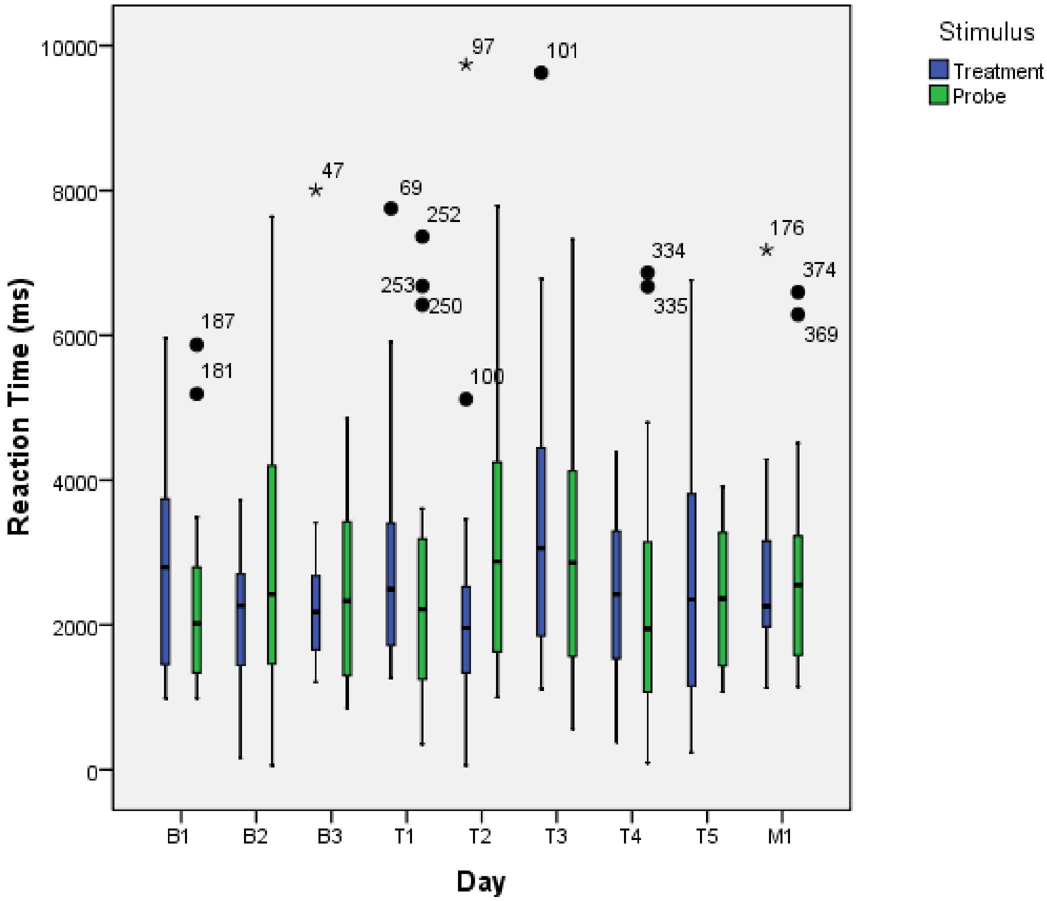


Figure 42

RR: PCA Reaction Time: Treatment Vs. Probe Stimuli Across Time

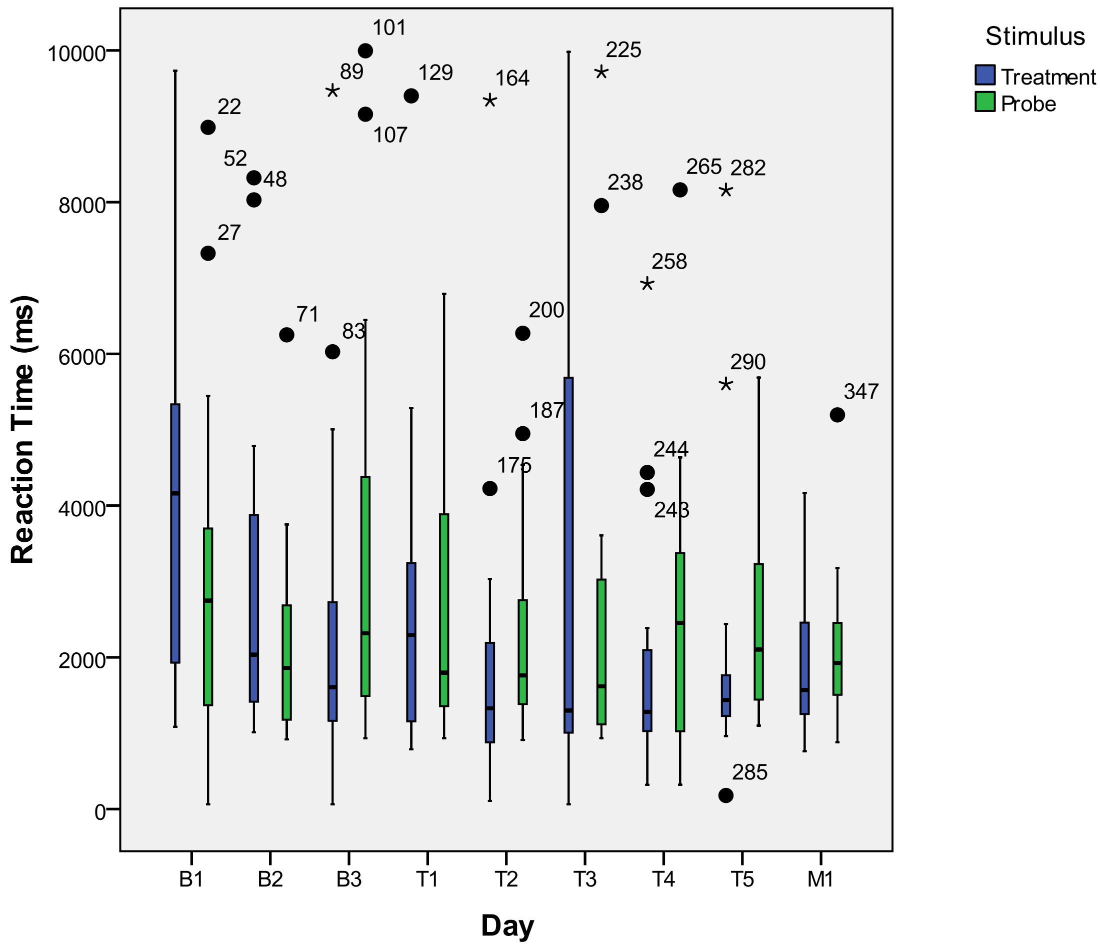


Figure 43

RR: SFA Reaction Time: Treatment Vs. Probe Stimuli Across Time

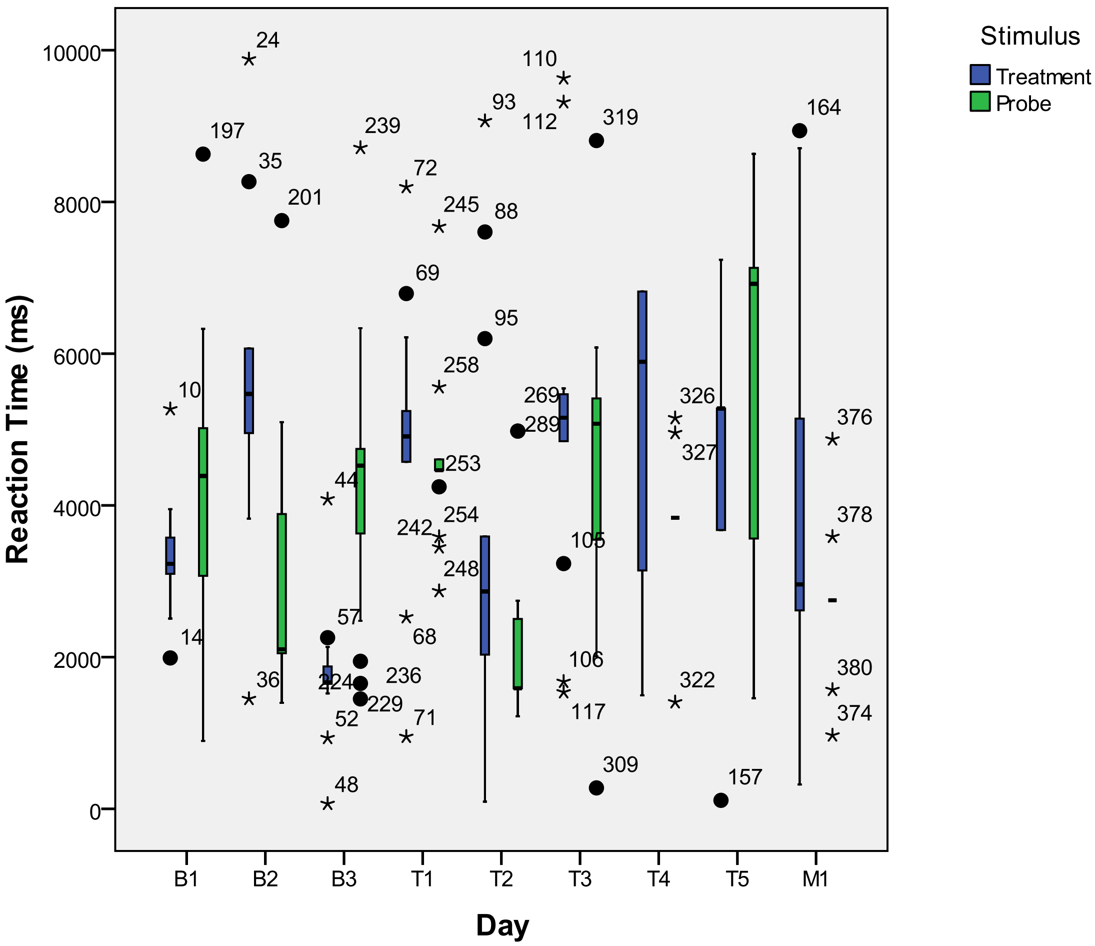


Figure 44

RM: PCA Reaction Time: Treatment Vs. Probe Stimuli Across Time

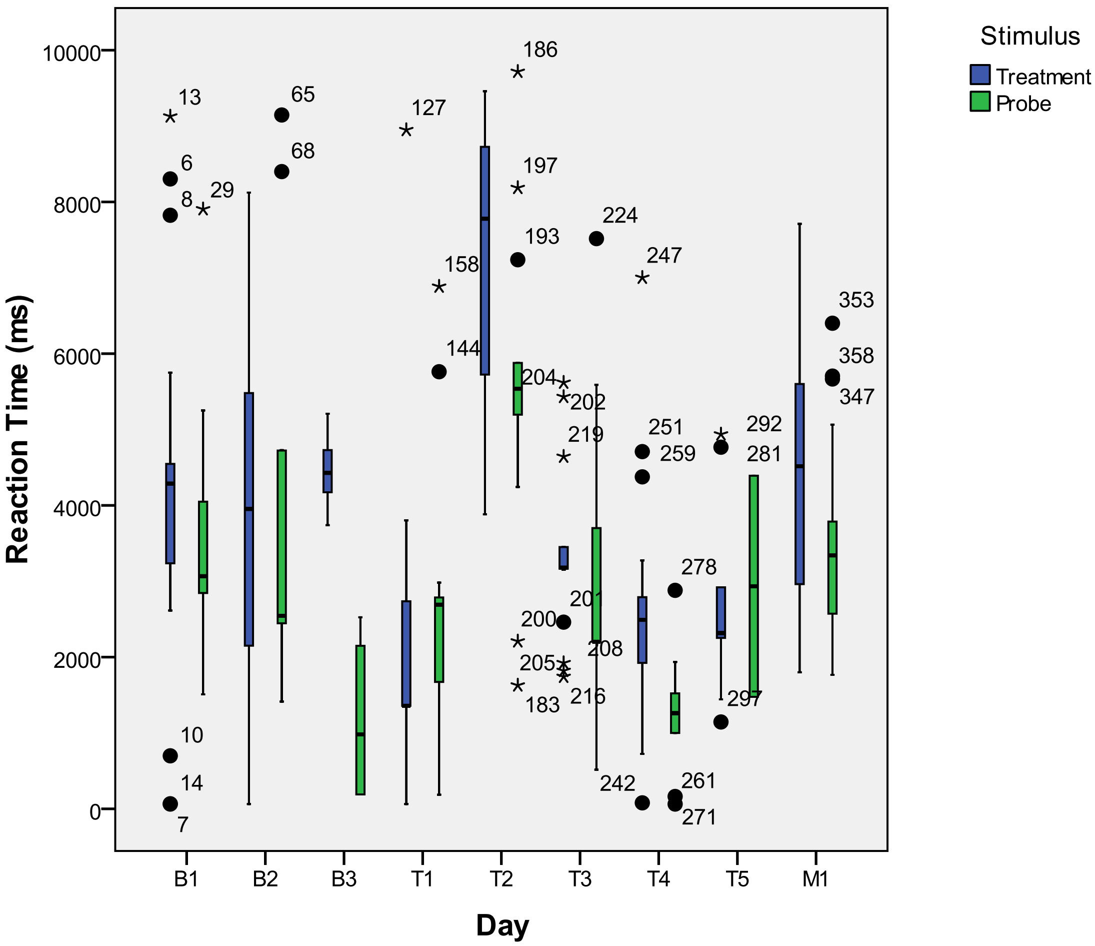


Figure 45

RM: SFA Reaction Time: Treatment Vs. Probe Stimuli Across Time participant three times periodically throughout the protocol to assess any treatment effects. Additionally, the second and third tests were administered within three days after the fifth treatment day to allow participant recovery and maintain experimental consistency. Statements regarding improvement, decline, or lack of change are discussed relative to change from pre-treatment test scores as well as in relationship to performance on the treatment protocols.

As can be seen in Table 4, IC's *AQ* increased from his pre-treatment performance across both post-treatment testing periods. This was a general treatment effect rather than a specific treatment effect, as improvement was noted after SFA with scores remaining stable after PCA treatment. His *AQ* was highest post-PCA (treatment 2), but only differed by .6 points in comparison to post-SFA performance (treatment 1). He showed increases in both Spontaneous Speech and Auditory Verbal Comprehension post-SFA (treatment 1) and post-PCA (treatment 2). He additionally showed specific improvement in Naming and Word Finding post-PCA (treatment 2). While both *AQ* scores increased, only increased accuracy (along with slower retrieval rates) resulted for SFA-treated stimuli in comparison to SFA-baseline measures.

JD's *AQ* increased from pre-treatment performance only after PCA treatment (see Table 4). Skill areas also improved on the WAB-R only after PCA treatment testing. Specifically, JD improved on Auditory Verbal Comprehension and Spontaneous Speech. For post-treatment SFA testing, WAB-R performance declined in all skill areas. Thus, despite increases in WAB-R AQ post-PCA treatment, significant accuracy effects were NOT found for after either SFA and PCA treatment; however, untreated stimuli were retrieved more accurately and rapidly post-PCA treatment than at baseline.

RR demonstrated increases relative to *WAB-R AQ* from pre-treatment performance to post-treatment 2 (SFA) only (see Table 4). Although *AQ* was lower on the post-treatment 1

(PCA) testing, he showed improvement in the area of Auditory Verbal Comprehension. On post-SFA testing, RR showed increases in the areas of Repetition and Naming and Word Finding. Spontaneous Speech scores remained constant across all testing. Accompanying findings on the standardized tests, both treatments resulted in a significant change in accuracy performance as well as significantly faster retrieval of treated stimuli following SFA treatment.

