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PROCESSING OF LEXICAL AMBIGUITY

IN PATIENTS WITH TRAUMATIC BRAIN INJURY

by

KAREN L. CHOBOR

A dissertation submitted to the Graduate Faculty in Speech and Hearing Sciences in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

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ABSTRACT

PROCESSING OF LEXICAL AMBIGUITY
IN PATIENTS WITH TRAUMATIC BRAIN INJURY

by

Karen L. Chobor

Advisor: Distinguished Professor Loraine K. Obler

Most words possess some indeterminacy in their meanings (Burgess and Simpson, 1988), so ambiguity may be a characteristic that pervades natural language processing (Simpson, Burgess and Peterson, 1987; Swinney, 1982). In English, it has been estimated that over 50% of words have more than one meaning (Ziff, 1967).

The majority of lexical ambiguity studies in normals have been interpreted according to a multiple, or exhaustive, access model, which refers to the access of all meanings of an ambiguous word upon presentation of that word. In studies using brain-injured subjects,

interpretation has centered on localizing the neurological substrate for such linguistic processing rather than determining the necessary cognitive mechanisms. Right hemisphere function has often been determined as necessary for successful processing of lexical ambiguity.

A comprehensive review of research in lexical ambiguity does not reveal such clear-cut interpretations, however. There are, in fact, a substantial number of studies using normals that speak to access according to context or frequency effects- referred to as "selective access", rather than "multiple access". Further, results of studies using brain-injured subjects reveal much evidence suggesting cognitive difficulties traditionally assigned to the frontal lobes as responsible the handling of multiple meanings.

The goal of this study was to determine the type of cognitive functions required for the successful interpretation of lexical ambiguity, and this was carried out using a lexical decision (reaction time) task and a matching task, presented to brain-injured and normal subjects. Three categories of ambiguous words were used: homonymy, polysemy, and metaphor. The most striking finding on the reaction time task was that patients evidenced significantly slower reaction times on metaphor as compared to the normals.

On the matching task, patients achieved accuracy rates which were comparable to those of the normals, a finding that suggests relative intactness of the semantic representations of these words despite a retrieval deficit.

ACKNOWLEDGMENTS

In Haiti, there is a saying: "Parol Gen Zel", which means "words have wings". To all of you who have been instrumental in the completion of this project, may my words of gratitude take flight.

Heeding the advice of my longtime mentor, Dr. Jason Brown, I did not set out for this dissertation to be a magnum opus, but rather, a simple work from which I would gain a little more insight into the ageless question, "what makes us think the way we do?" He taught me by his own example to be courageous in wedding science and art in the pursuit of this question, and I thank him for the endless opportunities that he offered me in making this possible.

Dr. Loraine Obler, a teacher most worthy of her title as Distinguished Professor, was unfailing in her dedication to my growth as a researcher and generous with her time and enthusiasm for my topic (gestures like calling me early one Sunday morning to be sure that I saw the New York Times article on metaphor were not uncommon!). I am grateful to her for being an inspiring role model.

Dr. Avraham Schweiger was with me every step of the way, and I am certain that this project would not have taken its shape without his generous offering of intellectual guidance, his talent in computer and statistical sciences, and above all, his encouragement and friendship.

Dr. Martin Gitterman helped me to see the trees amidst the forest, as he prodded me to justify every last detail of this study's methodology, the end result of which was a more stringent scientific work. I thank Dr. Irving Hochberg for his openness to my interdisciplinary inclinations in the accomplishment of this degree, and Dr. Helen Cairns for her helpful comments on the later drafts of my study. I also thank Elmira Goldberg for her assistance in generating the list of metaphoric words.

My family has been greatly supportive in this endeavor, as they have been with any of my interests. Dad, thanks for teaching me a love of words and for the fun we had in thinking up those with dual meaning. You'll recognize a lot of your ideas here. Mom, thanks for keeping me on the path to completion of this project, always reminding me that there would one day be a final version. Anna, I am grateful for your sisterly pride in my accomplishment and Johnny and Jennifer, for your continuous curiosity about my work. Christopher, how will I repay you for the days on end that you dedicated to helping me to meet deadlines, even if it meant calculating pages of numbers in the wee hours of the night after my computer jammed? I couldn't have completed this project without your technical wizardry, energy, and sense of humor.

And to Bartholomew...no words, not even metaphor or poetry, will capture the thankfulness that I feel for your belief in me and our journey together.

DEDICATION

This work is dedicated to the patients, my teachers.

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CHAPTER 1

INTRODUCTION

Most words possess some indeterminacy in their meanings (Burgess and Simpson, 1988), so ambiguity may be a characteristic that pervades natural language processing (Simpson, Burgess and Peterson, 1987; Swinney, 1982). In English, it has been estimated that over 50% of words have more than one meaning (Ziff, 1967).

A significant amount of research has been done in the field of lexical ambiguity comprehension in both normal and brain-injured subjects, using the distinct categories of homonymy, polysemy, and metaphor. Results of these investigations have been interpreted according to models of selective or multiple access, the former referring to the access of a single meaning of an ambiguous term over other meanings according to word frequency and/or context effects, and the latter referring to the access of all meanings of an ambiguous term. In practice, it is not always clear into which category a given ambiguous word falls. The reason is that both etymological and psychological factors are relevant, and these may sometimes contradict each other. For example, words that are readily perceived as having quite distinct senses, such as port (harbor) and port (alcoholic drink) turn out to have a (tortuous but

meaningful) link in a common Latin source (Durkin and Manning, (1989).

