Right Hemisphere Effects on Language Processing: Suppression or Activation Deficit

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RIGHT HEMISPHERE EFFECTS ON LANGUAGE PROCESSING: SUPPRESSION OR ACTIVATION DEFICIT

by

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A Thesis Submitted to the Faculty of The Graduate College in partial fulfillment of the requirements for the Degree of Master of Arts Department of Speech Pathology and Audiology

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Thank you, first of all, to the members of my committee for agreeing to be a part of this project. Without input from all of you, I would have been lost in the research process. Thank you also to my friends and family for understanding my short and to the point phone conversations when I was preoccupied with writing. And lastly, thanks to Jen Sova, my fellow thesis writer, for lots of laughs, support, and understanding that only someone writing a thesis could provide.

Sarah A. Orjada
This study was designed to add to the body of research that examines the possibility of semantic activation or suppression deficits as underlying right hemisphere communication disorders. Modified treatment techniques for activation and suppression deficits proposed by Myers (1999) were used as stimuli for the experimental tasks. A total of four RHD participants and four control participants matched in age, gender, and level of education were included in the study. The study aimed to answer the following questions. Do RHD or control participants have higher scores on the suppression tasks? Do RHD participants have longer reaction times? Do RHD or control participants have higher scores on the activation tasks? Do the RHD participants have a reduced number of responses in the activation task? Do the RHD participants perform better on the suppression task than activation task? Do control participants perform equally well on suppression and activation tasks? The results were examined both between and within groups for RHD and control groups. Results suggested that there was no support for an activation or suppression deficit in the RHD participants. Reaction times were longer for the control participants, which is contrary to expectations. Also contrary to prior research, the RHD participants had responses on the activation task that were within more semantic categories than control participants.
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CHAPTER I

INTRODUCTION

Historical Background of Problem

Introduction to the Present Study

This is a study of the possibility that activation or suppression deficits underly the communication deficits observed in patients with right hemisphere damage (RHD). Although left hemisphere communication deficits have been studied extensively, less is known about the effects of right hemisphere lesions on language processing. This study is designed to add information to the body of research examining the theoretical constructs of activation and suppression deficits in individuals with RHD.

Importance of the Right Hemisphere to Communication

The right hemisphere (RH) of the brain is often referred to as the "minor" hemisphere relative to language functioning. This term seems to imply that the right hemisphere is unimportant, diminishing its contributions to language expression and comprehension. Although largely ignored throughout history, the linguistic abilities affected by right hemisphere damage (RHD) are crucial to effective communication. Clinical symptoms of right hemisphere damage (RHD) as reported by Gainotti (1983) are that spontaneous speech can be excessive and rambling, humor is often primitive and
inappropriate, the conversational focus may be on insignificant details or include tangential remarks, and the usual range of intonation is sometimes limited.

Hier and Kaplan (1980) noted an "inexactness" in speech and a "vagueness" in language comprehension in RHD patients. It is difficult to imagine deriving pleasure from communicating with others if one must struggle to understand jokes and can only respond literally and incorrectly to indirect requests. Conversely, it is easy to imagine the complications arising with interpersonal communication in people with RHD.

Appreciating humor and metaphors, being able to take another's perspective, and understanding indirect requests are higher-level language skills that are necessary for enjoyable and effective communication. Deficits in these communication skills are often overlooked and considered less essential than the more overt language impairments observed in individuals with aphasia. These deficits are overlooked for a number of reasons, one of which may be that individuals with the above impairments may not be aware of or concerned about the effects of their language deficits. Another reason may be that communication deficits associated with left hemisphere lesions are usually considered more severe, whereas right hemisphere lesions are usually associated with more "subtle" communication deficits.

Although the sometimes subtle communication impairments that may arise from damage to the right hemisphere are so vitally important to the enjoyment of communicating and to maintaining interpersonal relationships, the mechanisms by which these impairments arise and how they are effectively treated are still largely not understood in contrast to the understanding of aphasia and its treatment. Effective treatment of communication deficits arising from right hemisphere damage could
potentially improve quality of life for these patients. In fact, speech and language services for individuals with RHD have been debated. Rivers and Love (1980) stated that speech and language services, both diagnostic and therapeutic, for such patients range from vigorous and thorough in some institutions to the withholding of services in other institutions on the assumption that the problems accompanying minor hemisphere lesions are transient or inconsequential. (p. 349)

This statement was written in 1980. It is not clear whether it is still the norm. Current data about services provided to individuals with RHD are not available.

**Past Disregard of the Right Hemisphere Contributions to Communication**

Most acquired language impairment research during the past 100 years has focused on the left hemisphere (LH) contributions to communication. This focus has resulted in a less sophisticated knowledge of the right hemisphere (RH) speech and language functions. More recently, the right hemisphere’s contribution to language comprehension and expression has assumed primary importance to some language scientists and speech-language pathologists. Oliver Sacks (1985) wrote,

> Although right-hemisphere syndromes are as common as left-hemisphere syndromes – why should they not be? – we will find a thousand descriptions of left-hemisphere syndromes in the neurological and neuropsychological literature for every description of a right-hemisphere syndrome....And yet, as Luria says, [right hemisphere functions] are of the most fundamental importance. (p. 3)

One of the reasons that the left hemisphere’s contribution to language performance has been more extensively studied may be because “people with damage to
the LH often have profound language disturbances, but people with damage to the right hemisphere (RH) generally seem to process language well" (Beeman, 1993). Even more recent literature published by respected scientists holds to the idea that “Damage to the left hemisphere is far more detrimental to language function than is damage to the right” (Gazzaniga, 1998, p. 51). Yet the level of language breakdown is different in LHD and RHD. Thus, the language deficits may not be so readily compared. LHD may result in aphasia, a breakdown at the word and sentence level whereas RHD may result in a breakdown at the level of discourse (Bloom, 1994).

A breakdown at the level of discourse may not be as obvious and easy to analyze as word or sentence-level deficits in aphasia. In a study referred to as the first to acknowledge the RH’s contribution to language, Eisenson (1962) stated that his hypothesis that individuals with RH lesions suffered certain linguistic deficits was contrary to popular opinion at the time. Eisenson said,

Typical reports in the American literature may be summed up along the following lines: Persons who have incurred non-progressive damage limited to the right cerebral hemisphere show impairments in the non-verbal performance items on intelligence tests, but little or no decrement in verbal tasks on the same test batteries. (p. 49)

Eisenson’s impression contrasted with the typical view. He noted that although individuals with RH damage did not present with aphasia, they were not “free of linguistic impairment” (p. 49).