RM showed increases from pre-treatment *WAB-R AQ* performance to both post-treatment PCA and SFA testing. Improvement was noted on all areas assessed including Spontaneous Speech, Auditory Verbal Comprehension, Repetition, and Naming and Word Finding on both post-PCA and post-SFA testing, with greatest increases in Spontaneous Speech. While there were no significant changes in accuracy for either treatment protocol, both treatments resulted in changes in retrieval rates. According to RM's treatment and generalization effect results, faster retrieval rates were found for treated stimuli when compared to baseline retrieval rates for SFA and slower retrieval rates were observed for both treated and probe stimuli following PCA treatment.

The last experimental question addressed whether performance differences on the *Test of Adolescent/Adult Word Finding (TAWF)* total raw score over time were reflective of changes in treatment performance for each participant. Table 5 is a display of total raw scores and expressive subtest scores on the *TAWF* for each participant, prior to any treatment, after treatment 1, and after treatment 2. Standard Scores (SS) are not presented because they were low and stable across all testing for each participant. The *TAWF* was administered to each participant three times periodically throughout the protocol to assess any treatment effects. Additionally, the second and third tests were administered within three days after the fifth treatment day to allow participant recovery and maintain experimental consistency. Statements regarding improvement, decline, or lack of change are discussed relative to change from pre-treatment test scores as well as in relationship to performance on the treatment protocols. As seen in Table 5, IC's total raw score on the *TAWF* increased from pre-treatment performance to post-treatment testing for both treatment protocols. Improvement was observed on all five subtests assessing noun retrieval, verb retrieval, sentence completion, description naming, and category naming on post-SFA and post-PCA. Greatest area of improvement across both treatments was in the area of noun retrieval. While IC's SFA and PCA *TAWF* total raw scores increased for both treatment protocols, only SFA treatment resulted in the statistically significant effects of increased accuracy and slower retrieval rate, yielding a trade-off between accuracy and speed of retrieval.

JD showed increases in *TAWF* total raw score from pre-treatment performance to both post-treatment testing periods (see Table 5). Improvement was observed on subtests assessing noun retrieval, verbal retrieval, and category naming, with scores remaining constant for description naming and category naming post-PCA treatment. Post SFA, decline was noted on description naming, with a corresponding increase on category naming. Greatest area of improvement across both treatments was in the area of noun retrieval. Increases were observed in post-treatment *TAWF* total raw scores after both treatments. However, significantly increased accuracy and faster retrieval of probe stimuli only were observed with PCA treatment. SFA treatment resulted in significantly slower retrieval rate.

RR's *TAWF* total raw score increased from pre-treatment performance for both post-treatment testing periods (see Table 5). Improvement was noted on all areas, except description naming, across both post-treatment testing periods. His greatest area of improvement across both treatments was in the area of noun retrieval. While RR showed increased *TAWF* total raw scores

Table 4
Western Aphasia Battery-Revised AQ Scores throughout the treatment protocol for each participant

Participant Testing Time	Aphasia Quotient Max=100	Spontaneous Speech Max=20	Auditory Verbal Comprehension Max=10	Repetition Max=10	Naming and Word Finding Max=10
IC					
Pre-Tx	76.3	13	7.65	9.4	8.1
Post-SFA	87.9	18	8.25	9.7	8
Post-PCA	88.5	18	8.95	8.6	8.7
JD					
Pre-Tx	72.6	13	7.1	8.3	7.9
Post-SFA	65.9	11	6.25	8	7.7
Post-PCA	78.6	17	7.4	8.1	6.8
RR					
Pre-Tx	71.0	13	9	7.2	6.3
Post-PCA	70.4	13	9.5	7.1	5.6
Post-SFA	73.2	13	9.2	7	7.4
RM					
Pre-Tx	44.4	7	7.4	2.8	5
Post-PCA	56.0	11	8.8	4.1	4.1
Post-SFA	59.2	11	7.8	6.4	4.4

Table 5

Test of Adolescent/Adult Word Finding Scores

Participant Testing Time	TOTAL RAW SCORE Max= 107	TOTAL SS Max >115	% Rank Max=99.9	PN: Nouns Max=37	PN: Verbs Max=21	Sentence Completion Max=16	Description Naming Max=12	Category Naming Max=21
IC								
Pre-Tx	60	71	2.0	22	12	10	7	9
Post-SFA	83	89	21	32	16	11	12	12
Post-PCA	82	88	19	33	16	13	10	10
JD								
Pre-Tx	40	<58	<0.1	15	10	8	5	2
Post-SFA	50	<58	<0.1	20	12	8	4	6
Post-PCA	56	<58	<0.1	26	15	8	5	2
RR								
Pre-Tx	15	<58	<0.1	3	7	1	2	2
Post-PCA	32	<58	<0.1	9	11	3	4	5
Post-SFA	35	<58	<0.1	11	12	3	2	7
RM								
Pre-Tx	10	<70	<1	2	1	5	0	2
Post-PCA	15	<70	<1	6	0	6	2	1
Post-SFA	12	<70	<1	4	1	5	1	1

after both treatments, neither treatment affected accuracy measures throughout the treatment protocol. Only SFA treatment resulted in significantly faster word retrieval following treatment.

RM showed increases on *TAWF* total raw score from pre-treatment performance for both post-treatment testing periods (see Table 5). Greatest area of improvement across both post-treatment testing was in the area of noun retrieval. While RM showed increased *TAWF* total raw scores after both treatments, there were no significant changes in accuracy throughout either treatment protocol.

CHAPTER IV.

DISCUSSION

The purpose of the current study was to examine the effects of subjective word familiarity on word retrieval ability and responsiveness to short, intensive treatment in aphasia. Four native-English speaking participants with chronic aphasia, underwent individual treatment using two treatment approaches, Semantic Feature Analysis (SFA) or Phonological Components Analysis (PCA). Each participant underwent two main phases in the experiment: a familiarity rating phase and a treatment phase. During the familiarity rating phase, the participant rated how familiar h/she was with Rossion and Pourtois (2004) pictures according to a participant-friendly rating scale (adapted from Fratalli, et al., 1995 (*ASHA FACS*); Gilhooly & Hay, 1977; Noble, 1953; Paul et al., 2003 (*QCL*)). Pictures were then named and only pictures misnamed 2 out of 3 trials were included as treatment and probe stimuli for the investigation. Treatment focused on retrieval of the familiar and unfamiliar stimuli for each participant. Both accuracy and reaction time measurements were obtained for all stimuli for baseline testing and at the beginning of each day of treatment during both treatment protocols for each participant. The effect of familiarity, treatment, and generalization within each treatment in addition to performance on the Aphasia Quotient of the Western Aphasia Battery-Revised and the Test of Adolescent/Adult Word Finding scores over the three testing sessions were examined for each participant.

Familiarity

The first experimental question addressed whether there was an effect of familiarity overall relative to word retrieval ability for any participant and/or a familiarity effect for a particular treatment type per participant. Subjective familiarity was analyzed in this investigation, specifically examining how this variable affects overall naming abilities in adults with aphasia. Thus, the first analysis examined whether there was an effect of familiarity relative to baseline stimuli for accuracy and reaction time for each participant. For accuracy, differences between familiar and unfamiliar stimuli were explored. Baseline accuracy measures revealed significant findings for two of the four participants. JD and RR experienced significantly greater accuracy for familiar than unfamiliar stimuli. These findings suggest that familiarity may be an influential factor relative to establishing more accurate word retrieval among these particular participants. Lack of significant findings for IC and RM suggests that subjective familiarity was less influential on their retrieval abilities. Overall, these results are congruent with findings from other studies examining familiarity which focused on AoA and word frequency; specifically, familiarity can be more or less influential on word retrieval abilities based on the individual participant (Brown & Watson, 1987; Hirsch & Ellis, 1994; Hirsch & Funnell, 1995, Gilhooly & Watson, 1981; Morrison & Ellis, 1992).

In contrast to JD and RR, no significant differences were found relative to retrieval accuracy for familiar and unfamiliar stimuli for IC or RM at baseline. These non-significant findings indicate that subjective familiarity is less influential on IC and RM's word retrieval abilities. Interestingly, while no significant distinction between familiar and unfamiliar stimuli was observed, IC demonstrated greatest accuracy whereas RM showed least accuracy across both types of stimuli at baseline. These observations are congruent with the participants' *WAB* and *TAWF* results at baseline; specifically, IC showed least severity whereas RM showed greatest severity relative to aphasic involvement. Thus, although overall severity of aphasia may be a good indicator of word retrieval ability, severity level may not be influential on sensitivity to familiarity relative to word retrieval. Furthermore, overall word retrieval ability may affect retrieval ability relative to subjective familiarity only for some participants.

While there are many alternate views of word retrieval and models that argue about the sequence of lexical processing, most models propose that “lexical selection is a two-stage process of successive search through two distinct modules” (Hadar, Jones, & Mate-Kole, 1987, p. 514) known as the semantic and phonological lexicon, respectively (Butterworth, 1980; Caramazza, 1997; Dell, 1986; Kay & Ellis, 1987; Harley, 1993; Humphreys, Riddoch & Quinlan, 1988; Kempen & Huijibers, 1983; MacKay, 1987; Morsella & Miozzo, 2002; Stemberger, 1985). Additionally, most models propose that concepts are mapped within a semantic memory network (Davis, 2007; Dell, 1986). Dell (1986) proposed that word retrieval is accomplished via a spreading-activation process, with varying activation levels determining which concept and which phonemes will be linked together to produce the final response. It may be argued that the ‘pivotal variables’ involved in the naming process influence by affecting the activation levels of lexemes, consequently making it more or less likely for a word to be produced. These ‘influential variables of naming’ (i.e. pivotal variables) can include: aphasia severity, type of task used to assess retrieval, operativity, imageability, visual complexity, lexical category, word length of the word, and types of familiarity (AoA, word frequency, and subjective familiarity).

Stemberger (1985) observed that higher frequency words have higher levels of activation at rest, so they have a higher chance of being retrieved and produced. Subjective familiarity of a word is not participant-specific; thus, its impact on an activation level would be variable across participants. Additionally, it can be assumed that subjective familiarity always affects the first, basic concept’s node activation level in the semantic system for participants with undisturbed experiential memories, but might intermittently participate in the summation process at subsequent node levels that fall within the lexical system. As aphasia does not typically impair experiential memories or memory capabilities in general, the first, basic concept's node activation level may be affected relative to subjective familiarity. Thus, subjective familiarity may play a role in the mental lexicon during initial concept selection, but either an active or inactive role at subsequent node levels in the process of lemma access. Subjective familiarity appears to be inactive during lemma access when it does not increase activation levels beyond a node's activation potential. A node's activation potential is determined by the sum of associated concepts multiplied by the strength of associations between concepts according to the spreading-activation theory (Dell, 1986). Subjective familiarity can be inactive at a node for two reasons. First, an experiential memory might not be strong enough to have an effect or remain involved past a certain node. Secondly, another lemma might be selected before subjective familiarity can influence an activation level and potentially affect selection. For JD and RR, subjective familiarity may be active at the initial concept node in the semantic memory network and in the process of lemma access.

For IC and RM, subjective familiarity may increase activation levels only at the initial concept node, but not beyond that level. Thus, beyond that level, it would be considered an inactive variable in the retrieval process. For JD and RR, subjective familiarity may have been actively involved in semantic processing and during lemma access because a usual influencing variable (s) was either inactive or not as active allowing the involvement of subjective familiarity to spread its own activation. In contrast, subjective familiarity only may have been active at the first node for IC because IC's subjective familiar and unfamiliar effects on activation levels were too similar to affect the final lemma and corresponding phonemic selections. For RM, resting node activation and association levels may be too disrupted for an effect of subjective familiarity relative to processing.

Greater accuracy at retrieving familiar than unfamiliar stimuli relative to JD and RR may be explained by more subjective familiarity with concepts contributing to higher activation levels leading to higher chances of being retrieved. Participants' misnaming of familiar stimuli may not be attributed to faulty subjective familiarity activation because aphasia typically does not impair experiential memories, the type of memories that are suspected to determine the familiarity assignment of stimuli. Rather, these incorrect responses may occur as a result of possible disruptions within the semantic and phonological system(s) regarding appropriate concept associations and/or disconnections between the semantic and phonological networks.

Reaction time relative to differences between familiar and unfamiliar stimuli at baseline also was examined for each participant. Results revealed significant findings for JD and RM. While JD had significantly faster retrieval for familiar words, RM's retrieval was significantly faster for unfamiliar words. It is possible that there are different activation levels for familiar and unfamiliar stimuli relative to speed of retrieval from the lexicon, with higher activation levels leading to faster retrieval. The existence of two modes of lexical retrieval also may contribute to an understanding of these findings. Goodglass et al. (1984) proposed that both a rapid, "automatic" and a slower "voluntary" search could occur during the process of lexical retrieval. Perhaps, JD's retrieval of familiar stimuli was more guided by "automatic" searching due to higher activation levels, but his retrieval of unfamiliar stimuli would be slower and rely on more "voluntary searching" due to lower activation levels. RM may experience the reverse scenario. There may be variability in reaction times across participants because every aphasic participant chooses one search method over the other depending on how stimuli affect activation levels and the corresponding strength of their conceptual and phonological associations. As anomia rarely impairs specific words, search methods for words may vary across retrieval attempts. For example, a participant might engage in faster, unconscious “automatic” searching to retrieve the word ‘cat’, but then consciously “voluntarily” search in another attempt if activation of the target word, ‘cat’ or another lexical item was not immediately retrieved. A participant would only “voluntarily” search if they perceived lag time and experienced frustration with this lag time (i.e. nonfluency/block). “Voluntary searching” enables time for independent cues or dependent cueing to occur. Dependent cueing is a novel-way of referring to the class of cues that originate from outside the struggling speaker including another person or device. The aphasia severity of the participant often will dictate the length of the “voluntary searching” phase. RM had the most severe aphasia and the longest mean reaction times across familiar and unfamiliar stimuli suggesting she relied mostly on the “voluntary searching” method. As patients with Wernicke’s aphasia often display a ‘press for speech tendency’, they would more likely engage in “automatic” searching. Fluent patients, overall, would not necessarily engage in more “automatic” faster searches than nonfluent patients because less output does not reflect processing speed, but rather impaired access to the lexical items that affects processing time.

Only JD experienced both significant accuracy and reaction time familiarity findings; specifically, he demonstrated significantly greater accuracy and faster retrieval for familiar stimuli, yielding a direct relationship between reaction and accuracy for familiarity at baseline. These findings suggest that subjective familiarity was more influential upon his lexical processing than the other participants. RM’s poor accuracy across familiar and unfamiliar stimuli, yet significantly faster retrieval of unfamiliar words may be the result of more dissociations of concepts for familiar stimuli, in addition to a specific category-deficit for familiar stimuli. While there may be more concepts that can be individually activated for the familiar words, pathways marking association may be more sparse or absent as the result of specific categorical deficits that occur from a partially impaired semantic system. In contrast, unfamiliar words may have more intact pathways marking associations between concepts, thus in this case, enabling faster retrieval of the unfamiliar words. If familiar and unfamiliar describe two different categories within the semantic system, then RM may be described as having more impaired access to familiar words. Specific categorical deficits among aphasia patients have been observed (Davis, 2007; Hillis and Caramazza, 1991; Funnell & Sheridan, 1992; Warrington and McCarthy's, 1987).