The majority of lexical ambiguity studies in normals have been interpreted according to the multiple, or exhaustive, access model. In studies using brain-injured subjects, interpretation has centered on localizing the neurological substrate for such linguistic processing rather than determining the necessary cognitive mechanisms. Right hemisphere function has often been assumed to be necessary for successful processing of lexical ambiguity (Gardner et al., 1983; Brownell et al., 1984).

A comprehensive review of the research in lexical ambiguity using both normal and brain-injured populations does not reveal such clear-cut interpretations. There are, in fact, a substantial number of studies that speak to selective access in favor of multiple access in normals. Further, results of studies using brain-injured subjects reveal much evidence suggesting cognitive difficulties traditionally assigned to the frontal lobes as responsible for the handling of multiple meanings. Such cognitive abilities include the conscious manipulation of dual meaning and the ability to shift from one category or concept to another, functions otherwise subsumed under the category of abstraction.

The purpose of this study was to clarify the cognitive functions required for the successful interpretation of lexical ambiguity. Brain-injured and normal subjects served as the study populations.

CHAPTER 2

REVIEW OF THE LITERATURE

Lexical ambiguity is a phenomenon whereby a single word may have more than one meaning. The two most common forms of lexical ambiguity are homonymy and polysemy, followed by metaphor. Homonymy is defined as one word having two or more distinct meanings, while both polysemy and metaphor refer to an instance whereby one word can have two or more related meanings. A finer distinction between the latter two reveals that metaphor is seen as instances of elliptical simile, where "like" or "as" is implied for the purpose of using one thing to stand for another. Thus, polysemy is an aspect of metaphor while remaining a distinct phenomenon.

Beardsley (1962) states that a term may have a central meaning (its ordinary designation) and a marginal meaning (its connotation). The standard designation of wolf, for example, might include "mammal", "four legged" and canine", whereas the marginal meaning would include "fierce", "voracious", "clever", etc. Meanings other than the central, or dominant, meaning are those which constitute polysemy and metaphor. The two divergent meanings of homonymy are, of course, both central meanings, such as the meanings for ball

("toy" or "a formal party for dancing").

Lexical Ambiguity: General Review

Simpson (1984) discusses three models which have emerged most prominently from the research in lexical ambiguity, as follows: (1) The Context-Dependent Model claims that the initial activation of a meaning of an ambiguous word is sensitive to the context in which it occurs. In its strongest form, it predicts that only the contextually appropriate meaning receives any processing whatsoever. Simpson (1984) cites a number of studies that reveal evidence of activation for contextually inappropriate meanings as well (Conrad, 1974; Onifer and Swinney, 1981; Seidenberg, Tanenhaus, Leiman, and Bienkowski, 1982); (2) The Ordered-Access Model emphasizes the fact that for most ambiguous words the various meanings are not encountered with equal frequency, contending that when an ambiguous word is presented, its meanings are retrieved in a serial self-terminating search, with the most frequent meaning activated first and evaluated based on the context. Limited support has been found for this model using sentence comprehension (Holmes, 1979) and lexical decision tasks (Simpson, 1981); (3) The Exhaustive Access Model states that the occurrence of an ambiguous word activates all of its meanings in memory. This

activation is completely independent of the frequency of the meanings or the context. Context, if present, is then used to select among the meanings, allowing only the contextually appropriate one to come to consciousness. Simpson (1984) presents much evidence which supports this model as the most likely, citing research using a variety of experimental tasks, including sentence completion (Olsen and McKay, 1974), recall following rapid serial visual presentation (Holmes et al., 1977), phoneme monitoring (Cairns and Hsu, 1980), lexical decision (Onifer and Swinney, 1981), word naming (Seidenberg et al., 1982), and Stroop interference (Oden and Spira, 1983).

One study (Holmes, 1979) that manipulated context and meaning frequency in a series of meaningfulness judgment experiments drew somewhat different conclusions, however. Responses were slower when the less frequent meaning was appropriate, indicating faster access to the dominant meaning. As the contextual bias toward the subordinate meaning was increased, comprehension latencies decreased, suggesting that strong context may be able to overcome the effects of meaning frequency.

Lexical search speed is related to words with multiple meanings, as suggested by the results of a study by Jastrzembski

and Stanners (1975). These authors, along with Rubenstein and his colleagues (Rubenstein, Garfield, and Millikan, 1970; Rubenstein, Lewis, and Rubenstein, 1971) found that words with a high number of meanings produced reliably shorter decision times in lexical decision tasks.