Although people with RH damage may seem to process language well, that perception does not mean that the RH plays no role in processing language. Beeman and
Chiarello (1998) explained, “The entire [palette] of language includes metaphor, connotation, and inference, and these may place special demands on the RH’s mode of language comprehension” (p. x). Individuals with RHD normally are able to understand literal meanings of words and sentences, but have difficulty interpreting discourse or nonliteral language (Kaplan et al., 1990). Results of Eisenson’s (1962) landmark study suggested that the RH contributes to high-level language functioning. Eisenson also suggested that language deficits associated with RHD might not be noticed in conversational speech because high-level language may not be regularly used in casual conversation.

Another reason that the right hemisphere is not as highly regarded for its language abilities might be because the reduced language performance of individuals with RHD could be explained by other deficits associated with RHD, such as visual perceptual problems, inattention, or impulsivity. For example, poor scores on language tests by individuals with RHD could be explained by difficulty processing visual information, difficulty maintaining attention to the task, and difficulty staying on task and inhibiting interfering behaviors. Individuals with RHD frequently present with deficits in visual perception, attention, and impulse control.

Rivers and Love (1980) focused on visual perception in their study. They gave examples of responses by neurologically normal (NN), left hemisphere lesioned (LHL), and right hemisphere lesioned (RHL) individuals on an oral story-telling test. The participants were shown a picture and were then asked to describe it. An example narrative from Rivers and Love follows.
NN group, subject number 7, story number 1: “Uh, these people here are havin’ trouble with their car. This woman comes walkin’ by with a dog. She’s removin’ the filter from there. She’s got the car started. She’s bein’ on her way.”

LHL group, subject number 7, story number 1: “(Unintelligible utterance.) Car story. An dat one. An this man work...workin’ on his car. An...she (unintelligible utterance), uh...(unintelligible utterance), this guy, drivin’.”

RHL group, subject number 7, story number 1: “A family going somewhere...He’s telling her to come on; she must not want to go. Like he’s beckoning for her to come on. He must be driving and just waiting for her to get in the car....in my mind (unintelligible utterance), family all together, see, and they go out. Pass this lady walking on the road looking (unintelligible utterance) and her dog. He’s tryin’ to court her to come get in the car.” (p. 361)

According to Rivers and Love (1980), the narrative produced by the RHL subject was untrue; there was no family and the story he told had no relation to the picture. The authors attributed the RHD individual’s deficits in understanding emotional subtleties of characters visually presented to a visual perceptual impairment. However, based on the transcribed description given by the RHD patient, the possibility of theory of mind (the ability to take another’s perspective) impairment also appears to be a possible interpretation, making the deficit attributable to possible cognitive-linguistic deficits. Diggs and Basili (1987) noted, “In an attempt to hold on to the traditionally held concept that the right hemisphere’s linguistic role is very minor, language factors are rarely mentioned” (p. 141). In their 1987 study, they found that the responses of RHD
individuals were more likely due to language deficits than to the above-mentioned perceptual and behavioral nonlinguistic factors.

**Research Questions**

The present study attempted to add to the body of research that suggests either an activation deficit (difficulty activating alternate word meanings) or suppression deficit (difficulty suppressing inappropriate or incorrect meanings) may be underlying deficits in RHD individuals. The present study was designed to address the following questions. Do RHD or control participants have higher scores for suppression tasks? Do RHD participants have longer reaction times? Do RHD or control participants have higher scores for activation tasks? Do the RHD participants respond within a reduced number of semantic categories in activation tasks? Do the RHD participants have a reduced number of responses in the activation task? Do the RHD participants perform better on the suppression task than activation task? Do control participants perform equally well on suppression and activation tasks?
CHAPTER II

REVIEW OF THE LITERATURE

Review of the Significance of the Right Hemisphere in Communication

Communication Deficits Secondary to Right Hemisphere Lesions

At present, there are no differential diagnostic categories for communication disorders associated with right hemisphere damage (Myers, 1999) as there are for those syndromes secondary to left hemisphere lesions. Communication disorders caused by damage in the left hemisphere regions subserving language are called aphasia, but there is no such umbrella term for communication disorders caused by damage to the right hemisphere. There are only the observable residual skills or impairments that are identified and labeled. Myers (1999) stated emphatically, “It is premature to use the term ‘RHD syndrome.’ Yet, it is not unreasonable to expect that there is an as yet unidentified set of core deficits that contribute to a central RHD communication disorder” (p. 244). However, Varley (1995) cautions that “just as aphasia is not a single coherent entity, neither are the communicative consequences of right, non-dominant hemisphere damage” (p. 369).

Individuals who have sustained right hemisphere damage present with a number of communication symptoms that are not characteristic of individuals with left hemisphere damage. RHD individuals have difficulty organizing sentences into a coherent narrative (Kaplan, Brownell, Jacobs, & Gardner, 1990). In addition, they exhibit problems appreciating metaphors and jokes (Winner & Gardner, 1977), and sometimes
they are unable to relate story events. This makes them unable to generate an overall theme of what they have heard (Hough, 1990). Kaplan, Brownell, Jacobs, and Gardner (1990) also noted that RHD patients have difficulty using the context of discourse to interpret another person's statements. Individuals with RHD may have difficulty integrating the context with indirect requests, resulting in an incorrect interpretation of the request (Weylman, Brownell, Roman, & Gardner, 1989). Myers (1999) provided a list of cognitive and communicative deficits of individuals who have sustained RH damage, as reduced:

- Discourse comprehension and production
- Communicative efficiency and specificity
- Capacity to process complex inferences
- Capacity to process alternate and ambiguous meanings
- Sensitivity to contextual information
- Sensitivity to emotional tone
- Use of prosodic information
- Appreciation of shared knowledge
- Reflection (shallow responses).

Alternate and Ambiguous Meanings

The present research project focused on one of the above deficits, the reduced capacity to process alternate and ambiguous meanings. Myers (1999) stated that the following competencies are affected by an individual's reduced capacity to generate
alternate meanings: appreciating non-literal meanings such as figurative language, indirect requests, and humor. Inference revision also may be negatively affected.

Factors that may contribute to deficits in comprehending alternate meanings for an individual with RHD are attentional and cognitive impairments, such as cognitive rigidity, activation deficit, and/or suppression deficit (Myers, 1999). Attentional and cognitive impairments often are cited as the cause of RHD symptoms. That is, RHD might result in fewer resources being available to the RHD individual to generate and maintain alternate meanings, resolve ambiguities, revise initial impressions, and generate secondary meanings for figurative language (Myers, 1999). The resulting cognitive rigidity might be related to reduced flexibility in conceiving alternate meanings (Myers, 1999). The focus of the present study was on the theoretical constructs of activation and suppression for processing multiple meanings.