Reaction times for IC and RR were not significantly different between the retrieval of familiar and unfamiliar stimuli. These patterns may be attributed to a relatively equal number of concepts activated at relatively proportionate levels, thus allowing the retrieval selection to occur in a similar amount of time. The partial disconnect theory (Kay & Ellis, 1987) might explain why faster retrieval for any participant does not correlate with accuracy of word retrieval. This theory proposes that "weak or fluctuating levels of activation between corresponding entries in the semantic system and the phonological lexicon" (p. 626) may cause word retrieval errors. Thus, faster retrieval of incorrect stimuli occurs because the selected incorrect lexical and/or phonological entries have higher levels of activation than the appropriate target entries.

The next analysis addressed whether there was a familiarity effect for a particular treatment type per participant relative to accuracy or reaction time. Accuracy of word retrieval was examined relative to differences between familiar and unfamiliar stimuli across the two treatment approaches for each participant. Results revealed no significant findings for either treatment type for any participant. However, in examining effectiveness of each treatment type relative to stimulus familiarity, some remarkable increases were observed particularly for familiar stimuli. Specifically, JD showed increases in word retrieval for familiar stimuli in both treatments.

The observation of significant accuracy results between familiar and unfamiliar stimuli at baseline for JD and RR, but not throughout treatment suggests that the treatment itself may have masked the subjective familiarity effects present at baseline. This may be more clearly identified when comparing mean baseline performance to the last day of treatment for each treatment approach (Table 2). However, treatment may have partially deactivated the effects of JD and RR's subjective familiarity by activating multiple nodes and associations between nodes in the semantic and phonological systems. Since SFA treatment is theorized to strengthen semantic associations between concepts (Boyle, 2004, Boyle & Coelho, 1995; Conley & Coelho, 2003; Lowell et al., 1995 Nickels, 2002; Nickels & Best, 1996) and PCA treatment is proposed to strengthen phonemic associations with lemmas (Leonard, Rochon, & Laird, 2008). Thus, it may be assumed that application of either treatment should lead to more accurate word retrieval.

In SFA treatment, the clinician assists a patient with word retrieval by guiding him/her to generate distinguishing semantic features for a target or concept (Boyle, 2004). SFA treatment has led to patient improvement in word retrieval of treated and untreated stimuli, suggesting strengthened semantic associations with some evidence of generalization (Boyle & Coelho, 1995; Conley & Coelho, 2003; Lowell et al., 1995).

PCA treatment, modeled after SFA, attempts to activate phonological associations by having the clinician guide a patient with aphasia relative to generating specific phonological features of a target word (Leonard, Rochon, & Laird, 2008). Similar to SFA, implementation of PCA also has resulted in successful treatment of anomia in individuals with aphasia including evidence of improved accuracy, generalization, and maintenance of retrieval abilities (Best, Herbert, Hickin, Osborne, & Howard, 2002; Boyle, 2004; Boyle & Coehlo, 1995; Conley & Coelho, 2003; Hicken et al., 2002; Wambaugh et al., 2004 & Wambaugh, 2003).

Successful application of SFA and PCA cueing strategies may increase activation levels of appropriate target semantic and phonological entries leading to accurate retrieval. Higher activation of semantic and phonological associations may reduce the effect of spreading activation for subjective familiarity. Thus, a treatment masking effect on subjective familiarity may explain the occurrence of non-significant findings among participants in the current study.

Reaction time relative to differences between familiar and unfamiliar stimuli also was examined across SFA and PCA treatments for each participant. Results revealed significant findings for IC for SFA. Specifically, IC was significantly slower for unfamiliar than familiar stimuli during SFA treatment. This observation may be the result of higher activation of concepts associated with familiar stimuli that enabled faster retrieval of the lexical items. However, it is important to note that IC was generally slower for both familiar and unfamiliar stimuli after SFA treatment, suggesting a speed-accuracy trade-off relative to word retrieval. Significant findings also were observed for RM during both PCA and SFA. Specifically, RM was significantly slower for familiar than unfamiliar stimuli during both treatments. The observation that RM showed no remarkable changes in speed of processing relative to familiar stimuli during either treatment suggests that slower processing may be the result of a complex disconnection between the semantic and phonological systems. The disconnection is described as 'complex' because two intensive treatments that attempted to strengthen both systems were not enough to speed up retrieval of familiar stimuli. No significant findings were observed for familiarity for either JD or RR during either treatment. However, JD had noticeably slower retrieval of familiar stimuli from baseline after both SFA and PCA treatments, suggesting a speed-accuracy trade-off relative to word retrieval. It is possible that JD and RR may have experienced complex disconnections between their semantic and phonological systems that were not responsive to treatment exposure relative to speed of processing. Furthermore, extending the treatment phases for each treatment type over a longer time period may have resulted in differential findings.

The relationship between accuracy and speed of word retrieval may vary depending upon the participant's sensitivity to stimulus familiarity. One participant, JD, demonstrated significant findings for both accuracy and reaction time relative to familiarity at baseline. Specifically, JD was more accurate and faster at retrieving familiar stimuli. However, during treatment, JD appeared to show a speed-accuracy trade-off, specifically demonstrating increased accuracy but slower retrieval time for familiar stimuli at the end of both treatments. Although other participants showed some sensitivity to stimulus familiarity via changes in word retrieval, their performance did not reflect a remarkable relationship between accuracy and reaction time.

Treatment Effects

The second experimental question addressed the effect of treatment overall and the effect of treatment for a particular treatment type per participant. Participants underwent two types of treatment, Semantic Feature Analysis (SFA) and Phonological Components Analysis (PCA) in a crossover design. This enabled each participant to engage in SFA or PCA as Treatment 1 and SFA or PCA as Treatment 2. Each participant consequently served as his/her own control. Semantic Feature Analysis and Phonological Components Analysis were selected as the two treatment approaches because while they have both shown to be equally effective at facilitating word retrieval in individuals with aphasia (Boyle, 2004; Leonard, Rochon, & Laird, 2008), their impact on word retrieval is still relatively unknown.

The first analysis examined whether there was an effect of treatment overall relative to accuracy and reaction time for each participant. For accuracy, baseline performance was compared to performance accuracy on day 5 of each treatment type. Treatment accuracy measures revealed significant findings for three of the four participants. Accuracy results revealed significant findings for IC, RR, and RM with SFA treatment and RR with PCA treatment with significantly increased accuracy after treatment. Only JD did not significantly benefit from either treatment. Boyle (2004) reported on two participants who underwent SFA treatment, who both experienced remarkable improvement in word retrieval with treatment. IC, RR, and RM appeared to benefit from SFA treatment because generating features, both independently and with intermittent clinician cueing, may have helped strengthen perceptual processing and as a result, their word retrieval abilities. Strong perceptual processing is an essential aspect of word retrieval because it is an important part of the encoding stage, where conceptual and lexical mapping must occur in order for a stimulus to be retrieved (Caramazza & Berndt, 1978; Davis, 2007). In addition, SFA treatment may have increased abilities at “select [ing] salient features to activate the appropriate semantic representation” (Boyle, 2004, p. 245).

Word retrieval improvement from SFA treatment among individuals with Broca’s, anomic, Wernicke’s, and conduction aphasia supports the claim that SFA treatment can improve retrieval in individuals with various degrees of lexical processing impairment (Boyle, 2004; Boyle & Coelho, 1995; Lowell, et al., 1995). Thus, SFA treatment offers viable improvement for various aphasic individuals regardless of their specific type of aphasia or their specific lexical-impairment(s) and time post-onset CVA. Relative to the treatment of aphasia, it is paramount to determine the most effective word retrieval intervention for a specific individual as each person responds differently as a result of the chronicity of aphasia, site and extent of brain-damage, as well as the specific basis for their word retrieval impairment, among other factors.

Using PCA, Leonard et al. (2008) found that seven of ten participants with various degrees of lexical impairments and types of aphasia experienced remarkable improvement in word retrieval ability. All participants appeared to exhibit impairments “situated at the lexical level or in the connections between the lexical and phonological processing” (p. 928). This observation is based on findings indicating lower performance on standardized naming tests and varied strengths and weaknesses on reading and word repetition tasks that assessed phonological processing. The three participants who did not benefit from PCA treatment had the most severe naming impairments, demonstrating the poorest performance on the Boston Naming Test and the Philadelphia Naming Test. In the current study, IC, RM, and JD did not significantly benefit from PCA treatment. While a severe naming impairment was attributed as the underlying cause for lack of improvement among participants in the Leonard et al. (2008) study, this explanation may not be applicable relative to lack of significant increases particularly for IC who showed significant improvement in word retrieval skills with SFA and showed strongest performance on the TAWF relative to the participants in the current study. Hence, findings for IC and RM may be explained by the presence of primarily semantic system impairments (Renvall, Laine, & Martin, 2005). PCA treatment may not be the most appropriate treatment method to improve word retrieval skills for IC and RM.

RR may have been the only participant to benefit from both types of treatments because he demonstrated impairment within both the phonological and semantic systems. His specific impairments may have consisted of isolated impairments within each system, a partial disconnection between the systems (Kay & Ellis, 1987), a “defect in the interface between the semantic system and the phonological system's verbal output lexicon", or a combination of these impairments (Raymer, et al., 1997, p. 215).

The non-significant pattern of improvement from either treatment relative to JD may be the result of an insufficient duration of treatment to have a remarkable effect on performance. Furthermore, intensity of each treatment session may have been too effortful for JD; thus, fatigue may have interfered with his ability to significantly improve retrieval performance. In this investigation, each treatment approach was implemented across five consecutive days, sessions ranging from 1-4 hours per day. It is possible that non-consecutive treatment days allowing more periods of rest in between treatment sessions in conjunction with shorter treatment sessions may have been a more beneficial pattern of therapy implementation for JD.

JD's response to treatment also may be related to the chronicity as well as the type of his aphasia. Specifically, a shorter chronicity of aphasia may be related to JD's non-significant treatment findings. However, RR has exhibited aphasia as the result of CVA for a relatively similar length of time as JD; thus, chronicity in isolation may not explain JD's lack of significant improvement in retrieval ability with treatment. Furthermore, IC's longer chronicity than both RR and JD in conjunction with his significantly improved word retrieval findings suggests that a participant's aphasia chronicity may not be adequate in determining a participant's response to treatment. Possibly considering both chronicity and type of aphasia may be of more value when considering a participant's response to particular word retrieval treatments. Specifically, both JD and IC exhibit Broca's aphasia; however, time post-stroke is remarkably longer for IC than JD. It is possible that IC is more "de-sensitized" to his aphasia; although he has not been exposed to speech-language treatment with any consistency over the last ten years, IC may be more integrated into his environment and subsequently more responsive to treatments geared towards facilitation of retrieval skills in general. Thus, it is certainly evident that aphasia recovery may occur beyond a decade, particularly if the individual is actively engaged in their environment. Although JD has been attending weekly treatment sessions for the past 5 years and has made positive changes in treatment, the treatment approaches used in this study may not necessarily be beneficial to enhancing his word retrieval skills.

Reaction time (RT) also was examined to determine treatment effects from SFA and PCA, independently, for each participant. For each treatment type, baseline RT performance was compared to RT performance on day 5 of each treatment. Prior to the current study, no treatment study incorporating SFA or PCA treatment methodology examined reaction time in relation to word retrieval. Reaction time was analyzed to more thoroughly assess a participant's response to SFA and PCA treatment. Results revealed significant findings for all participants with SFA treatment, but significant findings with PCA treatment were only observed for RM. Interestingly, IC and JD had significantly slower retrieval after SFA treatment, whereas RR and RM had faster retrieval with SFA treatment. In contrast to RM's significantly faster retrieval during SFA treatment, RM had significantly slower retrieval during PCA treatment. Non-significant findings were found for IC, JD, and RR for PCA treatment.

IC experienced significantly slower retrieval, yet higher accuracy during SFA treatment, particularly related to familiar stimuli. It is possible that slower perceptual processing to identify concepts and salient features, but ability to maintain activation of salient features occurred, thus enabling IC to activate more appropriate target lexical items and achieve higher accuracy during SFA treatment. Significantly faster retrieval and higher accuracy with SFA treatment for RR and RM may be related to their previous exposure to PCA treatment. Specifically, exposure to both treatments may have increased their speed of perceptual processing while maintaining salient feature activation levels to retrieve the appropriate target lexical item(s). However, it seems unlikely that RM's phonological system could account for her faster word retrieval with SFA treatment because PCA treatment revealed non-significant findings as well as no improvement with this approach (0% at baseline vs. 0% day 5). RM's significantly slower retrieval during PCA treatment further suggests that PCA treatment was either too challenging due to a severely impaired phonological system or it was not a viable approach to improve her word retrieval skills. Thus, SFA treatment seems to be a more facilitative approach than PCA relative to enhancing word retrieval skills for RM. It is more difficult to determine whether PCA or SFA treatment is a more viable form of treatment for RR as both treatments resulted in significantly improved accuracy; however, significantly faster retrieval after SFA treatment may indicate that SFA is a more facilitative treatment for RR.

Consideration of fluency classification relative to aphasia lends a more convincing argument in explaining why participants demonstrated slower or faster word retrieval after treatment. Fluency of verbal output may be related to speed of retrieval. IC and JD, both exhibit Broca's aphasia, a type of nonfluent aphasia. Significantly slower retrieval after SFA treatment for IC and JD could be related to the nature of their nonfluent aphasia. Individuals with nonfluent aphasia may require more processing time to increase their accuracy of word retrieval. In contrast, both RR and RM exhibit fluent types of aphasia and exhibited significantly faster reaction time after SFA treatment. It is possible that fluent speakers require less processing time to enhance the accuracy of their word retrieval abilities.

Exploring the relationship between accuracy and speed of word retrieval also is important relative to a participant's sensitivity to a particular type of treatment. IC appeared to demonstrate an accuracy and reaction time trade-off after SFA treatment. Specifically, IC showed increased accuracy but significantly slower RT after SFA treatment. These findings indicate an inverse relationship between speed and accuracy and that for IC, slower processing yields increased accuracy of retrieval with SFA treatment. This pattern was not observed for PCA treatment. However, RR showed significantly improved accuracy and faster retrieval following PCA treatment, suggesting a direct relationship between speed and accuracy specific to this treatment. Thus, treatment improvement relative to accuracy and reaction time varies among individuals and the nature of the treatment protocol.

Generalization Effects

The third experimental question addressed overall generalization of treatment effects and generalization regarding a particular treatment type per participant. Generalization is the most significant factor to assess the effectiveness of a treatment methodology. While semantic and phonologically-based treatments have been found to be equally effective at improving word retrieval abilities (Howard, Patterson, Franklin, Orchard-Lisle, & Morton, 1985), generalization to untreated items has been minimal even with an approach such as SFA (Boyle, 2004; Boyle & Coelho, 1995; Coelho, McHugh, & Boyle, 2000; Drew & Thompson, 1999; Kiran & Thompson, 2003; Lowell, Beeson, & Holland, 1995). In Boyle (2004), the two participants under investigation were able to name at least 3 more probe items than the maximum number retrieved during baseline sessions (Boyle, 2004). Modest improvements regarding changes in discourse production occurred in one SFA treatment study (Coelho et al., 2000), while no changes in discourse production occurred in an earlier SFA treatment study (Boyle & Coelho, 1995). Regarding PCA treatment, some have argued that no generalization to untreated items should occur for PCA because mapping from semantics to phonology is word-specific, rather than interconnected as words are organized in the semantic system (Howard, 2000; Miceli et al., 1996). Despite this argument, Leonard et al. (2008) observed that three of seven participants displayed generalization to untreated stimuli, indicating that the phonological system could be organized in a format more akin to the semantic system.