Jastrzembski and Stanners (1975) interpreted these results as indicating that words with multiple meanings have multiple memory entries, and the search process terminates with detection of one of the entries. However, they pointed out that there may not have been an adequate difference between the words Rubenstein et al. chose for homographs and nonhomographs. This possibility is supported by the fact that only one of four types of homographs resulted in reaction times significantly faster than those for nonhomographs (Rubenstein et al., 1971). Thus, they suggested that a more meaningful comparison was between words with a high number of meanings and those with a low number of meanings. Jastrzembski (1981) examined this question in a series of experiments and found that the number-of-meanings effect is independent of the frequency effect. Second, for the range of word frequency often used in word recognition experiments, it was found that the effect of number of meanings can be larger than the effect for word frequency. Thus, Jastrzembski (1981) suggested that, just like word frequency,

number of meanings must be regarded as an important variable affecting word recognition (c.f. Gernsbacher, 1984).

Additionally, working memory capacity constrains a reader's ability to maintain multiple interpretations of a lexical ambiguity during reading comprehension of sentences (Miyake et al., 1994). In this study, when the target homograph had one highly frequent meaning, high-span readers (i.e. large working memory capacity) showed little effect of ambiguity on encountering the disambiguation. This occurred irrespective of which interpretation of the homograph (dominant or subdominant) turned out to be correct, suggesting that they had both interpretations readily available.

In contrast, low-span readers showed a large ambiguity effect when the disambiguation was in favor of the subdominant interpretation, suggesting that they had only the dominant interpretation available.

Lexical Ambiguity: Studies Using Homonymy

As discussed by Simpson (1984), it has been found that subjects take longer to complete a sentence fragment that contains a

homograph than one that does not (Olsen and MacKay, 1974) and that they take longer to judge whether an ambiguous sentence is true or meaningful (Holmes et al., 1977). Holmes et. al. (1977) also employed a task whereby words forming a sentence were sequentially presented at a high rate, and the subject was instructed to recall as much of the sentence as possible. Recall of sentences that contained ambiguous words was consistently poorer than recall of those that did not, regardless of the context of the sentence.

Simpson (1984) states that the logic underlying such methods is that the increased response latencies (or poorer recall) occur because the comprehension process is made more difficult as one is forced to decide between two interpretations of the sentence. If the other sentential factors are held constant, the ambiguous word is identified as the source of the increased processing load, presumably because more than one meaning has been retrieved. This is in support of the exhaustive access view of lexical ambiguity.

Both context and frequency influenced retrieval in a study by Carpenter and Daneman (1981) where subjects were found to be more likely to retrieve the more frequent meaning of a homograph when it was more strongly primed by the context. In this study, subjects were asked to read aloud sentences which contained

homographs for which the two meanings differed in pronunciation.

The context effect can take its usual form in sentences, though this has also been observed at the single word level (Schvaneveldt et al., 1976). Using lexical decision tasks, these authors found that when the first and third words were related to the same meaning of the ambiguous second word (e.g. save-bank-money), the reaction time to recognize the third word decreased. However, when the first and third words were related to different meanings of the second word (e.g. river-bank-money), the reaction time for the third word was not reliably different from a control sequence with unrelated words. These authors concluded that this first word led the subject directly to the meaning of the ambiguous word that was consistent with that meaning. These data favor the selective access hypothesis; one meaning is always retrieved and, in the absence of context, the selection will be random.

Holley-Wilcox and Blank (1980), however, made a direct comparison between words primed by related ambiguous or unambiguous words. In the absence of context, and with equiprobable homographs, Schvaneveldt's model would predict that the facilitation following ambiguous words should be half of that seen following unambiguous primes, because the appropriate

meaning is retrieved, on the average, half of the time. The equal facilitation found by Holley-Wilcox and Blank in these conditions led them to conclude that, in the absence of context, both meanings are retrieved.

Simpson (1984) reports that one of the most frequently used processing complexity tasks is phoneme monitoring, where a subject listens to a sentence for comprehension and simultaneously monitors the sentence for a particular phoneme. Increasing the complexity of the sentence and thus the amount of attention that must be given for comprehension, results in longer latencies to respond when the target phoneme is presented. An initial study in this area by Foss (1970) showed that ambiguous sentences led to slower phoneme detection than did unambiguous sentences. Cairns and Kamerman (1975) showed that when the target phoneme was delayed until several syllables after the offset of the ambiguous word, there was no longer any difference in monitoring times for ambiguous and unambiguous sentences. These studies indicated that all of the meanings of an ambiguous word were initially activated and in a subsequent decision stage, context selected the appropriate meaning and made it available for further processing.

Similar phoneme monitoring latencies for ambiguous and

unambiguous sentences were found by Swinney and Hakes (1976) by the use of context that strongly predicted one meaning. They concluded that predictive context will successfully restrict access to a single meaning, while with weaker context, or in the absence of context, exhaustive access will be observed.

Onifer and Swinney (1981) asked their subjects to listen to sentences that were biased toward the primary or a secondary interpretation of a lexical ambiguity that occurred in each sentence. (For example, a primary sentence was: "The postal clerk put the package on the scale to see if it had enough postage", while a secondary sentence was "The dinner guests really enjoyed the specially prepared river bass, although one guest did get a scale caught in his throat". Simultaneously, subjects made lexical decisions about visually presented words, as follows for the above sentences: weight, source, fish, and coal. Decisions to words related to both the primary and secondary meanings of the ambiguity were facilitated when presented immediately following occurrence of the ambiguity in the sentence. This effect held under each of the two biasing conditions. However, when they were presented 1.5 sec following occurrence of the ambiguity, only visual words related to the contextually relevant meaning of the ambiguity were facilitated. These results also support the exhaustive access hypothesis, i.e. the

authors argue that lexical access is an autonomous subsystem of the sentence comprehension routine in which all meanings of a word are momentarily accessed, regardless of the factors of contextual bias or bias associated with frequency of use.