Processes of activation and resolution of ambiguous word meanings are not necessarily restricted to the RH. Atchley, Keeney, and Burgess (1999) stated that “although multiple word meanings are activated in both hemispheres, the rate of activation and the nature of how these meanings maintain activation over time differ between the two hemispheres” (p. 482). Of interest for this study is the effect of RH damage on the ability of individuals to resolve ambiguous meanings through either activation or suppression of the ambiguous word meanings.

Assessing the communicative functioning of individuals with RHD by using ambiguous word meanings may at first appear to be an unnatural context. Since only ambiguous words are used, it also may seem that the findings would not be generalizable to conversational speech. However, most words are somewhat ambiguous in the English
language, so ambiguity may be a general characteristic of language (Burgess & Simpson, 1988). For example, the word ball could possibly be related to a number of things, including the various types of balls, dancing, having fun, a shape, etc. The words “bark”, “sheet”, “train”, “kid”, “fan”, and “spring” also have a number of possible meanings and are therefore ambiguous without context. Ambiguity is particularly characteristic of indirect requests and humor, areas in which individuals with RHD may demonstrate difficulty.

A two-stage model of ambiguous word recognition has been proposed by Burgess and Simpson (1988). In this model, word meanings are first activated automatically, in order of their frequency, followed by a stage in which attention is allocated to the dominant meaning. Once attention is directed to the dominant meaning, additional time is required to redirect attention to the less dominant meaning(s). This effort needed to redirect attention results in suppression the less dominant meaning(s). This model of activation and suppression of ambiguous words was used in designing the present study.

**Coarse and Fine Semantic Processing**

Impairment in processing alternate and ambiguous meanings can be related to Beeman’s (1993) hypothesis of coarse versus fine semantic processing in the right and left hemispheres respectively. Beeman posited that linguistic deficits, such as the reduced capacity to process alternate and ambiguous meanings, arise from the RHD individual’s lack of access to remote semantic information on word meaning, which is primarily available in the right hemisphere. Beeman defined remote semantic information as meanings that are less frequently related to the target word. Kiefer (1998) hypothesized
that “Remote semantic information may be particularly useful in comprehending the metaphorical meaning of sentences or in maintaining coherence during discourse comprehension” (p. 379). Kiefer also stated that “Several lines of evidence suggest that close and remote semantic features of word meaning are processed differently by the left and right cerebral hemispheres” (p. 379), lending support to Beeman’s hypothesis of coarse and fine semantic processing in the cerebral hemispheres.

Remote semantic information in the right hemisphere seems to relate to the idea of coarse semantic coding. Beeman, Bowden, and Gernsbacher (2000) reported that the RH appears to maintain the activation of distant semantic relations of words or multiple interpretations of ambiguous words, whereas the LH activates only close semantic relations of words and single interpretations. An example of LH fine semantic coding and RH coarse semantic coding follows. Beeman and Chiarello (1998) gave an example using the word “foot.” The LH is able to activate strongly only closely related words (i.e., those with many semantic features), such as the words toes, sock, and heel. The LH would not consider distantly related meanings (i.e., remote semantic features) or interpretations of the word “foot” to mean the measurement “twelve inches” or the idiomatic expression “foot the bill,” while the RH would activate all of those meanings, although less strongly (Beeman & Chiarello, 1998). It appears that remote semantic information is available through the process of coarse semantic coding.

Taylor (1988) also proposed that the RH is most responsible for activation of semantic possibilities, while the LH is most responsible for their suppression. As Taylor said, “the RIGHT [hemisphere] proposes, and the LEFT [hemisphere] disposes” interpretations (p. 324). Grossman (1981) stated, “RH subjects may be overly analytic;
they may possess a diminished overview of the interwoven structure of a word’s referential field” (p. 328). This over-analysis occurs because the individual with RHD relies upon his/her LH (the more analytic hemisphere) to process language. Since the LH theoretically activates only closely related words, the over-analysis results in the individual with RHD having a lessened ability to activate the entire semantic field of a word, presumably resulting in impairments of humor, and understanding of indirect requests or figurative language.

**Neuroimaging Studies**

Neuroimaging data seem to support Beeman’s (1993) theory of coarse and fine processing in the cerebral hemispheres. Bottini et al. (1994) showed increased positron emission tomography (PET) signals in the RH when normal language users comprehended metaphors presumably requiring distant semantic activation or coarse coding. Abdullaev and Posner (1997) demonstrated an increased signal in the RH when the participants were required to give the least common use for a noun, as measured by event-related potentials (ERP) and functional magnetic resonance imaging (fMRI). The authors believed this finding suggested that the RH is more adept at activating more distantly related words, possibly because of the different processing styles of the two hemispheres. Using this model, damage to the RH would cause a reduction in the ability to activate distantly related meanings, suggesting that an activation deficit is most likely an underlying cause of multiple meaning deficits in RH damage.
Opposing Opinions

The conclusions drawn from the above research suggest that an activation deficit is the most likely explanation for multiple meaning deficits in RHD patients. Others believe that RH damage causes a suppression deficit, resulting in the inability to suppress multiple meanings. For example, Tompkins, Baumgaertner, and Lehman (2000) asserted that better comprehenders suppress contextually inappropriate or irrelevant information more quickly than less skilled comprehenders. The researchers stated that patterns from previous RHD studies suggested that there is a “propensity to maintain interpretations that have become inappropriate, rather than a failure to generate or consider alternative inferences” (p. 63). And so in contrast to those who propose an activation deficit basis, Tompkins and her colleagues proposed a suppression deficit to explain the multiple meaning deficits seen in RHD patients.

Potential of Research Analyzing Suppression and Activation Deficits

According to many who have studied right hemisphere communication function (Myers, 1999; Beeman, 1998; Tompkins et. al., 2000) suppression or activation deficits may be among the core impairments underlying some right hemisphere communication symptoms. A semantic suppression or activation deficit could explain a number of observed communication symptoms of individuals with RHD, including the extra time needed to arrive at a contextually appropriate meaning (Myers, 1999); difficulty in making inferences (Lehman-Blake & Tompkins, 2001); difficulty resolving multiple or competing interpretational clues; problems integrating multiple or disparate aspects of discourse context; difficulty comprehending literally false material such as in jokes and
indirect requests; difficulty comprehending discourse when initial assumptions must be revised to make sense; and difficulty taking another’s perspective (theory of mind deficits) (Tompkins et al., 2000). Therefore, research analyzing activation deficits (failure to activate multiple meanings) and suppression deficits (failure to suppress incorrect or unneeded alternate meanings) are promising areas of study.

Verbal Fluency and Word Finding in the Right Hemisphere

Verbal fluency and word finding research also sheds light on RH functioning. Verbal fluency tasks involve providing individuals with a word or category and asking him or her to say as many things as possible related to the target in a specified period of time. Certain deficits in verbal fluency can be expected from individuals with RHD. Prior research has shown that verbal fluency is more negatively affected in LHD than RHD and also in those with frontal lobe damage (Joanette & Goulet, 1986; Schwartz & Baldo, 2001).