In the current investigation, the generalization analyses examined whether there was an effect of generalization relative to accuracy and reaction time for each participant. For accuracy, baseline performance was compared to probe performance accuracy on day 5 of each treatment type. Probe accuracy measures revealed significant findings for JD relative to SFA treatment, with significantly greater accuracy for probe stimuli after treatment. No significant findings were observed for JD relative to PCA treatment or for IC, RR, or RM for either treatment.

Results for JD yielded a non-significant pattern of improvement from either treatment; thus, significant generalization relative to SFA treatment was a surprising observation. As JD did not experience a significant improvement in retrieval skills with SFA treatment, findings for the probe stimuli may not truly represent generalization of process. JD may have experienced a practice effect relative to the probe items, thus yielding the significant generalization finding. As mentioned, although treatment sessions for each treatment protocol were intense, the duration of treatment across time was short. Consequently, opportunities to generalize strategies gained from treatment were constrained and possibly limited occasions to apply newly learned processes to retrieval of untreated stimulus items. Thus, non-significant findings observed for JD relative to PCA treatment, and for IC, RR, or RM for either treatment may be an outgrowth of minimal opportunities to generalize newly learned skills.

Reaction time (RT) also was examined to determine generalization effects from SFA and PCA, independently, for each participant. For each treatment type, baseline RT performance was compared to RT performance for probe stimuli on day 5 of each treatment. Significant generalization effects relative to RT were found for IC, JD, and RM after PCA treatment only. IC and JD showed significantly faster retrieval after PCA treatment, whereas RM showed significantly slower retrieval after PCA treatment. No significant findings were observed for RR for PCA treatment. Additionally, no significant findings were observed for any participant for SFA treatment.

To adequately interpret generalization findings, it is necessary to explore the relationship between accuracy and reaction time across treatment in comparison to generalization findings. Although IC showed significantly faster retrieval of untreated items after PCA treatment, there was no evidence of a significant treatment effect relative to accuracy or reaction time. Thus, this finding may not be interpretable. No generalization was observed for SFA, although IC showed significant treatment accuracy increases. As mentioned, although JD showed significantly more accurate retrieval for untreated stimuli after SFA treatment, no remarkable treatment findings were observed. For PCA, although JD showed significantly faster retrieval for untreated stimuli, treatment effects were not significant for either accuracy or reaction time.

Although RR showed significantly increased accuracy of word retrieval of treated stimuli across both treatments with faster retrieval of treated stimuli with SFA treatment, no significant findings were found relative to accuracy or reaction time for untreated stimuli. RM showed significantly slower retrieval after PCA treatment for both treated and probe stimuli. As indicated, PCA treatment may have been too challenging for RM due to a severely compromised phonological system. It also is possible that the nature or underlying basis of RM’s word retrieval deficit was not conducive to this treatment approach.

Standardized Test Performance

The fourth experimental question addressed whether performance differences on the *Western Aphasia Battery-Revised (WAB-R)* Aphasia Quotient (*AQ*) over time were reflective of changes in treatment performance for each participant. The *WAB-R* was administered to each participant three times periodically throughout the protocol to monitor treatment effects. Improvement, decline, or lack of change are discussed relative to change from pre-treatment test scores as well as in relationship to performance on the treatment protocols.

While all participants showed increases for follow-up SFA and PCA treatment testing sessions, participant *AQ* and subtest scores varied. Increases in Spontaneous Speech for IC, JD, and RM and increases in Naming and Word finding scores among all participants suggests that the treatments positively influenced overall retrieval abilities.

IC's *WAB-AQ* increased from his pre-treatment performance across both post-treatment testing periods. This increase appears to be a general treatment effect rather than a specific treatment effect, as improvement was noted after SFA with scores remaining stable after PCA treatment. The increase in both *WAB-AQ* scores across treatments, yet only significantly increased accuracy resulting for treated stimuli after SFA treatment suggests that either treatment may be effective at improving advanced word retrieval skills, but SFA treatment might be more effective at specifically improving word retrieval.

JD's *AQ* increased from pre-treatment performance to post-treatment 2 (PCA), with skill areas only improving on post-PCA treatment testing. After SFA treatment, performance declined in all skill areas on the *WAB-R*. Significant findings of increased accuracy on untreated stimuli, but no significant findings relative to accuracy of treated stimuli for SFA treatment suggest that

PCA treatment was more effective at improving advanced word retrieval skills and word retrieval.

RR demonstrated increases relative to *WAB-R AQ* from pre-treatment performance to post-SFA treatment only. Increases in Naming and Word Finding scores on the *WAB-R* occurred on the post-SFA testing. Significant accuracy findings relative to increased word retrieval resulted for both treatments. However, increased *WAB-R AQ*, in addition to the significant accuracy findings after SFA treatment, suggests that SFA treatment was more effective at increasing word retrieval for RR. Significantly faster word retrieval after SFA treatment may additionally support this speculation.

RM showed increases from pre-treatment *WAB-R AQ* performance to post-testing for both PCA and SFA treatments. Improvement occurred in all *WAB-R* skill areas on both post-treatment tests. Increases on *WAB-R AQ* scores and significant findings of increased accuracy and faster word retrieval relative post-SFA treatment suggest that both treatments were effective at improving word retrieval, but SFA treatment might have been more effective.

The last experimental question addressed whether performance differences on the *Test of Adolescent/Adult Word Finding (TAWF)* total raw score over time were reflective of changes in treatment performance for each participant. Treatment studies targeting word retrieval have commonly used the Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1983) and the *TAWF*. Boyle (2004) administered both tests to participants during pre-baseline testing to assess each participant's initial word retrieval abilities. In this current investigation, the *TAWF* was administered to each participant three times periodically throughout the protocol to monitor treatment effects. Improvement, decline, or lack of change are discussed relative to change from pre-treatment test scores as well as in relationship to performance on the treatment protocols.

Greatest area of improvement across both treatments for all participants was in the area of noun retrieval on the *TAWF*, suggesting that the current treatment protocol focusing on retrieval of nouns most likely enhanced noun retrieval on this test battery.

IC's total raw score on the *TAWF* increased from pre-treatment performance to post-treatment testing after both treatment protocols. Similar to *WAB-R* results, scores remained stable after PCA treatment, once again suggesting that word retrieval treatment in general attributed to his improvement. Statistically significant increases in accuracy after SFA treatment suggests that SFA treatment might have been more effective at enhancing word retrieval on the *TAWF*. However, some improvements regarding reaction time after PCA treatment suggest that this latter protocol also enhanced retrieval.

JD showed increases in *TAWF* total raw score from pre-treatment performance to both post-treatment testing periods. Description naming and category naming scores were unchanged after PCA treatment; this finding may be due to the fact that PCA treatment does not specifically target those skill areas. After SFA treatment, decline was noted on description naming, but an increase occurred in the area of category naming. An increase in category naming in response to SFA treatment should be expected as assigning a target word to a category is an aspect of feature analysis. Statistically significant effects of increased accuracy and faster retrieval of probe stimuli, but no significant findings relative to accuracy of treated stimuli makes it difficult to conclude that SFA treatment was the more effective treatment at enhancing word retrieval for JD. Thus, both treatments may have been effective to some extent in improving word retrieval abilities.

RR's *TAWF* total raw score increased from pre-treatment performance for both post-treatment testing periods. Improvement was noted on all areas, with description naming improving more following PCA treatment and category naming improving more following SFA treatment. It was expected that both descriptive naming and category naming would show most improvement after SFA treatment due to the nature of this protocol. Overall, *TAWF* raw score improvement across both treatment testing periods with corresponding significant accuracy increases after both treatments. Thus, the *TAWF* suggests that both protocols were effective at improving word retrieval abilities.

RM showed increases on *TAWF* total raw score from pre-treatment performance for both post-treatment testing periods. Statistically significant effects of increased accuracy and faster retrieval of treated stimuli for SFA treatment suggest that SFA treatment was more effective at enhancing word retrieval than PCA treatment.

General Discussion

The purpose of this study was to investigate the effects of subjective word familiarity and its influence on word retrieval skills with short, intensive aphasia treatment. Four English-speaking participants with chronic aphasia received Phonological Components Analysis and Semantic Feature Analysis treatments in a crossover design. There has been limited research relative to the influence of subjective familiarity on word retrieval skills; furthermore, no studies to date have examined the effect of familiarity on improvement with treatments geared towards improving word retrieval in aphasia. These factors and the need for additional aphasia treatment studies for word retrieval strongly motivated this investigation.

It appears that subjective familiarity was a valuable factor to examine relative to aphasia. The variable of subjective familiarity has not been studied in terms of its effect on word retrieval. Other variables affecting familiarity, including word frequency and AoA, have been found to influence accuracy and speed of word retrieval with varying impact depending upon the individual participants (Brown & Watson, 1987; Hirsch & Ellis, 1994; Hirsch & Funnell, 1995, Gilhooly & Watson, 1981; Morrison & Ellis, 1992). Numerous studies have revealed that faster and accurate retrieval is associated with higher word frequency or AoA (Forster & Chambers, 1973; Goodglass, et al., 1969; Hirsch & Ellis, 1994; Howard, Patterson, Franklin, Orchard-Lisle, & Morton, 1985; Humphreys, et al., 1988; Monsell, Doyle, & Haggard, 1989; Oldfield & Wingfield, 1965).

Subjective familiarity is unique because it is completely dependent on the individual's own experiences and judgments of that experience. Snodgrass and Vanderwart (1980) defined subjective familiarity as "the degree to which one has come in contact with or thought about a concept" (p. 183). It is the most personal and individualized familiarity measure and can reflect an individual's performance across many modalities, including, but not limited to spoken and written language and drawing (Funnell & Sheridan, 1992).

In the current study, accuracy and reaction time baseline measures relative to differences between familiar and unfamiliar stimuli among the individual participants was analyzed. While significantly increased accuracy suggested improved word retrieval skills, significantly faster reaction time and its corresponding effect on subjective familiarity may suggest faster processing of stimuli. Participant findings relative to subjective familiarity suggest that this factor may be similar to AoA and word frequency by differentially influencing word retrieval abilities of individual participants with aphasia. Exploring the influence of familiarity at baseline in its existing state indicated which participants were more influenced relative to this factor in retrieval. Hence, it may be more advantageous to incorporate more familiar stimuli for JD and RR as they experienced significantly greater accuracy for familiar than unfamiliar stimuli at baseline. While anomia is not word-specific, with accuracy varying across retrieval attempts

(Davis, 2007; Goodglass, 1993; Thompson & Worall, 2008; Whitworth, Webster, & Howard, 2005), treatment focusing on retrieving familiar stimuli might promote more efficient communication among these particular participants. Overall, knowing whether subjective familiarity improves, disrupts, or does not affect an aphasic individual's word retrieval abilities is important because it may help guide treatment designs aimed at remediating word retrieval.

Analysis of retrieval of familiar and unfamiliar stimuli revealed that increased accuracy did not consistently correspond to faster retrieval for familiar or unfamiliar stimuli. Additionally, treatment approach did not bias a participant's retrieval accuracy or speed of retrieval relative to degree of familiarity of stimuli. Aphasia severity based on participant's *WAB-R AQ* also did not appear to influence sensitivity to familiarity relative to word retrieval as significant findings relative to increased accuracy among familiar and unfamiliar stimuli varied across participants.

Treatment exposure revealed findings relative to effect of familiarity on word retrieval that were unique to each participant. Although, some participants experienced significant effects of subjective familiarity at baseline prior to treatment, the effect of familiarity regarding improvement for the two treatment approaches may have been masked by higher activation of semantic and/or phonological associations. Greater activation of semantic associations may result from increased semantic associations between concepts as suggested relative to the effects of SFA treatment (Boyle, 2004, Boyle & Coelho, 1995; Conley & Coelho, 2003; Lowell et al., 1995 Nickels, 2002; Nickels & Best, 1996) as well as strengthened phonemic associations among lemmas relative to effects of PCA treatment (Leonard, Rochon, & Laird, 2008).

In the current investigation, treatment results indicated significant and non-significant findings relative to accuracy and speed of word retrieval across participants. Two participants experienced increased accuracy after SFA treatment, while one participant experienced increased accuracy after SFA and PCA treatment. These findings support previous accuracy findings with SFA (Boyle, 2004) and PCA treatment (Kendall et al., 2008; Leonard, et al., 2008; Rochon, et al., 2006). SFA treatment may have improved word retrieval for three of the participants by specifically increasing abilities at "select [ing] salient features to activate the appropriate semantic representation" (Boyle, 2004, p. 245). In Boyle (2004), two participants under investigation both experienced remarkable improvement after exposure to SFA treatment. Participants with impairments "situated at the lexical level or in the connections between the lexical and phonological processing" (Leonard, et al., p. 928) have been facilitated by PCA treatment. Specifically, Rochon, et al. (2006) observed an improvement in naming accuracy from 73% to 96% after treatment for four out of seven participants in a PCA treatment study.

Significantly improved accuracy and RT findings for these participants, diagnosed with different types of aphasia (Broca's, conductive, and anomic) support the claim that SFA treatment can improve retrieval in individuals with various degrees of lexical processing impairment (Boyle, 2004; Boyle & Coelho, 1995; Lowell, et al., 1995). The similar format of both treatment approaches, including participant's engagement in the "principle of choice" relative to feature selection (Hickin, Best, Herbert, Howard, & Osborne, 2002) may explain why PCA also is a successful treatment for remediating word retrieval in individuals with aphasia. Findings for reaction time in the current study suggest that one approach might be more facilitative than another; however, each participant showed a unique pattern of changes relative to the two treatment approaches. Depending on the extent of retrieval impairment as well as linguistic characteristics specific to each participant, there may not be a consistent and direct relationship between accuracy and reaction time. However, for both RR and RM, there was a direct relationship between accuracy and reaction time, specific to SFA treatment.

Generalization was examined in this study as it is the most significant factor to assess the effectiveness of a treatment methodology. Unlike evidence of treatment effects across studies, generalization to untreated items has been observed to be minimal for both treatment approaches, especially for SFA treatment (Boyle, 2004; Boyle & Coelho, 1995; Coelho, McHugh, & Boyle, 2000; Davis, 2007; Drew & Thompson, 1999; Kiran & Thompson, 2003; Lowell, Beeson, & Holland, 1995). While generalization effects have been limited for both treatment approaches, generalization of increased word retrieval to discourse production has been observed for both SFA (Coelho et al., 2000) and PCA treatment (Kendall et al., 2008).

In the current study, probe findings revealed that one participant demonstrated significant increases in accuracy relative to SFA treatment. As this participant did not experience a significant improvement in retrieval skills with SFA treatment, findings for the probe stimuli may not have truly represented generalization of process. Generalization might have occurred in this current study if the duration of each treatment approach was extended. Other studies demonstrating cases of generalization were longer in duration ranging in 4 weeks for each treatment phase (Boyle, 2004) to 96 hours of training over a 12 week period (Kendall et al., 2008).