Priming : A Method for Investigation Lexical Access

Priming is a method that allows direct assessment of the momentary access of the individual meanings of ambiguous words. It is often assumed that priming tasks are purer tests of lexical access and are less likely to be contaminated by postlexical processes than on-line tasks (Simpson, 1984). At least one priming task (lexical decision) is sensitive to a decision stage that compares the target stimulus with the context (Forster, 1981; West and Stanovich, 1982). Simpson (1984) considers the purest tasks to be those that measure a response only to the ambiguous word itself, and notes that such studies have been influential in the development of word recognition models (e.g. Jastrzembski, 1981).

One of the most commonly used methods in word recognition research is the lexical decision task, in which the subject must decide as rapidly as possible whether a visually presented letter string represents a word. Usually half of the stimuli are nonwords

and require a negative response, serving as foils. It has been shown that lexical decision speed is typically higher for a word that is preceded by information to which it is related (Meyer and Schvaneveldt, 1971). Simpson (1981) found greater facilitation for words related to the dominant meaning than for words related to the subordinate, relative to unrelated words.

The model that emerges from the lexical decision experiments discussed thus far suggests that, in the absence of context, all meanings of an equiprobable, ambiguous, word are activated. Despite the criticisms concerning the various processing complexity studies, the conclusion of most studies- that all meanings of an ambiguous word are activated to some degree-has been corroborated by a number of semantic priming experiments. However, in the absence of context or with neutral context, it appears that the more frequent meaning may enjoy some advantage in accessibility.

Studies typically show that the contextually appropriate meaning (or the more frequent meaning, depending on which variable is being examined) results in the greatest amount of facilitation (Simpson, (1981). The other meaning (context inappropriate or less frequent), although still leading to faster responses than unrelated stimuli, shows somewhat less facilitation. The experiments that this

pattern describes include Conrad (1974), Onifer and Swinney (1981), Swinney (1979), and Underwood (1980). The difference in facilitation for the two related meanings is often small and non significant, but the pattern holds across studies.

Many tasks have been used to investigate whether all meanings of an ambiguous word are retrieved or whether access favors the more frequent meaning. It appears that a simple distinction between selective (whether frequency or context based) and exhaustive access is not tenable. Instead, studies have consistently shown that more than one meaning will be activated, but the degree (or rate) of activation is still sensitive to the dominance of the meaning and the context in which it is presented, if available.

Another factor to be considered in examining the role of context is the associative strength between primes and targets. Tsusuki (1993) found evidence in support of the transition from multiple access, which is influenced by context-independent associative strength, to context-dependent access in the process of resolving lexical ambiguity. This study used a phonological priming paradigm between polysemous phonographic Kana words (primes) and compound ideogramic Kanji words (targets) in Japanese. At 300 ms SOA, results of reaction time showed a facilitation effect for both

contextually appropriate and inappropriate target words. At 500 ms SOA, while the facilitation of reaction time held for contextually appropriate targets, this effect was not obtained for contextually inappropriate targets. Results of error rates indicated a greater context-independent facilitation effect at 300 ms SOA than at 500 ms SOA.

However, Burgess and Simpson (1988) conducted a lexical priming experiment in which targets related to ambiguous primes were projected to the left and right visual fields in a lexical priming experiment with SOAs of 35 and 750 msec. For right visual field presentations, facilitation was found for the more frequent meaning at both SOAs and a decrease in facilitation for the less frequent meaning at the longer SOA. Left visual field presentation results indicated a decay of facilitation for the more frequent meaning at the longer SOA, while activation for the subordinate meanings increased. The authors summarize their results by stating that, while automatic processing occurs in both hemispheres, only the left hemisphere engages in controlled processing of ambiguous word meanings. In addition, they state that the right hemisphere has a special role in ambiguity resolution and that the right hemisphere lexicon possesses a richer endowment than earlier thought.

There are two possible accounts of multiple access models that are distinguished by their frequency constraints: frequency independent multiple access and frequency coded multiple access (Burgess and Simpson, 1988). Simpson and Burgess (1985) claim that a frequency coded multiple access model can account for the activation pattern in the processing of ambiguous words in isolation. They also studied intervals between the onset of the prime and the target SOA ranging from 16 to 750 msec. The results showed that the time-course of semantic activation varied as a function of meaning frequency. Dominant meanings showed facilitation at all SOAs. Subordinate meanings showed no facilitation at low SOAs, but activation built as SOA increased, so that by 300 msec, the subordinate meaning showed the same level of facilitation as the dominant. So, there is multiple access of meanings of ambiguous words as both meanings are available by 300 msec. After 300 msec, these authors found that facilitation for the subordinate meaning declines, but that facilitation for the dominant meaning was maintained.