People with RHD do show lowered performance on verbal fluency tasks (Joanette & Goulet, 1986). Their response patterns are, however, different. Individuals with RHD generally produce the same number of responses as control participants in the first 30 seconds of a verbal fluency task, but then have significantly more difficulty in the remaining amount of time, resulting in fewer responses during the last 30 seconds. Varley (1995) observed that participant performance suggested that at the beginning, participants with RHD recall the most automatic and closely related items. After that, the speaker’s recall strategy needs to be revised. It is at that point that RHD individuals begin to show difficulty. Since damage to the RH results in fewer and more closely related words, this
verbal fluency study supports the idea that the RH is more able to activate more distant word meanings. Varley (1995) stated that "Qualitative analysis of performance on verbal fluency tasks support the hypothesis that the linguistic deficit of RHD subjects does not result from loss of semantic knowledge, but instead results from failure to use appropriate strategies on the task" (p. 364). This conclusion was drawn because analysis of the results showed that the RHD participants did not produce significantly more incorrect answers. On the other hand, they did have different patterns of responses after the first 30 seconds of the 2-minute period.

Deficits in verbal fluency and word finding might be explained by other factors, such as disrupted cognitive skills, rather than being attributable to an underlying linguistic deficit. Varley (1995) stated,

These results suggest that the apparent lexical deficit revealed in RHD subjects on verbal fluency tasks may stem, not from a primary lexical deficit, but rather from a failure to use retained linguistic knowledge in the most appropriate way. The lexical deficit may not be a specific language disturbance, but a reflection of disruptions of cognitive processes which are used in the implementation of language knowledge. (p. 368)

Verbal fluency tasks may uncover valuable information about the right hemisphere's lexical-semantic abilities. "Since verbal fluency requires the evocation of lexical items, it also permits exploration of lexico-semantic processing" (Joanette & Goulet, 1986). Joanette, et al. (1988) stated that "it is obvious that a [verbal fluency] task according to a given set of rules does permit a glimpse of the cognitive processes necessary for the scanning of semantic knowledge in the context of verbal
communication” (p. 55). An increase in the number of errors on a verbal fluency task could indicate problems respecting semantic or task constraints. In other words, the error patterns could reflect the nature of RHD semantic impairment.

Analyzing the time variable or reaction time (how long it takes the individual to respond) provides information about the RHD patient’s automaticity and use of strategies for word retrieval (Joanette, et al., 1988). For example, a long reaction time might reflect difficulty activating word retrieval. “In timed, short tasks such as verbal fluency, the participant’s choice of words might reveal interesting features of his/her semantic network or semantic search strategies” (Schwartz & Baldo, 2001, p. 1209). For example, the first responses given during verbal fluency tasks are likely the responses the individual has encountered most often and therefore that response is more readily available. Selection of words that are closely related and then switching groups may show more semantic organization. For example, when an individual is asked to say all the words he/she can think of in 30 seconds, it is generally expected that someone with an organized semantic network and retrieval strategies will answer within categories. For example, they may respond with all zoo animals first, switch to pets, then to fish, etc.

According to Schwartz and Baldo (2001), optimal performance on verbal fluency tasks depends on bilateral temporal lobe associative grouping and bilateral frontal lobe switching. Those authors argued that patient case studies and neuroimaging data suggest that semantic representations are most likely stored bilaterally in the temporal lobes. That is, based on a verbal fluency task, patterns of responses showed that left frontal lobe (LFL) lesioned individuals’ error clusters exhibited unusual word profiles, whereas right
frontal lobe lesioned (RFL) patients produced more prototypical words. Based on these results, the examiners postulated that:

left frontal lobe processes appear to be constrained by fixed taxonomic systems, concerned with strong or prototypic semantic connections. In contrast, right frontal lobe processes subserve greater diversity of immediate associations, as if less influenced by the strength of their inter-connections....Thus, performance on verbal fluency and other complex tasks may rely on a subtle balance between the explorative attempts of the RH and conservative tendencies of the LH. (p. 1215)

Treatment Implications

Past treatment for communication disorders arising from damage to the right hemisphere of the brain has focused on alleviating or teaching compensation for the presenting symptoms as opposed to resolving the individual’s underlying deficits. For example, treatment often has focused on the individual’s impaired ability to understand figurative language by presenting and explaining idioms rather than treating the underlying deficit of the inability to discern alternate meanings. In general, treatment focusing on underlying impairment is presumably more effective than simply treating symptoms. That is, most therapists believe that by treating one underlying deficit, many of the symptoms may be alleviated concurrently. However, the underlying impairment(s) must be determined before effective treatments can be implemented. Determining the underlying impairments is where right hemisphere research appears to have been stalled.

Myers (1999) acknowledged the importance of determining whether an activation or suppression deficit is the underlying deficit that contributes to communication
difficulty in RHD. She wrote, “Treatment strategies for problems in activation versus problems in suppression would differ considerably” (p. 128). For example, the goal of Myers’ proposed treatments for activation deficits is to stimulate activation of alternate meanings. Activities include word association tasks, providing two meanings for homographs, providing two meanings for ambiguous phrases (such as headlines with double meanings), revising inferences, and/or providing words that belong to specific semantic categories. The goal of suppression deficit treatments, on the other hand, is to “improve awareness and conscious control over the suppression of inappropriate alternate meanings” (Myers, 1999). Tasks include rapidly providing one meaning of a homograph, rapidly selecting the most closely related word, and rapidly responding to the most appropriate sentence. Along with rapid responses, patients are led to explain the inappropriateness of incorrect choices to encourage conscious awareness and control over inappropriate alternatives. In these tasks, individuals are instructed to complete the suppression tasks as quickly as possible because it is assumed that they have activated the possible meanings and simply have difficulty choosing the correct meaning. Therefore, the aim is for the respondents to choose quickly the correct meaning in order to more closely resemble the faster language processing of individuals with “normal” language.

Current Treatment Techniques as a Research Tool

The present study expands on prior research by evaluating the presence of activation or suppression deficits as participants respond to treatment techniques. Some prior research, such as that conducted by Tompkins and her colleagues (2000), focused on presenting the participant with a sentence that ended with an ambiguous word, for
example "He dug with a spade." Then a probe word, such as the word "card," was presented at two interstimulus intervals on different trials. The participant was required to give a "yes" or "no" response to whether the probe word relates to the sentence. In this example, the participant should have answered "no" because, although the probe word conceivably related to the ambiguous word, it did not fit the semantic context of the sentence. The correctness of the response and response times at the two interstimulus intervals were measured.