Thus, the results of this investigation revealed that both subjective familiarity and SFA and PCA treatment differentially influenced aphasic individuals' word retrieval abilities. Aphasia type, severity, chronicity, and extent of lexical impairment did not appear to consistently influence familiarity or treatment effects relative to word retrieval. Relationships were observed between retrieval speed and accuracy for familiarity as well as treatment for some participants. Although some of the treatment results suggest a more facilitative effect of SFA than PCA, overall findings were unique to each participant.

Limitations of Study

One limitation of the investigation may be duration of treatment protocols. As mentioned, each treatment was 5 sessions per participant. Although each session was intense relative to length, limited duration of each treatment protocol may have limited observation of more significant findings relative to accuracy or speed of word retrieval for a few of the participants. Additional treatment exposure may enable further practice of the strategies, possibly increasing the opportunity for improved retrieval of both treated and untreated stimuli. Evidence of both significant treatment and generalization effects would justify significant findings for untreated stimuli as more than simply result of a 'practice effect.'

Stimuli may have been a limitation of this study. The experimental task stimuli and corresponding pictures originated from Rossion and Pourtois (2001), which is a colored adaptation of Snodgrass and Vanderwart's (1980) 260 black-and-white line drawings. These stimuli have been standardized for name agreement, image agreement, familiarity, and visual complexity. While colorful and standardized, these pictures are simple line-drawings, lacking detail. The static nature of these pictures may have influenced accuracy and processing speed of word retrieval on the experimental treatment protocols. Furthermore, size of the stimuli on the computer screen may have been a limitation. These pictures were enlarged but if there is too much enhancement, detail gets a bit blurry and may impact processing time for retrieval.

Additional pre-experimental testing, specifically examining the extent of semantic and phonological processing impairment, may have been helpful in interpreting results and treatment effectiveness. Additional tools that may have been appropriate to administer if time permitted including selected subtests from the *Psycholinguistic Assessments of Language Processing in Aphasia (PALPA)* (Kay, Coltheart, & Lesser, 1992) and the reading and writing subtests from the

WAB-R which would have also provided a Cortical Quotient (CQ) for each participant relative to this test.

Implications for Future Research

Examination of specific error types committed during the treatment protocols may provide further insight into the bases of participant's word retrieval deficits. This type of analyses also may offer additional information on the treatment effectiveness of a specific treatment type with a particular participant. Error analysis should be sensitive to phonological, lexical, and semantic nature of errors.

Another area of exploration using a similar protocol could be examining verb retrieval, rather than noun retrieval. Verb stimuli should be colorized pictures and comparable to the simplicity of the Rossion and Pourtois (2001) drawings to ensure some consistency among stimuli to compare results. Comparison of verb findings with the current study findings for noun retrieval may provide more information about organization of the lexical system as well as possible similarities and differences that may occur relative to accuracy and reaction time.

The current experimental protocol could be replicated with additional adults with aphasia. Additional research on individuals with aphasia will help determine the most effective word retrieval intervention for a specific individual. Findings for the current participants can be compared to observations with other individuals with aphasia, exploring influences of demographic variables such as age, education level, and gender. Comparative analyses can help explore trends that occur among aphasic individuals relative to stimuli familiarity and treatment exposure, enabling more effective aphasia intervention.

More explicit means of directly comparing experimental treatment results to standardized test results also should be explored. This type of analysis may enhance interpretation of results relative to congruence/incongruence of findings between the experimental treatment measures and standardized post-treatment measures. Further investigation of these types of relationships is suggested.

Summary and Conclusions

The current study explored the effects of subjective familiarity and intensive exposure of SFA and PCA treatments relative to word retrieval among four individuals with chronic aphasia. Results for subjective familiarity at baseline revealed significant findings relative to accuracy for two participants, JD and RR, with significantly greater accuracy for familiar than unfamiliar stimuli. Two participants, JD and RM, experienced significant effects of reaction time relative to familiarity at baseline. JD exhibited significantly faster retrieval for familiar versus unfamiliar words, whereas RM demonstrated significantly faster retrieval for unfamiliar versus familiar words. Thus, JD demonstrated a direct relationship between accuracy and RT for familiarity at baseline, with significantly increased accuracy and significantly faster retrieval for familiar stimuli.

The effect of familiarity during the course of treatment relevant to treatment type revealed significant findings only relative to reaction time for two participants. Specifically, IC was significantly faster for retrieval of familiar than unfamiliar stimuli for SFA. However, RM demonstrated significantly slower retrieval for familiar than unfamiliar stimuli for both SFA and PCA treatments. Thus, no distinct relationship was observed between accuracy and reaction time for familiar versus unfamiliar stimuli within either treatment type for any participant when exploring participant performance during treatment. However, when comparing baseline to end of treatment performance, it was observed that JD demonstrated noticeable increases in performance for familiar stimuli after both treatment approaches with evident slower reaction time for these stimuli; thus, there appeared to be an increased accuracy and slower speed of retrieval trade-off relative to processing of familiar stimuli for this participant.

Examination of treatment effects for SFA and PCA revealed that two participants, IC and RM displayed significantly increased accuracy of word retrieval after SFA treatment. RR demonstrated significantly increased accuracy after both treatments. Reaction time findings for the effects of treatment revealed significantly slower retrieval for IC and JD after SFA treatment, whereas RM and RR showed significantly faster retrieval after SFA. Thus, IC appeared to demonstrate a trade-off between accuracy and speed of retrieval relative to performance on SFA treatment: increased accuracy, slower speed of retrieval. After PCA treatment, the only significant finding was significantly slower retrieval for RM. Thus, direct relationship for accuracy and RT relative to treatment effect was observed for both RR and RM, specific to SFA treatment, with increased accuracy accompanied by significantly faster retrieval. No generalization effects were shown for any participant relative to accuracy or reaction time for either treatment.

All participants exhibited improvement on the *WAB-R-AQ* and *TAWF* raw scores for at least one of the treatment approaches. Improvement in spontaneous speech on the *WAB-R* and in noun retrieval on the *TAWF* after both treatments was evident for all participants.

The present investigation successfully demonstrated the influence of subjective familiarity on word retrieval and affirmed the varied effectiveness of SFA and PCA treatment with four participants with aphasia. This study additionally advanced understanding of the process of word retrieval relative to accuracy and reaction time. Subjective familiarity and effects of PCA and SFA treatment enhanced accuracy and speed of retrieval for some of the participants; thus, significant findings of practical and clinical significance validate this research and motivate further exploration.

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APPENDIX A: Participant/Caregiver Questionnaire

Participant/Caregiver Questionnaire

Participant Questions

Today's Date : ____________________

Your Birthdate : _______________________

Gender : Male___ Female___

Race : _______

Highest Education Level: ______________________

Profession: ___________________________________

Instructions: Circle **YES** or **NO**

1. Are you a native English speaker? **YES** **NO**
2. Do you have a high-school diploma? **YES** **NO**
3. Before my stroke, I wrote with my right-hand only. **YES** **NO**
4. Before my stroke, I wrote with my left-hand only. **YES** **NO**

MEDICAL HISTORY

5. Did you have a stroke? **YES** **NO**
6. Do you have aphasia? **YES** **NO**

When did you have your stroke? _______________________________________

7. Have you received or are you currently receiving speech therapy? **YES** **NO**

What did/do you work on in therapy? ____________________________________

____

8. Do you have any other disorders aside from aphasia from your stroke that affect your speech, hearing, vision, understanding, thinking, or memory? **YES** **NO**

If so, please list ____

<u>Caregiver Questions</u>

1. What is your relationship with the participant?

   ____

2. How long have you known the participant? ______________________________

APPENDIX B: Participant-Friendly Familiarity Rating Scale

Participant-Friendly Familiarity Rating Scale

☹☹☹☹ Never

☹☹ Rarely

☹ ☺ Sometimes

☺☺ Often

☺☺☺☺ Very often

APPENDIX C: Caregiver-Devised Familiarity Rating Scale

Caregiver Rating Scale

Directions:

This is a test to find out how familiar the participant is with certain words. This word *familiarity* will be measured by finding out how often the participant has come in contact with certain words. You will be shown 260 pictures representing nouns and you are to rate each one as to the number of times you think the participant has experienced it by verbally choosing and/or pointing to the word: **NEVER, RARELY, SOMETIMES, OFTEN,** or **VERY OFTEN**. There may be some words which the participant might have *used* or *heard* more often than he/she has seen them. Or there may be other words which the participant has seen more often than he/she has used or heard them. In such cases, always give the word the highest rating of the three areas (used, heard, seen).

The five possible ratings are described by the words NEVER, RARELY, SOMETIMES, OFTEN, AND VERY OFTEN. This means the participant has seen or heard or used the particular word (in writing or speech):

NEVER (*patient has never seen or heard or used the word in his/her life*)
RARELY (*patient has seen or heard or used the word at least once before, but only rarely*)
SOMETIMES (*patient has sometimes seen or heard or used the word, but not often*)
OFTEN (*patient has often seen or heard or used the word, but not very often*)
VERY OFTEN (*patient has seen or heard or used the word nearly every day of his/her life*)

(adapted from Frattali et al., 1995 (ASHA FACS); Gilhooly & Hay, 1977, p. 12; Noble, 1953, p.564; Paul et al., 2003 (QCL))

APPENDIX D: List of Stimuli for Each Participant

IC-SFA Stimuli			
Familiar-Treatment	**Familiar-Probe**	**Unfamiliar-Treatment**	**Unfamiliar-Probe**
bed	desk	leopard	tiger
hand	helmet	seahorse	snail
pineapple	onion	saw	pliers
chisel	wrench	raccoon	giraffe
lobster	eagle	caterpillar	grasshopper
belt	pants	artichoke	asparagus
wine glass	frying pan	celery	lettuce
mushroom	pepper	french horn	accordion
window	moon	heart	button
doll	flute	crown	boot

IC-PCA Stimuli			
Familiar-Treatment	**Familiar-Probe**	**Unfamiliar-Treatment**	**Unfamiliar-Probe**
chicken	turtle	fox	goat
bread	cloud	rooster	peacock
blouse	clock	kettle	spindle
picnic basket	school bus	well	bear
corn	cherry	tennis racket	watering can
flower	football	harp	drum
pot	nut	mitten	button
fork	grapes	penguin	monkey
couch	dresser	pumpkin	carrot
motorcycle	suitcase	skunk	squirrel

JD- SFA Stimuli			
Familiar-Treatment	**Familiar-Probe**	**Unfamiliar-Treatment**	**Unfamiliar-Probe**
butterfly	fly	penguin	eagle
desk	dresser	gorilla	tiger
envelope	doll	clothespin	cannon
football	necklace	cigar	sled
stool	rocking chair	windmill	roller skate
lamp	sweater	artichoke	celery
lobster	pot	caterpillar	beetle
lemon	strawberry	flute	trumpet
telephone	truck	mushroom	cherry
chisel	thumb	peacock	owl

JD- PCA Stimuli			
Familiar-Treatment	**Familiar - Probe**	**Unfamiliar-Treatment**	**Unfamiliar-Probe**
mitten	glove	rhinoceros	elephant
piano	guitar	seahorse	snail
toe	potato	alligator	monkey
garbage	candle	corn	asparagus
salt shaker	screwdriver	top	crown
axe	wheel	donkey	goat
toothbrush	paintbrush	raccoon	skunk
refrigerator	umbrella	spider	spindle
ant	nut	fox	swan
blouse	vest	tennis racket	bee

RR- PCA Stimuli			
Familiar-Treatment	**Familiar-Probe**	**Unfamiliar-Treatment**	**Unfamiliar-Probe**
table	desk	barrel	box
sock	button	camel	fox
thumb	glove	cigar	anchor
cup	vase	violin	french horn
fork	hanger	purse	basket
couch	bicycle	seahorse	swan
onion	pear	artichoke	asparagus
foot	lips	flute	accordion
watch	lock	rolling pin	bat
cap	helmet	giraffe	kangaroo

RR- SFA Stimuli			
Familiar-Treatment	**Familiar -Probe**	**Unfamiliar-Treatment**	**Unfamiliar-Probe**
peanut	cow	airplane	alligator
belt	bow	eagle	bottle
envelope	grasshopper	donkey	clothespin
arrow	axe	thimble	cannon
church	harp	elephant	gorilla
lightswitch	lemon	cigarette	ashtray
glasses	moon	top	rooster
garbage	dog	wine glass	frog
peacock	pig	snowman	spindle
blouse	traffic light	chisel	lion

RM-PCA Stimuli			
Familiar-Treatment	**Familiar-Probe**	**Unfamiliar-Treatment**	**Unfamiliar-Probe**
couch	glass	chicken	mouse
desk	hair	kangaroo	french horn
lettuce	plug	helmet	ostrich
fish	necklace	fly	giraffe
kettle	tree	gorilla	roller skate
toothbrush	watering can	cigar	lion
traffic light	lemon	snowman	penguin
shirt	telephone	spindle	pig
window	lamp	drum	windmill
piano	table	monkey	rhinoceros

RM-SFA Stimuli			
Familiar-Treatment	**Familiar-Probe**	**Unfamiliar-Treatment**	**Unfamiliar-Probe**
dog	dresser	wine glass	leopard
ear	leg	penguin	cigarette
key	nose	spider	lion
lobster	envelope	seal	snail
lips	nail file	sled	ashtray
tree	pitcher	french horn	helicopter
stove	tomato	camel	mouse
watering can	squirrel	chain	mountain
doorknob	ironing board	bottle	saw
table	cannon	axe	top

APPENDIX E: IRB Approval Letter

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

TO: Monica Hough, PhD, Dept of CSDI, ECU—Mailstop 668

FROM: UMCIRB KK

DATE: December 28, 2009

RE: Expedited Category Research Study

TITLE: "The effect of word familiarity and treatment approach on word retrieval skills in aphasia"

UMCIRB #09-0877

This research study has undergone review and approval using expedited review on 12.22.09. This research study is eligible for review under an expedited category because of the following reasons:

- Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving x-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.) Examples: (a) physical sensors that are applied either to the surface of the body or at a distance and do not involve input of significant amounts of energy into the subject or an invasion of the subject's privacy; (b) weighing or testing sensory acuity; (c) magnetic resonance imaging; (d) electrocardiography, electroencephalography, thermography, detection of naturally occurring radioactivity, electroretinography, ultrasound, diagnostic infrared imaging, doppler blood flow, and echocardiography; (e) moderate exercise, muscular strength testing, body composition assessment, and flexibility testing where appropriate given the age, weight, and health of the individual.

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

- Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(2) and (b)(3). This listing refers only to research that is not exempt.)

The Chairperson (or designee) deemed this **unfunded** study **no more than minimal risk** requiring a continuing review in **12 months**. Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The investigator must adhere to all reporting requirements for this study.