Lexical Ambiguity: Studies Using Polysemy

In comparison to homonymy, polysemy has received relatively little attention in the literature on lexical ambiguity, yet these two

word types have much in common. For example, to determine whether an instance of the polysemous word mouth refers to a facial aperture, the entrance to a cave, or the place where a river meets the ocean involves both semantic knowledge and the use of context. Polysemy has in common with homonymy that context must be implicated at some stage of successful normal processing, but differs from homonymy in that the possible meanings of a polysemous word are not completely mutually exclusive (Durkin and Manning, 1989). By definition, a polysemous word is one in which its different senses sustain a shared, or core, meaning (Colombo and Flores d'Arcais, 1984; Deane, 1988; Durkin, Crowther, and Shire, 1986; Grober, 1976).

On these grounds, it would be worthwhile to investigate language users' processing of polysemy by means of methods similar to those currently employed widely in studies of lexical ambiguity using homonymy, such as lexical decision and word naming tasks. These tasks measure recognition time for target words that are primed by ambiguous words. Targets are either related to the dominant or subordinate meaning of the prime or are unrelated to the prime. Generally, the evidence from such tasks indicates that more than one meaning of a homonym is activated initially (Simpson, 1984; but see Glucksberg et al., 1986 for an alternative account).

In the case of polysemy, however, the dominant sense is related to the subordinate sense(s). Caramazza and Grober (1976) have argued that it would be uneconomic to store every sense of a polysemous word as an independent word and they propose that lexical processing must involve a constructive process exploiting some relatively narrow core meanings plus contextual information Gernsbacher (1984) found that number of word meanings (operationalized as dictionary counts) did not influence lexical decision latency. However, Gernsbacher herself claimed that the number of dictionary definitions may not accurately reflect the number of meanings that are represented in memory In response to this, Millis and Button (1989) attempted to determine whether more psychologically valid measures of polysemy affect lexical decision time. Three metrics were used to represent the meanings that subjects actually access from memory (accessible polysemy): (1) the first meanings subjects think of when asked to define stimulus words, (2) all the meanings subjects generate for words, and (3) the average number of meanings subjects generate. The results showed that the second and third metrics of polysemy influenced lexical decision time, whereas the first metric (representing mostly the access to dominant meanings for words) only approached significance.

Some suggest a two-stage model of ambiguous word recognition, whereby 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 reallocate attention to the subordinate. This difficulty in reallocating resources results in inhibition for responses to words related to the subordinate meaning (Burgess and Simpson, 1988). This implies active, capacity-limited processes as well as automatic spreading activation components of ambiguous word processing. This appears to be true for phonological ambiguity as well, i.e. heterophonic homographs with two meanings and two pronunciations (Frost et al., 1990).

Lexical Ambiguity and Brain Function

Right Hemisphere Function and Lexical Ambiguity

The right hemisphere has traditionally been considered to be responsible for the comprehension of meanings secondary to the central meaning of a word (Gardner et al., 1983; Brownell et al., 1984). This includes alternative meanings (Chiarello, 1988) and the appreciation and integration of relationships in verbal discourse and narrative materials (Brownell, Potter, and Michelow, 1984) as well

as the understanding of jokes (Gardner, 1994).

Patients with right hemisphere brain damage exhibit a striking amount of difficulty in handling complex linguistic material. They exhibit clear difficulties in abstracting morals and in acquiring a sense of the overall gestalt of linguistic entities; they seem unable to appreciate the relations among key points of a story or joke. They may exhibit difficulties in interpreting phrasal metaphor or using verbal context to make linguistic judgments. Confronted with complex linguistic entities, these patients exhibit clear and recurring difficulties relating to the abilities to conceptualize the unit as a whole, to appreciate its purpose and form, and to integrate specific elements appropriately within these forms. Many of these patients seem insensitive to the context in which these linguistic entities are produced and utilized (Burns et al., 1983). The insensitivity to non literal meaning has also been observed at the single word level (Gardner et al., 1983). The right hemisphere also makes some contribution to language comprehension and reading processes (Krashen, 1976, Searleman, 1977, Gazzaniga, 1983).

Though there is overlap between right hemisphere functions and tasks of lexical ambiguity, it is clear from a summary of the work in this area (see below) that dichotomizing the functions of the left

and right hemisphere will not suffice in explaining brain-damaged patients' difficulty with such material. In analyzing the cognitive processes that are necessary for the interpretation of ambiguous words, particularly the "abstract" demands in the accessing of the multiple meanings of a lexical item, it appears that these may be more localized to the frontal lobe. Thus, the anterior:posterior dichotomy of brain function may be of equal importance or of greater importance than (left:right) hemispheric asymmetry when investigating lexical ambiguity.

Frontal Lobe Function and Lexical Ambiguity

Traditionally, damage to the frontal lobes has been associated with impairments in abstract thinking (Goldstein, 1948). It has been argued that abstraction and metaphoric thinking depend on a common underlying mechanism of part:whole relationship (Brown, 1995).