From this experimental design, it was hypothesized that if individuals with RHD had a suppression deficit, they should have had more difficulty than control participants at the long probe interval, while control participants would not have had difficulty at the long probe interval, presumably because the control participants would have suppressed the inappropriate response by that time. In other words, it was expected that both the control and RHD individuals would have had difficulty at the short probe interval because both groups would hypothetically still have been in the process of suppressing the incorrect response. But at the long probe interval, the control participants should have suppressed the incorrect response, while the RHD individuals would still be attempting to suppress the incorrect response if a suppression deficit is present. This would result in slower processing and responding.

The data showed that individuals with RHD took the same amount of time to respond during both stimulus intervals, whereas control participants were quicker at the long interval. Tompkins et al. (2000) concluded that this result indicated that RHD individuals must have a suppression deficit. However, the results also could be explained
by asserting that individuals with RHD were demonstrating difficulty activating the appropriate response at both stimulus intervals.

Because some of the previous data could be interpreted in more than one way, treatment tasks, rather than this experimental method, were used in the present study to attempt to clarify that ambiguity. Theoretically, if individuals with RHD perform significantly more poorly on the activation treatment tasks than a matched control participant, then an activation deficit might be implicated as impairing the RHD individual’s ability to manage alternate and ambiguous meanings. Similarly, if individuals with RHD perform significantly more poorly on the suppression treatment task than a matched control participant, then a suppression deficit might be implicated. Performance on the activation and suppression tasks could also be analyzed within each participant; for example, if RHD or control participants perform better on suppression than activation tasks, an activation deficit may be present in either group.
CHAPTER III

METHODS

Description of the Current Study

Participants

Four right hemisphere damaged (RHD) adults and 4 non-brain damaged (NBD) control participants were included in this study. One other potential RHD participant was not included in the study due to failure passing one of the screening tasks. Task administration was limited to presentation by the student investigator, who was trained in the administration of standardized and nonstandardized test protocols. Testing was audio and video recorded for the purposes of verifying scoring accuracy and establishing reliability of scoring.

Each RHD participant (See Table 1) was matched with a control participant similar in age, of the same sex, and matched in level of education (See Table 2). Levels of education were defined as follows: 1) Did not finish high school, 2) High school diploma, 3) Some college, 4) 4-year college degree, and 5) Education beyond bachelor's degree.

Table 1: RHD participants

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Age</th>
<th>Education</th>
<th>Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>79</td>
<td>4-year college degree</td>
<td>Male</td>
</tr>
<tr>
<td>01</td>
<td>58</td>
<td>High school diploma</td>
<td>Female</td>
</tr>
<tr>
<td>88</td>
<td>70</td>
<td>High school diploma</td>
<td>Male</td>
</tr>
<tr>
<td>05</td>
<td>70</td>
<td>High school diploma</td>
<td>Male</td>
</tr>
<tr>
<td>99</td>
<td>79</td>
<td>Did not finish high school</td>
<td>Male</td>
</tr>
</tbody>
</table>
Inclusion Criteria for RHD Participants

Potential RHD participants were required to meet the following criteria:

- Be between 40 and 80 years of age;
- Have sustained a unilateral lesion in the right hemisphere of the brain, per CT or MRI scan;
- Be at least 6 months post onset of the unilateral lesion;
- Present with vascular etiology; and
- Pass the Mini-Mental State Examination (MMSE) with a score of 27 or more out of a possible 30 points.

Exclusion Criteria for RHD Participants

Potential RHD participants were excluded if they met the following criteria:

- Have bilateral lesions;
- Fail hearing screening; and/or
- Have other neurological diagnoses.

Inclusion Criteria for Control Participants

Potential control participants were required to meet the following criteria:

- Be between 40 and 80 years of age, as matched to the RHD participants (+/- 2 years);
- Match in sex to the RHD participants;
- Match in educational level to the RHD participants; and
- Pass the MMSE with a score of 27 or higher out of a possible 30 points.

**Exclusion Criteria for Control Participants**

Potential control participants were excluded from the study if they met the following criteria:

- Fail hearing screening;
- Have a history of stroke; and/or
- Have a history of other neurological disease.

**Screening Tasks**

To verify whether participants met the criteria, screening procedures were performed before the experimental tasks. These lasted no longer than 45 minutes, including time for the student investigator to explain the tasks to the participants. A hearing screening was conducted by asking the participant to repeat a list of ten spondee words (See Appendix B). Aided hearing was allowed. The participants passed if they were able to repeat all of the words. If the participant’s hearing was not sufficient for the tasks, the participant did not complete the remaining screening tests or the experimental tasks.

The Mini-Mental State Examination (MMSE) (Folstein et al., 1975) and the Mini-Inventory of Right Brain Injury (MIRBI-2) (Pimental & Kingsbury, 2000) were administered to screen for cognitive function and severity of impairment related to right
brain damage, respectively. The participants were required to pass the MMSE with a score of 27/30 to participate in the study. If the participant did not pass the MMSE, he/she was excused from the rest of the study. The MIRBI-2 was administered only to the RHD participants and was used to place them in categories of severity due to right hemisphere injury, rather than to include or exclude the participants from the study. The hearing screening was administered first, the MMSE second, and the MIRBI-2 third for the RHD participants. Table 3 shows features of the screening tasks.

Table 3 – Screening tasks

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Administration Time</th>
<th>Maximum Portion of a Session</th>
<th>Areas Assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hearing Screening</td>
<td>5 minutes</td>
<td>.08</td>
<td>Hearing acuity</td>
</tr>
<tr>
<td>Mini-Mental State Examination (MMSE)</td>
<td>5-10 minutes</td>
<td>.17</td>
<td>Orientation, attention, calculation, language, memory, and visuospatial construction.</td>
</tr>
<tr>
<td>Mini Inventory of Right Brain Injury-2 (MIRBI-2)</td>
<td>15-30 minutes</td>
<td>.5</td>
<td>Visual scanning, integrity of gnosis, integrity of body image, visuoverbal processing, visuosymbolic processing, integrity of praxis, affective language, higher level language skills, affect, and general behavior</td>
</tr>
</tbody>
</table>

Experimental Tasks

The treatment approaches used in the present study were slightly modified from Myers (1999). In the activation task, the participant was asked to provide words that
related to a given stimulus word, such as "bark." The participant was visually and auditorily presented with the stimulus words, which were all homographs, that is, a word with a single spelling that has two or more meanings. The task was structured in the form of a verbal fluency task. The participant was asked to tell the student investigator all the words he/she could think of that related to the stimulus word in one minute.