The above referenced research study has been given approval for the period of **12.22.09** to **12.21.10**. The approval includes the following items:

- Internal Processing Form (received 12.3.09)
- Appendix A: Informed Consent (received 12.22.09)
- Appendix B: Invitation to Potential Participants
- Appendix C: Participant /Caregiver Questionnaire
- Appendix D: Caregiver Rating Scale
- Appendix E: Participant-Friendly Scale
- Appendix F: Treatment Models
- Appendix G: Procedural Timeline

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

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

APPENDIX F: Consent Form

Informed Consent form
CONSENT DOCUMENT

Title: The effect of word familiarity and treatment approach on word retrieval skills in aphasia

Principal Investigator: Monica S. Hough, Ph.D., CCC-SLP
Health Sciences Building, Room 3310V, 2310T
Department of Communication Sciences & Disorders
East Carolina University

Secondary Investigator: Jacqueline Dorry
Second Year Master's Student
Department of Communication Sciences & Disorders
East Carolina University

Institution: East Carolina University

Address: Department of Communication Sciences & Disorders (CSDI)
College of Allied Health Sciences
Health Sciences Bldg, Suite 2310T
East Carolina University
Greenville, North Carolina 27858

Telephone #: 919-412-9901 (Dorry)
252- 744-6090 (Hough)

This consent document may contain words that you do not understand. You should ask the study coordinator to explain any words or information in this consent form that you do not understand.

INTRODUCTION

You have been asked to participate in a research study being conducted by Jacqueline Dorry, second year master's student under the direction of Monica S. Hough, Ph.D., Professor, Department of CSDI. This research study is designed to investigate whether word familiarity affects word retrieval in response to treatment. In particular, this study will help (a) determine if word retrieval increases as a result of treatment focusing on stimuli that is familiar to the subject and (b) determine whether semantic feature analysis treatment or phonological components treatment is more effective at increasing word retrieval and the rate of word retrieval when paired with familiar stimuli.

PLAN AND PROCEDURES

All data will be collected by Jacqueline Dorry. It will involve me undergoing 19 days that involve naming pictures and receiving treatment that may help improve my overall word retrieval abilities. I understand that prior to participating in this study, I will complete a hearing screening, the Test of Adolescent and Adult Word Finding (TAWF- if not already taken in the past 2 months), the Western Aphasia Battery (if not already taken within the past 2 months), and I will rate pictures according to how familiar I think they are to me.

I understand that I will look at pictures on a computer and rate them by circling my choice with a pencil on a piece of paper. I understand I can ask for assistance to be reminded about the directions at any time. I shall withdraw from the study whenever I deem necessary without any repercussions on my work as a faculty member, staff member or student at East Carolina University. I understand that participation in this study has nothing to do with my current treatment at the ECU SLH Clinic or at PCMH.

If I choose to participate, I will be tested at the ECU SLH Clinic, room 10, the Adult Language Lab, Room 2310T, or a room in the Pitt Rehabilitation Facility. Total time for each testing day will range from 50 minutes to three hours in length. Total time for each treatment day will be approximately 50 minutes in total. Testing and treatment days will be scheduled in accordance with both my and the researcher's schedule. The total duration of the study will be approximately 3 weeks.

POTENTIAL RISKS AND DISCOMFORTS

Although it is not possible to predict all possible risks or discomforts that participants may experience in any research study, the present investigators anticipate no major risks or discomforts will occur in the present project. The participant may discontinue the study with no penalty and at will.

POTENTIAL BENEFITS

The literature is limited relative to investigations that examine how stimuli familiar to the patient affects word retrieval. In addition, no study has been found that analyzes how word familiarity affects word retrieval in response to phonological components analysis and semantic feature analysis treatment.

SUBJECT PRIVACY AND CONFIDENTIALITY OF RECORDS

I understand that all records related to the study will remain confidential. My name will not be used to identify information or results in scientific presentations or publications. My data will be coded to conceal my identity. All computer data collected will be stored on the principal investigator's laptop computer or on digital video disks (DVD) stored in a locked storage cabinet, with access limited to the above listed persons.

TERMINATION OF PARTICIPATION

I may stop participating at any time I choose without penalty, loss of benefits, or without jeopardizing any continuing medical care at this institution.

COSTS OF PARTICIPATION

There will be no costs to me for participating in this research study.

COMPENSATION AND TREATMENT FOR INJURY

The policy of East Carolina University and/or Pitt County Memorial Hospital does not provide for payment or medical care for research participants because of physical or other injury that result from this research study. Every effort will be made to make the facilities of the School of Medicine and Pitt County Memorial Hospital available for care in the event of injury.

A corporate sponsor may pay for some physical injuries caused by a research study; however, there is no corporate sponsor for this investigation. You should notify the study coordinator as soon as you believe you have experienced any study related illness, adverse event, or injury. The study coordinator will determine if the adverse event or injury was a result of your participation in this study. The study coordinator is not responsible for expenses that are due to pre-existing medical conditions, underlying disease, your negligence or willful misconduct, or the negligence or willful misconduct of other individuals involved in the research study. You do not give up any legal rights as a research participant by signing this consent form.

VOLUNTARY PARTICIPATION

Participating in this study is voluntary. If you decide not to be in this study after it has already started, you may stop at any time without losing benefits that you should normally receive. You may stop at any time you choose without penalty, loss of benefits, or without a causing a problem with your medical care at this institution.

PERSONS TO CONTACT WITH QUESTIONS

The investigators will be available to answer any questions concerning this research, now or in the future. You may contact the investigators, Jacqueline Dorry or Dr. Monica S. Hough at phone numbers 919-412-9901 (Dorry) or 252-744-6090 (Hough). If you have questions about your rights as a research subject, you may call the Chair of the University and Medical Center Institutional Review Board at phone number 252-744-2914 (8am-5pm). If you have a question about injury related to this research, you may call PCMH Risk Management Office at 252-847-

5246 and/or the ECU Brody School of Medicine Risk Management Office at 252-744-1857 (8am-5pm) and/or the ECU Risk Management Office at 252-328-2010.

CONSENT TO PARTICIPATE

Title: The affect of word familiarity and treatment approach on word retrieval ability in aphasia

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

____

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

____

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

WITNESS: I confirm that the contents of this consent document were orally presented, the participant or guardian indicates all questions have been answered to his or her satisfaction, and the participant or guardian has signed the document.

____

Witness's Name **(PRINT)** **Signature** **Date**

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

____

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

____

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

APPENDIX G: Accuracy Data at Baseline for Each Participant

IC Accuracy: Familiarity Effect on Word Retrieval at Baseline

Stimuli	F (%)	UF (%)
B1.[a] SFA Tx	70	20
B1.[a] SFA P	50	60
B1. PCA Tx	70	90
B2. PCA Tx	60	100
B3. PCA Tx	60	80
B1. PCA P	80	70
B2. PCA P	70	60
B3. PCA P	80	50

[a] only one SFA baseline taken due to experimental error.

JD Accuracy: Familiarity Effect on Word Retrieval at Baseline

Stimuli	F (%)	UF (%)
B1.[a] SFA Tx	50	50
B1.[a] SFA P	60	30
B1. PCA Tx	40	30
B2. PCA Tx	40	40
B3. PCA Tx	50	50
B1. PCA P	60	20
B2. PCA P	50	20
B3. PCA P	60	40

[a] only one SFA baseline taken due to experimental error.

RR Accuracy: Familiarity Effect on Word Retrieval at Baseline		
Stimuli	F (%)	UF (%)
B1. PCA Tx	40	10
B2. PCA Tx	30	20
B3. PCA Tx	20	0
B1. PCA P	20	10
B2. PCA P	30	30
B3. PCA P	50	20
B1. SFA Tx	40	20
B2. SFA Tx	40	30
B3. SFA Tx	10	50
B1. SFA P	40	20
B2. SFA P	60	10
B3. SFA P	40	10

RM Accuracy: Familiarity Effect on Word Retrieval at Baseline		
Stimuli	F (%)	UF (%)
B1. PCA Tx	10	10
B2. PCA Tx	0	0
B3. PCA Tx	0	10
B1. PCA P	10	10
B2. PCA P	0	0
B3. PCA P	0	0
B1. SFA Tx	10	10
B2. SFA Tx	30	10
B3. SFA Tx	10	0
B1. SFA P	0	0
B2. SFA P	10	0
B3. SFA P	10	0

Fisher's Exact Test Tables for All Baselines for Each Participant

IC Accuracy: Fisher's Exact Count of Baselines		
n=160	Familiar	Unfamiliar
Correct	54	54
Incorrect	26	26

JD Accuracy: Fisher's Exact Count of Baselines		
n=160	Familiar	Unfamiliar
Correct	41	28
Incorrect	39	52

RR Accuracy: Fisher's Exact Count of Baselines		
n= 240	Familiar	Unfamiliar
Correct	42	22
Incorrect	78	98

RM Accuracy: Fisher's Exact Count of Baselines		
n= 240	Familiar	Unfamiliar
Correct	10	5
Incorrect	110	115

IC Accuracy: Effect of Familiarity for Word Retrieval at Baseline Regardless of Treatment Approach				
Stimuli Type	N	Range (%) min- max (range)	M (%)	SD (%)
FAMILIAR	8	50-80 (40)	67.50	10.351
UNFAMILIAR	8	10-100 (90)	65.00	27.775

JD Accuracy: Effect of Familiarity on Word Retrieval at Baseline Regardless of Treatment Approach				
Stimuli Type	N	Range (%) min- max (range)	M (%)	SD (%)
FAMILIAR	8	40-60 (20)	51.25	8.345
UNFAMILIAR	8	20-50 (30)	35.00	11.952

RR Accuracy: Effect of Familiarity on Word Retrieval at Baseline Regardless of Treatment Approach				
Stimuli Type	N	Range (%) min- max (range)	M (%)	SD (%)
FAMILIAR	12	10-60 (50)	35.00	13.817
UNFAMILIAR	12	0-50 (50)	19.17	13.114

RM Accuracy: Effect of Familiarity on Word Retrieval at Baseline Regardless of Treatment Approach				
Stimuli Type	N	Range (%) min- max (range)	M (%)	SD (%)
FAMILIAR	12	0-30 (30)	7.50	8.660
UNFAMILIAR	12	0-10 (10)	4.10	5.149

APPENDIX H: RT Data at Baseline for Each Participant

IC Reaction Time: Familiarity Effect on Word Retrieval at Baseline

Stimuli	F (ms)	UF (ms)
B1.[a] SFA Tx	2056	3202
B1.[a] SFA P	2462	3049
B1. PCA Tx	3262	2602
B2. PCA Tx	2806	3305
B3. PCA Tx	4865	4065
B1. PCA P	3382	2137
B2. PCA P	3066	2857
B3. PCA P	4307	3878

[a] only one SFA baseline taken due to experimental error

JD Reaction Time: Familiarity Effect on Word Retrieval at Baseline

Stimuli	F (ms)	UF (ms)
B1.[a] SFA Tx	2017	2235
B1.[a] SFA P	3288	3170
B1. PCA Tx	1949	2900
B2. PCA Tx	2727	2747
B3. PCA Tx	1943	3479
B1. PCA P	2288	2434
B2. PCA P	1829	4373
B3. PCA P	2732	3248

[a] only one SFA baseline taken due to experimental error

RR Reaction Time: Familiarity Effect on Word Retrieval at Baseline		
Stimuli	F (ms)	UF (ms)
B1. PCA Tx	2661	3013
B2. PCA Tx	1876	2422
B3. PCA Tx	3027	1823
B1. PCA P	2451	2004
B2. PCA P	1555	4249
B3. PCA P	2507	2429
B1. SFA Tx	3938	4334
B2. SFA Tx	2911	3005
B3. SFA Tx	2877	1868
B1. SFA P	3198	2857
B2. SFA P	1742	2611
B3. SFA P	3798	2989

RM Reaction Time: Familiarity Effect on Word Retrieval at Baseline		
Stimuli	F (ms)	UF (ms)
B1. PCA Tx	3575	3111
B2. PCA Tx	6068	4953
B3. PCA Tx	1877	1659
B1. PCA P	5018	3121
B2. PCA P	3886	2103
B3. PCA P	3894	4744
B1. SFA Tx	5018	3121
B2. SFA Tx	3886	2103
B3. SFA Tx	3894	4744
B1. SFA P	5018	3121
B2. SFA P	3886	2103
B3. SFA P	3894	4744

Independent Sample T-tests for RT at Baseline

IC Reaction Time (ms): Familiarity Effect on Word Retrieval at Baseline

Rating	N	M	SD	Std. Error M
Familiar	80	3276.60	1808.836	202.234
Unfamiliar	80	3111.85	1598.686	178.739

IC Reaction Time (ms): Independent Samples T-test	t-test for Equality of Means						
						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	M Difference	Std. Error Difference	Lower	Upper
Equal variances not assumed	.610	155.650	.542	164.750	269.900	-368.390	697.890

JD Reaction Time (ms): Familiarity Effect on Word Retrieval at Baseline

Rating	N	M	SD	Std. Error M
Familiar	80	2357.06	1401.722	156.717
Unfamiliar	80	3076.49	1225.258	136.988

JD Reaction Time (ms): Independent Samples T-test	t-test for Equality of Means						
						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	M Difference	Std. Error Difference	Lower	Upper
Equal variances not assumed	-3.456	155.223	.001	-719.425	208.149	-1130.595	-308.255

RR Reaction Time (ms): Familiarity Effect on Word Retrieval at Baseline

Rating	N	M	SD	Std. Error M
Familiar	120	2711.68	2146.817	195.977
Unfamiliar	120	2803.30	1692.270	154.482

RR Reaction Time (ms): Independent Samples T-test	t-test for Equality of Means						
						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	M Difference	Std. Error Difference	Lower	Upper
Equal variances not assumed	-.367	225.692	.714	-91.625	249.543	-583.357	400.107

RM Reaction Time (ms): Familiarity Effect on Word Retrieval at Baseline

Rating	N	M	SD	Std. Error M
Familiar	120	3922.86	1852.124	169.075
Unfamiliar	120	3203.50	1958.488	178.785

RM Reaction Time (ms): Independent Samples T-test	t-test for Equality of Means						
						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	M Difference	Std. Error Difference	Lower	Upper
Equal variances not assumed	2.923	237.262	.004	719.358	246.070	234.598	1204.119

IC Reaction Time: Effect of Familiarity for Baselines Regardless of Treatment Approach				
Stimuli Type	N	Range (ms) min- max (range)	M (ms)	SD (ms)
FAMILIAR	80	424-9914 (9490)	3276.60	1808.836
UNFAMILIAR	80	1127-9899 (8772)	3111.85	1598.686

JD Reaction Time: Effect of Familiarity for Baselines Regardless of Treatment Approach				
Stimuli Type	N	Range (ms) min- max (range)	M (ms)	SD (ms)
FAMILIAR	80	712-9006 (8294)	2357.06	1401.722
UNFAMILIAR	80	1387-8508 (7121)	3076.49	1225.258

RR Reaction Time: Effect of Familiarity for Baselines Regardless of Treatment Approach				
Stimuli Type	N	Range (ms) min- max (range)	M (ms)	SD (ms)
FAMILIAR	120	64-9995 (9931)	2711.68	2146.817
UNFAMILIAR	120	63-9732 (9669)	2803.30	1692.270

RM Reaction Time: Effect of Familiarity for Baselines Regardless of Treatment Approach				
Stimuli Type	N	Range (ms) min- max (range)	M (ms)	SD (ms)
FAMILIAR	120	63-9881 (9818)	3922.86	1852.124
UNFAMILIAR	120	63-9128 (9065)	3203.00	1958.580