This study investigated the relationship between the comprehension of lexically ambiguous words and the ability to apprehend an item as belonging to more than one category, the ability to simultaneously hold more than one category in one's mind, and the ability to shift from one category (or concept) to another. Such conceptual or categorical thinking skills, first described by

Goldstein (1948) as an "abstract attitude", have traditionally been assigned to the frontal lobe (Luria, 1966). In concrete behavior, the category cannot be accessed from the instance, e.g. the color "red" is not abstracted independent of a red apple. If the patient can accomplish this task, he may not arrive at two or more categories from an instance, e.g. that an apple is a member of the category of shape (round), of color and of food. The impairment of abstraction can be relatively selective, as in defects of color naming or sorting, or it can be generalized and affect a great many perceptual tasks.

In the latter cases, the deficiency is the basis for impairments on tests such as the Wisconsin Card Sorting Test (1948), in which the patient is required to sort objects along several dimensions. Given an instance of a category, e.g. shown a round red object and asked to group it with similar objects, the patient cannot derive the target category from the member items, nor can the patient sort along several dimensions (color, shape, etc.).

Lezak (1995) describes conceptual difficulties, or problems with abstraction, as involving at least (1) an intact system for organizing perceptions even though specific perceptual modalities may be impaired; (2) a well-stocked and readily available store of remembered learned material; (3) the integrity of the cortical and

sub cortical interconnections and interaction patterns that underlie thought; and (4) the capacity to process two or more mental events at a time.

It is proposed that the basis for difficulty with lexical ambiguity involves problems with mental shift- considered a cognitive (conceptual) function associated with the frontal lobe- rather than the reduced utility of the right hemisphere with linguistic items. On this view, brain damaged patients who have difficulty (disproportionate to performance on other standardized measures) on tests which require the ability to appreciate two concepts at a single time, to shift from one interpretation of a word or concept to another or to inhibit one interpretation of a word or concept so as to emphasize a different one, would be expected to have difficulty handling lexical ambiguity.

In sum, it is proposed that the same mental process is responsible for (a) appreciating lexical ambiguity and for (b) mental shift tasks. The prediction is that a subject who performs poorly on (a) will also perform poorly on (b). It is also predicted that subjects who perform well on (a) will perform well on (b). However, it is not expected that patients who perform poorly on (b) will necessarily also perform poorly on (a). Thus, while intact mental shift is

necessary for lexical ambiguity tasks, it is a general cognitive function that is not only applied to such tasks.

Effects of Brain Injury on the Comprehension of Multiple Meanings

It is commonly known by clinicians that brain damaged patients without aphasia have difficulty with polysemous words. For example, given a target word such as bank, and asked to point to words such as money, river, etc., that go with the target word, they will often select only one meaning. Other cases, asked the color of an orange, may say yellow or red.

A similar phenomenon occurs with verbal nouns, e.g. "what do you shovel snow with? Such patients are unable to deal with more than one meaning or interpretation at a time. There is an inability to retrieve the alternative concept, perhaps due to blocking or persistence of the initial interpretation out of which the ambiguous item develops.

There have been relatively few studies that speak to the question of lexical ambiguity in the brain-injured population, and findings among those that do exist have been inconsistent. It is likely that this arises from (1) difficulty in drawing distinctions between

homonymous, polysemous, and metaphoric words which results in a lack of uniformity-within and across studies-of the selection of stimuli, and (2) differences in the manner of presentation of a task and the required response mode. These issues are illustrated below.

Winner and Gardner (1977) presented tasks of metaphoric competence, i.e. matching metaphoric phrases to pictures followed by verbal description, to groups of normal and brain damaged subjects. For the right hemisphere brain damaged (RBD) patients, 43% of the initial responses were metaphoric, with the most frequent erroneous choice being the literal picture, chosen approximately as often as the metaphoric one (40% of the time). However, when asked to describe metaphors, these patients did quite well. The left-hemisphere brain damaged (LBD) patients selected the metaphoric picture in their initial choice 58% of the time, with literal pictures chosen 18% of the time. These patients had difficulty in describing metaphors. This double dissociation of performances on the two metaphor tasks clarifies the contributions made by each hemisphere to linguistic and aesthetic functioning. More importantly, however, competent performance of the RBDs on the verbal description condition invalidates the common assertion that they are insensitive to metaphor.

Brownell et al. (1990) examined metaphoric sensitivity to single polysemous words, whereby subjects were asked to judge semantic relatedness among a set of common adjectives: warm, loving, cold, and hateful. Non-brain-damaged subjects based their relatedness judgments primarily on antonym association and on metaphoric equivalence. RBDs showed normal use of antonymic association, but less than normal use of metaphoric equivalence. LBDs showed the opposite: their results revealed a normal use of metaphoric equivalence but a decreased use of antonymic relatedness. Both groups of patients performed more poorly than the control subjects in both metaphoric adjective and the non metaphoric noun condition. The LBDs' impaired performance in this language task is not surprising, however, the poor performance by the non aphasic RBDs suggests a general deficit in the appreciation of alternative meanings that extends beyond the non literal interpretations of words and phrases to include homonymous nouns whose secondary meanings are not metaphoric. (Further, the LBDs' spared performance on metaphor tasks suggests that metaphor interpretation does not fall into the traditional realm of language processing.) These results suggest a qualitative difference in the manner in which left- and right- brain-damaged patients process certain aspects of word meaning. The authors point out the striking finding that relative to the LBDs, the RBDs do not appreciate

metaphoric meaning fully even at the single word level. This is inconsistent with the study by Winner and Gardner (1977) since in the latter study, the RBDs could use language to interpret metaphor.