The suppression task also involved homographs. Participants were told which meaning is the most common and then they were asked to give an uncommon meaning. The investigator was careful to explain that the least common meaning was not necessary; only an uncommon meaning was required. Prior to testing, a list of meanings of the homographs was compiled in order to determine which definition was considered most common. The investigator distributed a list of 25 homographs along with their corresponding possible definitions to fellow graduate students, faculty, and staff members at Western Michigan University, with the instructions to indicate the most common definition of the homograph. Results were compiled into spreadsheet format, the most common definition for each word were determined, and the 20 homographs with the most agreement were used for the experimental task (See Appendix C). The remaining 5 homographs were used for the practice task (See Appendix C).

Scoring for the activation task was the number of responses in one minute, correctness, and the percentage of semantic categories possible to which the given words belonged. Scoring for the suppression task was the response time and correctness. Scoring for correctness on both the activation and suppression tasks was based on the multidimensional scoring system of the Porch Index of Communicative Ability (PICA) (Porch, 1981). The five dimensions scored are Accuracy, Responsiveness, Completeness,
Promptness, and Efficiency. The participants' performance on activation tasks was compared to their performance on suppression tasks and to the performance of control participants in both conditions.

Table 4 – Experimental tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Administration Time</th>
<th>Maximum Portion of a Session</th>
<th>Areas Assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activation task</td>
<td>20 minutes</td>
<td>.33</td>
<td>Ability of the participant to activate words in semantic categories</td>
</tr>
<tr>
<td>Suppression task</td>
<td>20 minutes</td>
<td>.33</td>
<td>Ability of the participant to suppress alternate meanings of words by giving an uncommon definition of a word</td>
</tr>
</tbody>
</table>

Description of Sessions

The screening tests and experimental tasks were completed during one 1½-hour session. Experimental testing took place after the screening tasks and took no longer than 45 minutes. The first participant was given the 8-item activation task first and the 20-item suppression task second. An unrelated task of asking the participants to address an envelope to themselves separated the activation and suppression tasks. The significance of the task was to allow the participants to have a break from thinking about words and their definitions. For each additional participant, the order of the activation and suppression task was alternated. Alternating activation and suppression tasks reduced the possibility of better results on one of the tasks due to task position. Two practice questions preceded the activation task, and five practice questions preceded the
suppression task. The rationale for having an unequal number of questions for each task was so that the approximate time needed to complete each task would be comparable.

The testing took place at an agreed upon location at the convenience of the participants. The location was quiet with minimal distractions and was able to accommodate the testing equipment. The suggested and preferred location of testing was Western Michigan University's Charles Van Riper Language, Speech, and Hearing Clinic; however none of the participants were able to travel to the suggested location, so the student investigator and the participants agreed upon alternate locations. Short breaks from testing were incorporated to reduce fatigue when necessary.

Participant Performance – Screening Tasks

A total of five individuals with RHD were recruited for participation in the present study. Four of the individuals were able to participate, while one individual was excluded for failure of the MMSE. See Table 5 for results of the screening tasks.

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Hearing Screening</th>
<th>MMSE</th>
<th>MIRBI-2 (Score-Severity)</th>
<th>Inclusion in study</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Passed – 10/10</td>
<td>Passed – 29/30</td>
<td>38/43 – Normal</td>
<td>Yes</td>
</tr>
<tr>
<td>01</td>
<td>Passed – 10/10</td>
<td>Passed – 27/30</td>
<td>40/43 – Normal</td>
<td>Yes</td>
</tr>
<tr>
<td>88</td>
<td>Passed – 10/10</td>
<td>Passed – 29/30</td>
<td>38/43 – Normal</td>
<td>Yes</td>
</tr>
<tr>
<td>05</td>
<td>Passed – 10/10</td>
<td>Passed – 28/30</td>
<td>38/43 – Normal</td>
<td>Yes</td>
</tr>
<tr>
<td>99</td>
<td>Passed – 10/10</td>
<td>Failed – 23/30</td>
<td>22/43 – Moderate</td>
<td>No</td>
</tr>
</tbody>
</table>

Four individuals were recruited as control participants to match the number of RHD participants included in the study. Their results on the screening tasks are found in Table 6.
Each RHD participant was matched with a control participant who had no history of stroke or neurological disease, was within 2 years of the same age, had the same level of education, and was of the same sex. The participants were matched as follows: S13 & S22, S01 & S06, S88 & S83, and S05 & S41.

### Inter-rater Reliability

A second scorer reviewed the scoreable data. Inter-rater reliability was calculated for each dimension of accuracy, responsiveness, completeness, promptness, and efficiency. A total reliability score was calculated based on the scores on all the dimensions (See Table 7). In the cases in which there was disagreement, the student investigator reviewed the responses and determined the most appropriate score.
Scoring Methods

Suppression Task

For the suppression task, the participant was given a homograph, such as the word “bank,” was told the most common definition, and then was asked to give an uncommon meaning of the word. The response was scored for accuracy, responsiveness, completeness, promptness, and efficiency. One point was awarded for each of the dimensions the participant’s response reflected. Criteria for awarding points are as follows:

- **Accurate**: Response relates to the target word. No point is given if the response is the same as the given definition, even if stated in different words.
- **Responsive**: Point is given if the participant responds when cued.
- **Complete**: Point is given if the participant completes the response.
- **Prompt**: Based on reaction time. Reaction time was measured as the time between the end of the student investigator’s instructions to the beginning of the participant’s response. Reaction times were plotted on a graph for each response. Point is given if the reaction time is under 5 seconds and/or less than 3 seconds longer than a participant’s response time that was under 5 seconds. See Appendix D for graph of all reaction times, showing which qualified as prompt.
- **Efficient**: Efficiency of definition. Point is given if not verbose or tangential as judged by the scorers.
An average accuracy, promptness, and efficiency score was calculated for each participant and plotted in bar graph format. Responsiveness and completeness were excluded from the score due to a lack of variability on these dimensions. There were twenty words that were scored on 3 variables each, resulting in a possible 60 points for each participant for the suppression task. The highest score possible is 1.00 (or 100%) and the lowest possible score is 0.00.

Activation Task

For the activation task, each participant was given a homograph such as the word “ball” and asked to say everything they could think of that was related to that target word in one minute. The responses were scored for accuracy, responsiveness, completeness, promptness, and efficiency. One point was awarded for each of the variables present in the participant’s responses. Guidelines for scoring are as follows:

- Accurate: Point given if all responses relate to the target word.
- Responsive: Point given if the participant responds when cued.
- Complete: Point given if the participant finishes the response.
- Prompt: Based on reaction time. Reaction time was measured as the time between the end of the student investigator’s instructions to the beginning of the participant’s response. Reaction times were plotted on a graph for each response. Point is given if the reaction time is under 5 seconds and/or less than 3 seconds longer than a participant’s response time that was under 5 seconds. See Appendix D for graphs of all reaction times.
• Efficient: Point given if the one minute is used efficiently. A point is given if there are no repetitions of responses and if there is a ratio of between 25%:75% and 75%:25% of responses in the first 30 seconds to second 30 seconds respectively. If the individual repeats a response, no point is given even if the ratio is within the stated limits.