APPENDIX I: Accuracy Data throughout Each Treatment Approach for Each Participant

IC Accuracy: Effect of Familiarity Relative to Treated Stimuli		
Treatment Approach and Day	F Tx (%)	UF Tx (%)
SFA T1	70	80
SFA T2	90	90
SFA T3	80	100
SFA T4	80	70
SFA T5	100	80
PCA T1	100	90
PCA T2	80	90
PCA T3	70	90
PCA T4	90	100
PCA T5	70	90

JD Accuracy: Effect of Familiarity Relative to Treated Stimuli		
Treatment Approach and Day	F Tx (%)	UF Tx (%)
SFA T1	50	60
SFA T2	60	70
SFA T3	50	70
SFA T4	70	70
SFA T5	90	50
PCA T1	40	50
PCA T2	70	60
PCA T3	70	50
PCA T4	70	60
PCA T5	60	70

RR Accuracy: Effect of Familiarity Relative to Treated Stimuli		
Treatment Approach and Day	F Tx (%)	UF Tx (%)
PCA T1	20	30
PCA T2	20	40
PCA T3	30	70
PCA T4	80	50
PCA T5	50	50
SFA T1	40	20
SFA T2	10	0
SFA T3	50	20
SFA T4	50	40
SFA T5	60	70

RM Accuracy: Effect of Familiarity Relative to Treated Stimuli		
Treatment Approach and Day	F Tx (%)	UF Tx (%)
PCA T1	0	20
PCA T2	0	20
PCA T3	20	10
PCA T4	0	0
PCA T5	0	0
SFA T1	20	10
SFA T2	10	0
SFA T3	40	30
SFA T4	20	40
SFA T5	20	40

Fisher’s Exact Test Tables for Treated Data (T1-T5-Tx) per Tx Type

IC SFA Treatment Accuracy: Fisher’s Exact Data for Treated Data (T1-T5)		
n=100	Familiar	Unfamiliar
Correct	42	42
Incorrect	8	8

IC PCA Treatment Accuracy: Fisher’s Exact Data for Treated Data (T1-T5)		
n=100	Familiar	Unfamiliar
Correct	41	46
Incorrect	9	4

JD SFA Treatment Accuracy: Fisher’s Exact Data for Treated Data (T1-T5)		
n=100	Familiar	Unfamiliar
Correct	32	32
Incorrect	18	18

JD PCA Treatment Accuracy: Fisher’s Exact Data for Treated Data (T1-T5)		
n=100	Familiar	Unfamiliar
Correct	31	29
Incorrect	19	21

RR PCA Treatment Accuracy: Fisher's Exact Data for Treated Data (T1-T5)		
n=100	Familiar	Unfamiliar
Correct	20	24
Incorrect	30	26

RR SFA Treatment Accuracy: Fisher's Exact Data for Treated Data (T1-T5)		
n=100	Familiar	Unfamiliar
Correct	26	32
Incorrect	24	18

RM PCA Treatment Accuracy: Fisher's Exact Data for Treated Data (T1-T5)		
n=100	Familiar	Unfamiliar
Correct	20	14
Incorrect	30	36

RM SFA Treatment Accuracy: Fisher's Exact Data for Treated Data (T1-T5)		
n=100	Familiar	Unfamiliar
Correct	11	12
Incorrect	39	38

IC Accuracy: Effect of Familiarity Relative to Treated Stimuli				
Treatment and Stimuli Type	N	Range (%) min- max (range)	M (%)	SD (%)
SFA FAMILIAR	5	70-100 (30)	84	11.402
PCA FAMILIAR	5	70-100 (30)	82	13.038
SFA UNFAMILIAR	5	70-100 (30)	84	11.402
PCA UNFAMILIAR	5	90-100 (10)	92	4.472

JD Accuracy: Effect of Familiarity Relative to Treated Stimuli				
Treatment and Stimuli Type	N	Range (%) min- max (range)	M (%)	SD (%)
SFA FAMILIAR	5	50-90 (40)	64.00	16.733
PCA FAMILIAR	5	40-70 (30)	62.00	13.038
SFA UNFAMILIAR	5	50-70 (20)	64.00	8.944
PCA UNFAMILIAR	5	50-70 (20)	58.00	8.367

RR Accuracy: Effect of Familiarity Relative to Treated Stimuli				
Treatment and Stimuli Type	N	Range (%) min- max (range)	M (%)	SD (%)
SFA FAMILIAR	5	40-60 (20)	52.00	8.367
PCA FAMILIAR	5	20-80 (60)	40.00	25.495
SFA UNFAMILIAR	5	30-80 (50)	64.00	20.736
PCA UNFAMILIAR	5	30-70 (40)	48.00	14.832

RM Accuracy: Effect of Familiarity Relative to Treated Stimuli				
Treatment and Stimuli Type	N	Range (%) min- max (range)	M (%)	SD (%)
SFA FAMILIAR	5	10-40 (30)	22.00	10.954
PCA FAMILIAR	5	0-20 (20)	4.00	8.944
SFA UNFAMILIAR	5	0-40 (40)	24.00	18.166
PCA UNFAMILIAR	5	0-10 (10)	4.00	5.477

Effect of Familiarity of Stimuli Across Time for Each Participant

IC Accuracy: Effect of Familiarity of Stimuli Across Time

Treatment Approach and Day	F (%)	UF (%)
SFA B1	60	45
SFA T1	75	65
SFA T2	85	75
SFA T3	85	90
SFA T4	80	70
SFA T5	90	75
SFA 1-month post	80	75
PCA B1	75	80
PCA B2	65	80
PCA B3	70	65
PCA T1	85	80
PCA T2	70	80
PCA T3	70	80
PCA T4	85	80
PCA T5	70	80
PCA 1-month post	75	85

JD Accuracy: Effect of Familiarity of Stimuli Across Time

Treatment Approach and Day	F (%)	UF (%)
SFA B1	55	40
SFA T1	45	55
SFA T2	50	65
SFA T3	55	55
SFA T4	55	50
SFA T5	65	45
SFA 1-month post	65	55
PCA B1	50	25
PCA B2	45	30
PCA B3	55	45
PCA T1	60	60
PCA T2	85	60
PCA T3	75	75
PCA T4	80	60
PCA T5	75	65
PCA 1-month post	60	70

RR Accuracy: Effect of Familiarity of Stimuli Across Time		
Treatment Approach and Day	F (%)	UF (%)
PCA B1	30	10
PCA B2	30	25
PCA B3	35	10
PCA T1	30	20
PCA T2	25	35
PCA T3	35	40
PCA T4	55	40
PCA T5	30	50
PCA 1-month post	35	30
SFA B1	40	15
SFA B2	50	15
SFA B3	25	5
SFA T1	55	25
SFA T2	45	25
SFA T3	60	45
SFA T4	60	35
SFA T5	45	45
SFA 1-month post	35	20

RM Accuracy: Effect of Familiarity of Stimuli Across Time		
Treatment Approach and Day	F (%)	UF (%)
PCA B1	15	10
PCA B2	15	25
PCA B3	25	10
PCA T1	20	15
PCA T2	15	35
PCA T3	30	40
PCA T4	15	40
PCA T5	5	50
PCA 1-month post	15	30
SFA B1	25	15
SFA B2	45	15
SFA B3	25	5
SFA T1	40	25
SFA T2	25	25
SFA T3	50	45
SFA T4	40	35
SFA T5	35	45
SFA 1-month post	30	20

APPENDIX J: RT Data through Both Treatment Types for Each Participant

IC Reaction Time: Effect of Familiarity Relative to Treated Stimuli

Treatment Approach and Day	F Tx (ms)	UF Tx (ms)
SFA T1	3284	3926
SFA T2	2452	3611
SFA T3	2957	3829
SFA T4	2435	2088
SFA T5	3045	4346
PCA T1	2236	2088
PCA T2	1954	2212
PCA T3	2451	2067
PCA T4	4143	2678
PCA T5	2541	4190

JD Reaction Time: Effect of Familiarity Relative to Treated Stimuli

Treatment Approach and Day	F Tx (ms)	UF Tx (ms)
SFA T1	2755	2506
SFA T2	2297	2593
SFA T3	1881	2611
SFA T4	3585	4072
SFA T5	3597	3024
PCA T1	2402	2922
PCA T2	2628	2731
PCA T3	N/A[a]	N/A[a]
PCA T4	2639	2395
PCA T5	3426	2143

[a] no data due to experimental error

RR Reaction Time: Effect of Familiarity Relative to Treated Stimuli

Treatment Approach and Day	F Tx (ms)	UF Tx (ms)
PCA T1	2870	2829
PCA T2	1726	2722
PCA T3	3844	3159
PCA T4	2513	2368
PCA T5	2465	2919
SFA T1	2759	2453
SFA T2	2058	1846
SFA T3	2264	3947
SFA T4	1855	1920
SFA T5	2446	1458

RM Reaction Time: Effect of Familiarity Relative to Treated Stimuli

Treatment Approach and Day	F Tx (ms)	UF Tx (ms)
PCA T1	5244	4574
PCA T2	2865	3590
PCA T3	4846	5465
PCA T4	6819	3142
PCA T5	5277	3675
SFA T1	2736	1358
SFA T2	8726	5724
SFA T3	3451	3179
SFA T4	2491	2790
SFA T5	2920	2253

Independent Sample T-tests for RT of Treated Stimuli

IC SFA Reaction Time (ms): Effect of Familiarity for Treated Stimuli

Rating	N	M	SD	Std. Error M
Familiar	50	2834.48	1378.965	195.015
Unfamiliar	50	3559.94	1940.227	274.390

IC SFA Reaction Time (ms): Independent Samples T-test	t-test for Equality of Means						
						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	M Difference	Std. Error Difference	Lower	Upper
Equal variances not assumed	-2.155	88.439	.034	-725.460	336.631	-1394.397	-56.523

IC PCA Reaction Time (ms): Effect of Familiarity for Treated Stimuli

Rating	N	M	SD	Std. Error M
Familiar	50	2665.08	2163.816	306.010
Unfamiliar	50	2506.50	1817.201	256.991

IC PCA Reaction Time (ms): Independent Samples T-test	t-test for Equality of Means						
						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	M Difference	Std. Error Difference	Lower	Upper
Equal variances not assumed	.397	95.158	.692	158.580	399.608	-634.725	951.885

JD SFA Reaction Time (ms): Effect of Familiarity for Treated Stimuli

Rating	N	M	SD	Std. Error M
Familiar	50	2792.34	1739.123	245.949
Unfamiliar	50	3005.46	1771.593	250.541

JD SFA Reaction Time (ms): Independent Samples T-test	t-test for Equality of Means						
						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	M Difference	Std. Error Difference	Lower	Upper
Equal variances not assumed	-.607	97.966	.545	-213.120	351.087	-909.843	483.603

JD PCA Reaction Time (ms): Effect of Familiarity for Treated Stimuli

Rating	N	M	SD	Std. Error M
Familiar	40	2774.03	1945.130	307.552
Unfamiliar	40	2547.65	1311.335	207.340

JD PCA Reaction Time (ms): Independent Samples T-test	t-test for Equality of Means						
						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	M Difference	Std. Error Difference	Lower	Upper
Equal variances not assumed	.610	68.381	.544	226.375	370.915	-513.700	966.450

RR PCA Reaction Time (ms): Effect of Familiarity for Treated Stimuli

Rating	N	M	SD	Std. Error M
Familiar	50	2683.52	1796.572	254.074
Unfamiliar	50	2889.82	1818.994	257.245

RR PCA Reaction Time (ms): Independent Samples T-test	t-test for Equality of Means						
						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	M Difference	Std. Error Difference	Lower	Upper
Equal variances not assumed	-.571	97.985	.570	-206.300	361.564	-923.812	511.212

RR SFA Reaction Time (ms): Effect of Familiarity for Treated Stimuli

Rating	N	M	SD	Std. Error M
Familiar	50	2276.24	2365.990	334.602
Unfamiliar	50	2324.66	2208.729	312.361

RR SFA Reaction Time (ms): Independent Samples T-test	t-test for Equality of Means						
						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	M Difference	Std. Error Difference	Lower	Upper
Equal variances not assumed	-.106	97.540	.916	-48.420	457.742	-956.848	860.008

RM PCA Reaction Time (ms): Effect of Familiarity for Treated Stimuli

Rating	N	M	SD	Std. Error M
Familiar	50	5010.24	1805.257	255.302
Unfamiliar	50	4089.16	1890.274	267.325

RM PCA Reaction Time (ms): Independent Samples T-test	t-test for Equality of Means						
						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	M Difference	Std. Error Difference	Lower	Upper
Equal variances not assumed	2.492	97.793	.014	921.080	369.651	187.500	1654.660

RM SFA Reaction Time (ms): Effect of Familiarity for Treated Stimuli

Rating	N	M	SD	Std. Error M
Familiar	50	4064.76	2809.828	397.370
Unfamiliar	50	3060.78	1696.868	239.973

RM SFA Reaction Time (ms): Independent Samples T-test	t-test for Equality of Means						
						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	M Difference	Std. Error Difference	Lower	Upper
Equal variances not assumed	2.163	80.545	.034	1003.980	464.209	80.271	1927.689

IC Reaction Time: Effect of Familiarity for Treated Stimuli				
Stimuli Type	N	Range (ms) min- max (range)	M (ms)	SD (ms)
SFA FAMILIAR	50	740-8157 (7417)	2834.48	1378.965
PCA FAMILIAR	50	946-9688 (8742)	2665.08	2163.816
SFA UNFAMILIAR	50	1068-8868 (7800)	3559.94	1940.227
PCA UNFAMILIAR	50	325-9564 (9239)	2506.60	1817.210

JD Reaction Time: Effect of Familiarity for Treated Stimuli				
Stimuli Type	N	Range (ms) min- max (range)	M (ms)	SD (ms)
SFA FAMILIAR	50	849-8384 (7535)	2834.98	1754.491
PCA FAMILIAR	40	1052-8825 (7773)	2774.02	1945.130
SFA UNFAMILIAR	50	773-8684 (7911)	3006.54	1771.353
PCA UNFAMILIAR	40	1133-6735 (5602)	2547.65	1311.335

RR Reaction Time: Effect of Familiarity for Treated Stimuli				
Stimuli Type	N	Range (ms) min- max (range)	M (ms)	SD (ms)
SFA FAMILIAR	50	63-9401 (9338)	2276.24	2365.990
PCA FAMILIAR	50	63-9625 (9562)	2683.52	1796.572
SFA UNFAMILIAR	50	320-9981 (9661)	2324.66	2208.729
PCA UNFAMILIAR	50	756-9738 (8982)	2889.82	1818.994

RM Reaction Time: Effect of Familiarity for Treated Stimuli				
Stimuli Type	N	Range (ms) min- max (range)	M (ms)	SD (ms)
SFA FAMILIAR	50	63-9459 (9396)	4064.76	2809.828
PCA FAMILIAR	50	95-9630 (9535)	5010.24	1805.257
SFA UNFAMILIAR	50	138-7565 (7427)	3060.78	1696.868
PCA UNFAMILIAR	50	112-9315 (9203)	4089.16	1890.274

APPENDIX K: Accuracy Data for Treated Stimuli for Each Participant

McNemar's Test Tables for Baselines Vs. Day 5- Treated Stimuli for Each Participant