Tompkins (1990) presented an auditory lexical decision task to LBDs and RBDs, in which they heard a priming phoneme string and then a target phoneme string, either a real word or a non-word. Subjects were asked to indicate whether the target string was a word or not; accuracy and time data were collected. Critical target words were ambiguous adjectives (e.g. sharp), which were paired with four prime types. Valid metaphoric primes were adjectives describing human attributes, and reflected the target's metaphoric meaning (e.g. smart-sharp). Valid literal primes were antonyms of the target, and related to its literal meanings (dull-sharp). Unrelated primes were other ambiguous adjectives that had no association with the target that followed (e.g. warm-sharp). Results of this study showed that brain damaged subjects' auditory lexical decisions for ambiguous target words can be facilitated by primes related to the metaphoric or literal meanings of those words. Brain damaged subjects' performance in conditions conducive to automatic processing resembled that of controls in all ways, except for absolute speed. Of note, RBDs did not have difficulty accessing metaphoric aspects of word meaning, perhaps because access

proceeded relatively automatically in this task.

Gagnon et al. (1994) questioned the contribution of the right hemisphere in semantic processing of the metaphoric meaning of ambiguous words as suggested by Brownell et al. (1990) and others. Subjects were given (1) a word triad task in which they had to match words according to the secondary metaphoric or secondary neutral meaning of ambiguous target words, and to (2) a word dyad task where they had to detect the presence of semantic-metaphoric and semantic-neutral relationships within pairs of words. The triad task tested the preference to select a semantic meaning over another while the dyad task was used to evaluate the capacity to perceive the presence of a semantic link within a pair of words.

The results of Gagnon et al.'s (1994) study did not indicate a clear disparity between LBD and RBD patients' ability to handle metaphor. The RBDs performed similarly to the LBDs for the metaphoric and neutral triad task, but significantly worse than the controls on the metaphoric triads. The LBD group always performed significantly lower than the controls in the dyad task. However, the RBDs performed similarly to the controls and much better than the LBDs when they had to perceive the presence of a primary meaning and an alternative neutral meaning in the dyad task. The RBD group

performed like the LBD aphasic group and were significantly worse than the control group when they had to perceive the presence of an alternative semantic metaphoric meaning in a pair of words.

Milberg et al. (1987) studied the processing of lexical ambiguities in Wernicke's and Broca's aphasic patients on performance of a lexical decision task. They were to decide whether the third word of an auditorily presented triplet series of words was "real" or not. The first and third words of each triplet were related to one, both, or neither meaning of the second word which was semantically ambiguous. The performance pattern of the Wernicke's aphasics was similar to that of normals; they showed selective access to different meanings of the ambiguous words, as demonstrated by the fact that the context provided by the first word affected semantic facilitation on the third word. In contrast, Broca's aphasics showed no semantic facilitation in any priming condition. These results are consistent with previous findings, suggesting that semantic representations may be largely spared in Wernicke's aphasics. The authors state that the complete failure of Broca's aphasics to demonstrate semantic facilitation in any condition in the experiment suggests that they may have a deficit either in the underlying representation of words or in accessing this information via automatic processing routines. The latter is

consistent with the idea that impaired processing of lexical ambiguity requires intact frontal function.

In contrast to these findings, Katz (1988) found that on an auditory lexical decision task with stimulus pairs containing ambiguous (semantically-related) or unambiguous (unrelated) words as primes, Broca's aphasics produced a pattern of results similar to normal subjects; namely, faster reaction times for target words preceded by semantically related than unrelated words (i.e. semantic priming). These results do not support Milberg et al. (1987) but rather suggest that the subjects in the Milberg et al. (1987) study had difficulty with the word triplet paradigm used.

It is clear from the studies reviewed here that there is no consensus on the neurological or cognitive localization of lexical ambiguity. However, there is ample evidence that questions the contribution of the right hemisphere as necessary for this realm of language processing.

GENERAL SUMMARY

While there is controversy concerning most aspects of lexical ambiguity and its neural representation, some points can be made from the preceding discussion. First, all known meanings of a word are available to normal subjects (Simpson, 1984). Context, if present, then constrains interpretation (Onifer and Swinney, 1981). There is controversy over how long context effects take, whether meaning frequency or dominance affects the order and strength of meaning selection and whether meaning selection occurs automatically or under the control of the subject. However, once a meaning has been selected, additional but non relevant meanings of the ambiguous word are suppressed or eliminated within a third of a second so as not to interfere with the appropriate interpretation (Swinney, 1979).

While neuropsychological studies are contradictory, damage to the right hemisphere does not produce a consistent impairment on tasks of lexical ambiguity, nor does damage to the left hemisphere result in its consistent relative sparing. There is, however, evidence in the clinical literature that the frontal lobes play an important role in word meaning interpretation or in the underlying ability to scan multiple interpretations serially or simultaneously.