An average accuracy, promptness, and efficiency score was calculated for each participant and plotted in bar graph format. Responsiveness and completeness were excluded due to a lack of variability in these dimensions. There were 8 words scored on 3 dimensions each, resulting in a possible 24 points for each participant for the activation task. The highest score possible is 1.00 (or 100%) and the lowest possible score is 0.00.

Percentage of Semantic Categories (Activation Task)

Another method for scoring the activation task responses was to place each participant’s responses into semantic categories. A percentage of semantic categories used was calculated for each participant and placed in bar graph format. The percentage was calculated by counting the number of semantic categories generated by each participant and dividing by the number of semantic categories generated by the entire participant population.

Number of Responses (Activation Task)

The final method of scoring the activation task was calculating the number of responses generated by each participant. An average number of responses was calculated for each participant for the entire task and placed in bar graph format.
CHAPTER IV

FINDINGS

Results

Between Subjects Data

Results of RHD participants as compared to control participants follow. The suppression task scores are discussed first; then the results for the activation task scores are discussed.

Suppression Task Scores

Results. RHD participants in general had higher scores for the suppression task than the control participants (See Figure 1). Three of the four RHD participants scored higher than their matched control participants. The difference between RHD participants and control participants was minimal and probably not statistically significant.

The results suggest that there was no significant difference between RHD and control participants on the suppression task with the variables measured. The results are more consistent with Beeman’s (1993) research, which suggested a suppression deficit is less likely than an activation deficit as the cause of right hemisphere communication impairments. They are less consistent with Tompkins’ (2000) research that suggested a suppression deficit is more likely an underlying source of RH communication impairments.
Reaction Time (Suppression Task)

Reaction time was part of the overall suppression score as the promptness variable. Here it is examined separately. Three of the four control participants had longer reaction times than their matched RHD participants (See Figure 2). These longer reaction times suggest that the control participants had more difficulty suppressing the given definition than the RHD participants. This does not lend support to a suppression deficit underlying right hemisphere communication disorders. However, the small sample size made it impossible to test the statistical significance. In addition, there are difficulties in using reaction times to make any definitive conclusions. Those issues will be included in the discussion.
Activation Task Scores

Results. Two RHD participants and 2 control participants performed better on this measure of the activation task (See Figure 3). The differences in scores were minimal and likely not statistically significant. The results suggest that there was no significant difference between the RHD and control participants on this measure of the activation task. This is contrary to Beeman’s hypothesis that an activation deficit underlies right hemisphere communication impairments.
Results. RHD participants on average placed activated words in more semantic categories than control participants (See Figure 4). Three out of four RHD participants used more semantic categories than did control participants. The results suggest that the RHD participants were able to activate more of a variety of responses. However, the results were not tested for statistical significance. This is contrary to expectations, if, as some research suggests, RHD individuals should be impaired in activating a variety of word meanings.
Results. Two control and 2 RHD participants had higher numbers of responses than their matched participants (See Figure 5). The results suggest that there is no significant difference in the number of responses generated by RHD and control participants during the activation task. This supports current verbal fluency research by Varley (1995) discussed in Chapter II that suggests RHD participants produce the same number of responses as control participants during the first 30 seconds of a verbal fluency task. Varley’s statement that a reduced number of responses during the last 30 seconds of a verbal fluency task may be characteristic of individuals with RHD, however, was not supported in this study.
Within Subjects Data

Results of performance on suppression vs. activation tasks follow. The activation task scores and the suppression task scores can be compared because the tasks were scored according to the same criteria. Since the point values for the tasks were different, the scores were reduced to percentages to allow for comparison. Limitations of this method are addressed in the discussion. The RHD participants are discussed with the control participants following.

RHD Participants

The RHD participants performed slightly better on the suppression task than the activation task (See Figure 6). The small sample size made it impossible to analyze the
results for statistical significance, but they do suggest that the RHD participants performed more poorly on the activation than suppression task.

![Figure 6](image)

**Figure 6**
**Within subjects (RHD part.)**

Control Participants

Control participants, as well, performed slightly better on the suppression task than the activation task (See Figure 7). Since the control participants also scored higher on the suppression task than the activation task, support for an activation deficit in RHD individuals from this study is reduced.
Figure 7
Within subjects (control part.)

Scores

Subjects

Suppression
Activation

S22
S06
S83
S41
CHAPTER V

DISCUSSION

Discussion of Results

Summary of Results

The present study was designed to add to the research examining the presence of a suppression or activation deficit in individuals with right hemisphere damage. A total of four RHD and four control participants were included in the study. Responses were compared both between and within subjects. Due to the small number of participants and the nature of the data collected, statistical analysis of results was not possible.

Between subject analysis suggested that there was no noteworthy difference between RHD and control participants for suppression task scores, activation task scores, or number of responses (activation task). Differences that may have been considerable were noted for reaction times (suppression task) and percentage of semantic categories (activation task). Contrary to past research that suggests that RHD individuals have difficulty responding quickly (Tompkins, et al., 2000), the RHD participants had lower reaction times in this study than the controls, suggesting that they suppressed the incorrect response more quickly than control participants. Also contrary to prior research that suggests that damage to the right hemisphere restricts access to remotely related semantic categories (Beeman, 1993), RHD participants in this study were able to activate meanings in more semantic categories than were control participants.
Within subject analysis showed that both the RHD and control groups performed slightly better on the suppression task than the activation task. Since the control group showed similar performance to the RHD group, past research that suggests an activation deficit in individuals with RHD is not supported with this data.

Study Limitations

The present study has a number of limitations that may have affected the results. An obvious detriment to the study was the small number of participants. Another is that no method has been identified that will effectively uncover a suppression or activation deficit. The methods used in this study were treatment methods that supposedly treat underlying suppression and activation deficits, but they have not been proven to be valid measures of the underlying constructs, to the knowledge of the investigator.

A reason for the lack of support for either an activation or suppression deficit in this study may have been due to the level of impairment of the RHD participants. All of the RHD participants scored within the normal range on the MIRBI-2 and may have been too similar in function to the control participants to show any real differences on the experimental tasks. Another limitation was that site of lesion was not determined for the RHD participants. It is possible that the lesion site was in an area of the right hemisphere that would not cause linguistic impairment.