IC SFA Treatment Accuracy: Treated Data (B-Tx5)	
n= 20 Baseline, 20 Tx p= 0.00781	Baseline-Treatment, Day 5
Correct-Correct	10
Incorrect-Correct	8
Correct-Incorrect	0
Incorrect-Incorrect	2

IC PCA Treatment Accuracy: Treated Data (B-Tx5)	
n= 60 Baseline, 20 Tx p= 1	Baseline-Treatment, Day 5
Correct-Correct	13
Incorrect-Correct	3
Correct-Incorrect	3
Incorrect-Incorrect	1

JD SFA Treatment Accuracy: Treated Data (B-Tx5)	
n= 20 Baseline, 20 Tx p= 0.219	Baseline-Treatment, Day 5
Correct-Correct	8
Incorrect-Correct	5
Correct-Incorrect	1
Incorrect-Incorrect	6

JD PCA Treatment Accuracy: Treated Data (B-Tx5)	
n= 60 Baseline, 20 Tx p= 0.219	Baseline-Treatment, Day 5
Correct-Correct	8
Incorrect-Correct	5
Correct-Incorrect	1
Incorrect-Incorrect	6

RR PCA Treatment Accuracy: Treated Data (B-Tx5)	
n= 60 Baseline, 20 Tx p= .0312	Baseline-Treatment, Day 5
Correct-Correct	6
Incorrect-Correct	6
Correct-Incorrect	0
Incorrect-Incorrect	8

RR SFA Treatment Accuracy: Treated Data (B-Tx5)	
n= 60 Baseline, 20 Tx p= .0312	Baseline-Treatment, Day 5
Correct-Correct	6
Incorrect-Correct	6
Correct-Incorrect	0
Incorrect-Incorrect	8

RM PCA Treatment Accuracy: Treated Data (B-Tx5)	
n= 60 Baseline, 20 Tx Could not determine p-value	Baseline-Treatment, Day 5
Correct-Correct	0
Incorrect-Correct	0
Correct-Incorrect	0
Incorrect-Incorrect	20

RM SFA Treatment Accuracy: Treated Data (B-Tx5)	
n= 60 Baseline, 20 Tx p= .0312	Baseline-Treatment, Day 5
Correct-Correct	1
Incorrect-Correct	6
Correct-Incorrect	0
Incorrect-Incorrect	13

APPENDIX L: RT Data for Treated Stimuli for Each Participant

IC SFA Reaction Time (ms): Baseline Vs. T5 (treated)

Rating	N	M	SD	Std. Error M
B1	20	2628.90	945.750	211.476
T5	20	3695.10	2165.341	484.185

IC SFA Reaction Time (ms): B1 Vs. T5 (treated) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	-1066.200	2250.362	503.196	-2.119	19	.048	-2119.402	-12.998

IC PCA Reaction Time (ms): Baseline Vs. T5

Rating	N	M	SD	Std. Error M
B1	20	3441.10	1048.997	234.563
T5	20	3365.45	2237.930	500.416

IC PCA Reaction Time (ms): B1 Vs. T5 (treated) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	75.650	2824.720	631.627	.120	19	.906	-1246.360	1397.660

JD SFA Reaction Time (ms): Baseline Vs. T5 (treated)

Rating	N	M	SD	Std. Error M
B1	20	2082.90	595.026	133.052
T5	20	3066.80	1439.715	321.930

JD SFA Reaction Time (ms): B1 Vs. T5 (treated) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	-983.900	1366.344	305.524	-3.220	19	.005	-1623.369	-344.431

JD PCA Reaction Time (ms): Baseline Vs. T5 (treated)

Rating	N	M	SD	Std. Error M
B1	20	2625.15	787.466	176.083
T5	20	2784.50	2150.505	480.868

JD PCA Reaction Time (ms): B1 Vs. T5 (treated) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	-159.350	2557.014	571.766	-.279	19	.783	-1356.069	1037.369

RR PCA Reaction Time (ms): Baseline Vs. T5 (treated)

Rating	N	M	SD	Std. Error M
B1	20	2470.35	1005.367	224.807
T5	20	2691.95	1718.434	384.254

RR PCA Reaction Time (ms): B1 Vs. T5 (treated) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	-221.600	2054.719	459.449	-.482	19	.635	-1183.238	740.038

RR SFA Reaction Time (ms): Baseline Vs. T5 (treated)

Rating	N	M	SD	Std. Error M
B1	20	3305.95	1720.862	384.796
T5	20	1951.60	1793.122	400.954

RR SFA Reaction Time (ms): B1 Vs. T5 (treated) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	1354.350	2194.592	490.726	2.760	19	.012	327.249	2381.451

RM PCA Reaction Time (ms): Baseline Vs. T5 (treated)

Rating	N	M	SD	Std. Error M
B1	20	3540.55	731.396	163.545
T5	20	4475.95	1418.235	317.127

RM PCA Reaction Time (ms): B1 Vs. T5 (treated) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	-935.400	1564.903	349.923	-2.673	19	.015	-1667.797	-203.003

RM SFA Reaction Time (ms): Baseline Vs. T5 (treated)

Rating	N	M	SD	Std. Error M
B1	20	4178.10	1139.579	254.818
T5	20	2586.55	954.836	213.508

RM SFA Reaction Time (ms): B1 Vs. T5 (treated) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	1591.550	1545.275	345.534	4.606	19	.000	868.339	2314.761

APPENDIX M: Accuracy Data for Probe Stimuli for Each Participant

McNemar's Test Tables for Baselines Vs. Probe-Day 5 Stimuli for Each Participant

IC SFA Probe Accuracy: Probe Data (B-P5)	
n= 20 B, 20 P p=.125	Baseline-Probe, Day 5
Correct-Correct	10
Incorrect-Correct	6
Correct-Incorrect	1
Incorrect-Incorrect	3

IC PCA Probe Accuracy: Probe Data (B-P5)	
n= 60 B, 20 P p=1.5	Baseline-Probe, Day 5
Correct-Correct	13
Incorrect-Correct	1
Correct-Incorrect	1
Incorrect-Incorrect	5

JD SFA Probe Accuracy: Probe Data (B-P5)	
n= 20 B, 20 P p=.0391	Baseline-Probe, Day 5
Correct-Correct	8
Incorrect-Correct	8
Correct-Incorrect	1
Incorrect-Incorrect	3

JD PCA Probe Accuracy: Probe Data (B-P5)	
n= 60 B, 20 P p=.180	Baseline-Probe, Day 5
Correct-Correct	7
Incorrect-Correct	7
Correct-Incorrect	2
Incorrect-Incorrect	4

RR PCA Probe Accuracy: Probe Data (B-P5)	
n= 60 B, 20 P p=.375	Baseline-Probe, Day 5
Correct-Correct	5
Incorrect-Correct	4
Correct-Incorrect	1
Incorrect-Incorrect	10

RR SFA Probe Accuracy: Probe Data (B-P5)	
n= 60 B, 20 P p=.375	Baseline-Probe, Day 5
Correct-Correct	5
Incorrect-Correct	4
Correct-Incorrect	1
Incorrect-Incorrect	10

RM PCA Probe Accuracy: Probe Data (B-P5)	
n= 60 B, 20 P p=1	Baseline-Probe, Day 5
Correct-Correct	0
Incorrect-Correct	1
Correct-Incorrect	0
Incorrect-Incorrect	19

RM SFA Probe Accuracy: Probe Data (B-P5)	
n= 60 B, 20 P p=1	Baseline-Probe, Day 5
Correct-Correct	0
Incorrect-Correct	1
Correct-Incorrect	0
Incorrect-Incorrect	19

IC Accuracy: Treatment Vs. Probe Stimuli Across Time

Treatment Approach and Day	Tx (%)	Probe (%)
SFA B1	50	55
SFA T1	75	65
SFA T2	90	70
SFA T3	90	85
SFA T4	75	75
SFA T5	90	75
SFA 1-month post	65	90
PCA B1	80	75
PCA B2	80	65
PCA B3	70	65
PCA T1	95	70
PCA T2	85	65
PCA T3	80	70
PCA T4	95	70
PCA T5	80	70
PCA 1-month post	80	80

JD Accuracy: Treatment Vs. Probe Stimuli Across Time		
Treatment Approach and Day	Tx (%)	Probe (%)
SFA B1	50	45
SFA T1	55	45
SFA T2	65	50
SFA T3	60	50
SFA T4	70	35
SFA T5	70	40
SFA 1-month post	60	60
PCA B1	35	40
PCA B2	40	35
PCA B3	50	50
PCA T1	45	75
PCA T2	65	80
PCA T3	60	90
PCA T4	65	75
PCA T5	65	75
PCA 1-month post	65	65

RR Accuracy: Treatment Vs. Probe Stimuli Across Time		
Treatment Approach and Day	Tx (%)	Probe (%)
PCA B1	25	15
PCA B2	25	30
PCA B3	10	35
PCA T1	25	25
PCA T2	30	30
PCA T3	50	25
PCA T4	65	30
PCA T5	50	30
PCA 1-month post	40	25
SFA B1	25	30
SFA B2	30	35
SFA B3	5	25
SFA T1	35	45
SFA T2	45	25
SFA T3	65	40
SFA T4	55	40
SFA T5	45	45
SFA 1-month post	30	25

RM Accuracy: Treatment Vs. Probe Stimuli Across Time		
Treatment Approach and Day	Tx (%)	Probe (%)
PCA B1	10	15
PCA B2	10	30
PCA B3	0	35
PCA T1	10	25
PCA T2	20	30
PCA T3	45	25
PCA T4	25	30
PCA T5	25	30
PCA 1-month post	20	25
SFA B1	10	30
SFA B2	25	35
SFA B3	5	25
SFA T1	20	45
SFA T2	25	25
SFA T3	55	40
SFA T4	35	40
SFA T5	35	45
SFA 1-month post	25	25

JD Accuracy: Effect of Familiarity on Treated and Untreated Stimuli Across Time

Treatment Approach and Day	F tx (%)	F probe (%)	UF Tx (%)	UF probe (%)
SFA B1	50	60	50	30
SFA T1	50	40	60	50
SFA T2	60	40	70	60
SFA T3	50	60	70	40
SFA T4	70	40	70	30
SFA T5	90	40	50	40
SFA 1-month post	60	70	60	50
PCA B1	40	60	30	20
PCA B2	40	50	40	20
PCA B3	50	60	50	40
PCA T1	40	80	50	70
PCA T2	70	100	60	60
PCA T3	70	80	50	100
PCA T4	70	90	60	60
PCA T5	60	90	70	60
PCA 1-month post	50	70	80	60

RR Accuracy: Effect of Familiarity on Treated and Untreated Stimuli Across Time

Treatment Approach and Day	F tx (%)	F probe (%)	UF Tx (%)	UF probe (%)
PCA B1	40	20	10	10
PCA B2	30	30	20	30
PCA B3	20	50	0	20
PCA T1	20	40	30	10
PCA T2	20	30	40	30
PCA T3	30	40	70	10
PCA T4	80	30	50	30
PCA T5	50	10	50	50
PCA 1-month post	50	20	30	30
SFA B1	40	40	10	20
SFA B2	30	30	20	30
SFA B3	20	50	0	20
SFA T1	40	60	20	10
SFA T2	10	40	0	10
SFA T3	50	60	20	30
SFA T4	50	40	40	10
SFA T5	60	60	70	20
SFA 1-month post	60	60	50	20

RM Accuracy: Effect of Familiarity on Treated and Untreated Stimuli Across Time				
Treatment Approach and Day	F tx (%)	F probe (%)	UF Tx (%)	UF probe (%)
PCA B1	10	10	10	10
PCA B2	0	0	0	0
PCA B3	0	0	10	0
PCA T1	0	20	20	10
PCA T2	0	0	20	0
PCA T3	20	20	10	10
PCA T4	0	0	0	0
PCA T5	0	0	0	0
PCA 1-month post	10	0	20	0
SFA B1	10	0	10	0
SFA B2	30	10	10	0
SFA B3	10	10	0	0
SFA T1	20	10	10	20
SFA T2	10	10	0	0
SFA T3	40	10	30	0
SFA T4	20	20	40	30
SFA T5	20	10	40	0
SFA 1-month post	20	30	30	0

APPENDIX N: RT Data for Probe Stimuli for Both Treatments for Each Participant

IC SFA Reaction Time (ms): Baseline Vs. P5 (probe)

Rating	N	M	SD	Std. Error M
B1	20	2755.50	1132.163	253.159
P5	20	3296.35	1434.083	320.671

IC SFA Reaction Time (ms): B1 Vs. P5 (probe) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	-540.850	1676.378	374.850	-1.443	19	.165	-1325.419	243.719

IC PCA Reaction Time (ms): Baseline Vs. P5 (probe)

Rating	N	M	SD	Std. Error M
B1	20	3272.00	1339.268	299.469
P5	20	2485.60	1663.873	372.053

IC PCA Reaction Time (ms): B1 Vs. P5 (probe) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	786.400	1660.099	371.209	2.118	19	.048	9.450	1563.350

JD SFA Reaction Time (ms): Baseline Vs. P5 (probe)

Rating	N	M	SD	Std. Error M
B1	20	3343.60	1656.957	370.507
P5	20	2898.80	557.781	124.724

JD SFA Reaction Time (ms): B1 Vs. P5 (probe) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	444.800	1845.010	412.557	1.078	19	.294	-418.691	1308.291

JD PCA Reaction Time (ms): Baseline Vs. P5 (probe)

Rating	N	M	SD	Std. Error M
B1	20	2806.60	901.857	201.661
P5	20	1612.80	675.894	151.134

JD PCA Reaction Time (ms): B1 Vs. P5 (probe) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	1193.800	1080.770	241.667	4.940	19	.000	687.984	1699.616

RR PCA Reaction Time (ms): Baseline Vs. P5 (probe)

Rating	N	M	SD	Std. Error M
B1	20	2532.40	1014.520	226.853
P5	20	2382.80	1173.694	262.446

RR PCA Reaction Time (ms): B1 Vs. P5 (probe) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	149.600	1502.363	335.939	.445	19	.661	-553.527	852.727

RR SFA Reaction Time (ms): Baseline Vs. P5 (probe)

Rating	N	M	SD	Std. Error M
B1	20	2865.95	1518.804	339.615
P5	20	2475.70	1273.059	284.665

RR SFA Reaction Time (ms): B1 Vs. P5 (probe) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	390.250	1629.344	364.332	1.071	19	.298	-372.306	1152.806

RM PCA Reaction Time (ms): Baseline Vs. P5 (probe)

Rating	N	M	SD	Std. Error M
B1	20	3794.35	978.255	218.744
P5	20	5347.00	2280.323	509.896

RM PCA Reaction Time (ms): B1 Vs. P5 (probe) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	-1552.650	2973.848	664.973	-2.335	19	.031	-2944.454	-160.846

RM SFA Reaction Time (ms): Baseline Vs. T5 (probe)

Rating	N	M	SD	Std. Error M
B1	20	2738.75	1106.252	247.365
P5	20	2933.50	1495.363	334.373

RM SFA Reaction Time (ms): B1 Vs. P5 (probe) Paired Samples Test	Paired Differences							
							95% Confidence Interval of the Difference	
	Mean	Std. Dev	Std. Error M	t	df	Sig. (2-tailed)	Lower	Upper
Equal variances not assumed	-194.750	832.625	186.181	-1.046	19	.309	-584.430	194.930