Reaction times used as a measure in this study result in the same questions addressed in Chapter II. That is, just because the control participants in this study were slower to respond does not necessarily mean that the control participants demonstrated a suppression deficit. It may represent a number of thought processes or other variables.
One possible explanation for the slower reaction time on the part of one of the participants was due to education. That participant was a college graduate who reported during testing that, during the course of his education, he learned that when giving a definition one should not give examples or use the word in the definition. His longer reaction times, therefore, could likely be attributed to a different kind of "suppression." This may have been either because he put more thought into his definitions than individuals with lower educations, or he may have been deciding more carefully which definition was the least common, although directed that only an uncommon definition (not the least common) was necessary. There was an attempt to control for education by matching participants according to educational level, but not all of the participants included in the study were of the same educational level. Nor would that guarantee the same experiences or training. So, if the participant concentrates his or her effort into the quality of response, the reaction time could very well be longer and yet not reflect a suppression deficit.

One of the control participants (S #41) expressed anxiety during testing. He related that when confronted he is often unable to think of the words he wants to use. He stated often during testing that he is "not good with words" and demonstrated word-finding difficulties during conversation. He said that when answering questions for a telephone survey, he "went blank and couldn't think of nothing." He did not answer two of the questions during the suppression task because he was unable to think of alternate definitions for the target word. He also had longer reaction times because he repeated each word before he responded because it helped him "think of words." He appeared nervous during testing even after assurances that he was completing the tasks exactly the
way he was asked, but he did not want to discontinue testing. After testing, he said, “You wouldn’t think it would be that hard, would you? Just thinking of things.”

Another control participant might not have performed up to her potential during testing. She had returned from out of town after attending a funeral for a family member the day of testing. She was unable to participate any other day that the student investigator was available. She appeared to be physically and emotionally fatigued, but expressed willingness to participate in the experiment.

It is an impossible task to attempt to control for the prior semantic knowledge of 8 individuals. Because everyone has different life and educational experiences, we all have different semantic repertoires. Although education was controlled for in the study, the semantic knowledge of the participants varied, and the participants themselves demonstrated that they knew different people have knowledge of different words. They also made statements as to how their experiences caused them to give certain definitions during the course of testing. One participant quickly gave a definition of the word star because her “grandson was in a play and he was the leading role.” When asked to give an alternate definition of “fire,” that same participant responded that she “heard a lot of that around here” because her husband was a foreman and one of his job responsibilities was to fire employees. Another participant gave an alternate definition for “kid” as a baby goat, and then stated “probably never get that from a city person,” demonstrating his knowledge that experience shapes each individual’s lexicon.

A limitation of the scoring method for the within subjects data is that although a concentrated effort was made to make the activation and suppression tasks comparable, reducing scores of two different tasks to percentages may not be enough to draw strong
conclusions. A better method, which would require a large scale study involving a greater number of participants, would have been to compare z scores for each of the tasks so that the standard deviations from the mean on each task could be compared to allow for better and stronger conclusions.

Another possibility is that medications taken by the participants could have an effect on the results of the study. Although this did not appear to be the case, one RHD participant was taking Remeron® at the date of testing, which has a possible side effect of abnormal thinking. A majority of the other medications taken by participants had the generic side effects of fatigue, dizziness, weakness, and/or headache.

Direction for Future Research

Suppression and activation deficits are promising areas of research. It seems that we currently do not have effective methods of detecting the presence of either of the deficits. Reaction times often are used, but as discussed earlier, one cannot say why the times were longer or shorter. There are treatment techniques for suppression and activation deficits, but we still do not know whether either or both of the deficits exist.

Communication deficits in individuals with right hemisphere damage may or may not be due in part to activation or suppression deficits. More research is needed to explore all the possible deficits underlying the observable symptoms exhibited by individuals with RHD to either support or rule out possibilities. Since individuals with RHD are heterogeneous, it is very possible that one of the underlying deficits may be present in one individual, and another deficit may be present in a different individual. More and better research is needed so that we will be able to test and determine what deficits are
present in each individual, so that the most effective treatment techniques can be carried out.

Single-subject research determining the effectiveness of suppression and activation treatments may be an alternative to experimental testing. A patient’s response to the treatment could be an indicator of whether the deficit exists, as long as the clinician can be sure that the treatment addresses activation or suppression alone.
Appendix A

Human Subjects Institutional Review Board Approval
Date: July 23, 2002

To: Michael Clark, Principal Investigator  
Sandra Giista, Co-Principal Investigator  
Nickola Nelson, Co-Principal Investigator  
Linda LeBlanc, Co-Principal Investigator  
Sarah Prill, Student Investigator for thesis

From: Mary Lagerwey, Chair

Re: HSIRB Project Number: 02-06-04

This letter will confirm that your research project entitled “Right Hemisphere Effects on Language Processing: Suppression or Activation Deficit” has been approved under the full category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may only conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: June 19, 2003
Appendix B

Audiological Screening Word List
Audiological Screening Word List

Instructions: "I will say a word to you and I want you to listen and repeat it. This is testing your hearing."

1. baseball
2. hotdog
3. cowboy
4. popcorn
5. mushroom
6. iceberg
7. airplane
8. birthday
9. pancake
10. oatmeal
Appendix C

Experimental Tasks
Semantic Activation Practice
Task
Word Activation - Naming

coat

fast
<table>
<thead>
<tr>
<th>Semantic Activation</th>
<th>ball</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Task</td>
<td></td>
</tr>
<tr>
<td>Word Activation - Naming</td>
<td></td>
</tr>
<tr>
<td>match</td>
<td>sheet</td>
</tr>
<tr>
<td></td>
<td>bark</td>
</tr>
</tbody>
</table>
pound

right

hard
Semantic Suppression Practice
Task
Uncommon Definitions

pitcher
- A position in baseball
- A container for liquids

bat
- A club used to hit a ball
- A flying animal
- To wink your eyes

top
- A shirt
- Lid of a container
- Toy
- Uppermost point

snap
- Break
- A closure, like a replacement for a button
- A noise you can make with your fingers

calf
- A baby cow
- Part of the leg
Semantic Suppression
Experimental Task
Uncommon Definitions

bank
pen
play
sink
star
Appendix D

Reaction Time Graphs
Reaction Times – Suppression Task

**Bank**

Subjects
1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41

**Pen**

Subjects
1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41
Play

Subjects
1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41

Sink

Subjects
1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41
Subjects
1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41

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1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41
Subjects
1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41
Spring

Reaction time (seconds)

Subjects

1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41

Fan

Reaction time (seconds)

Subjects

1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41
Train

Subjects
1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41

Bill

Subjects
1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41
Trip

Subjects
1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41

Foot

Subjects
1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41
Bright

1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41

Rose

1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41
Bar

Subjects
1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41

Glasses

Subjects
1 = S05; 2 = S88; 3 = S06; 4 = S01; 5 = S13; 6 = S22; 7 = S83; 8 = S41
BIBLIOGRAPHY


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