RESEARCH QUESTIONS

The purpose of the present investigation is to examine the possible contributing factors for the observations documented above, particularly the inconsistency of brain-damaged patients' abilities to access alternate word meanings. This includes the lack of any clear-cut disparity in the abilities of left- and right-hemisphere damaged patients to perform such tasks and the uncertainty of any difference in the automatic and conscious processing of ambiguous words. The following specific questions will be addressed:

(A) Do patients with abstraction problems (as measured by neuropsychological tests) show reduced priming for ambiguous words and their multiple meanings, relative to unrelated words, despite their abstraction problems? To answer this question, subjects will participate in a lexical decision task that will measure speed of response using target ambiguous words paired with their multiple meanings, along with unrelated words and non-words.

(B) Are problems with abstraction (as measured by neuropsychological tests) related to decreased ability to perceive

lexical ambiguity of the three types tested here, i.e. homonymy, polysemy, and metaphor? To answer this question, experimental subjects will be administered a matching task whereby they will be required to match target ambiguous words with their multiple meanings, presented along with unrelated word choices.

(C) Comparing brain-injured and normal subjects, are there differences in performance on tasks of lexical ambiguity of the three types tested here, i.e. homonymy, polysemy, and metaphor (with specific attention to metaphor, given the greater abstraction demands on this word category)?

CHAPTER 3

METHODOLOGY

Subjects

Two groups of subjects were selected for this study. One of these groups consisted of 16 traumatically brain-injured (TBI) patients selected from an area outpatient rehabilitation center according to the criteria listed below. The other group consisted of 22 normal subjects drawn from the same rehabilitation setting (personnel and visitors), also according to the criteria listed below. Ages ranged from 19 to 45 years. Monolingualism was determined by having subjects rate their general experience with languages other than English according to a Likert scale (see Appendix A). Those scoring 2 or below (range: 0-4) were included in the study. All subjects were right handed; handedness was determined by A.J. Harris's Test of Lateral Dominance (1958). Education level was determined by asking the subject to indicate the highest degree attained by the time of testing, and only those subjects with a minimum of a high school education were included in the study. All subjects had normal or corrected vision and audition. The TBI subjects consisted of patients who had sustained a single traumatic

brain injury over six months ago, with no other history of neurological or psychiatric disorders. The normal subjects had no history of neurological or psychiatric disorders.

In order to ensure adequate comprehension of the experimental procedures, subjects were required to achieve 100% yes/no reliability for six personally relevant or general information questions from the Western Aphasia Battery (Kertesz, 1982). Subjects were required to perform at a minimum of 90% accuracy on a 40-item practice run on a computer-generated reaction time task to ensure the ability to perform Task One. They were also required to demonstrate at least 90% accuracy in matching 4 choices to a target synonym arrayed in the manner in which Task Two was presented so as to indicate that visual/reading ability was sufficient to process printed stimuli physically similar to that task.

The age range for the experimental group was 19-45 with a mean of 36.8 years. Twelve of the 16 patients in this group graduated college, while the remainder each had a high school education. Eight of the 16 were male and 8 were female. Duration postonset ranged from 8 to 48 months.

The age range for the normal controls was 19-45 with a mean of

30.5 years. Sixteen of the 22 controls graduated college, while the remainder each had a high school education. Twelve of the 22 controls were male and 10 were female.

Test Procedures

Each TBI subject was required to perform Tasks One and Two (see below) in addition to undergoing a neuropsychological evaluation described below, while each normal control was required to perform only Tasks One and Two, in addition to receiving the Raven's Progressive Matrices (Raven, 1960) and the Shipley Institute of Living Scale (Zachary, 1991), both of which can be converted into IQ scores.

Half of the subjects underwent Task One followed by Task Two; the other half underwent the reverse. Further, stimuli for both Task One and Task Two were randomized. The following ensured attention to the task: (a) subjects were visually and auditorily alerted to Task One by a large cross presented in the center of the screen, along with an audible tone; (b) only those subjects with accuracy scores of 80% or above on Task One were included; (c) subjects were given 2 ten-minute breaks at equal intervals during Task One; and (d) only those experimental subjects who were able to sustain 40 minutes of

therapy were included in the study.

Task One (for both groups of subjects)

Task One consisted of a lexical decision task. Subjects were asked to indicate whether a letter string was a word or not by pressing a key on the computer's keyboard designated "yes" or "no". Each subject was seated in front of a Macintosh Quadra 605 computer with a 14 inch colored monitor which presented stimuli at regular intervals, described below. Stimuli were presented in black on white background via the software package, Mac Probe, which collects reaction time and accuracy data.

The task was introduced to subjects with the following instructions:

"You will hear a sound which will alert you to pay attention to the computer screen. At the same time, you will see a cross on the screen which is also intended to hold your attention. Then you will see two different words on the computer screen, shown one after the other. The first will be shown for only a short while, and may or may not be related to the second word. Do not pay attention to the first word. When the second word comes on the screen, press the "yes" key if you think it is a word in English and the "no" key if you do not think it is a word in English. Press the chosen key as quickly

as possible."

These instructions were followed by:

(a) An audible "beep" lasting 500 msec which served as a warning signal intended to direct the subject's attention to the computer screen.

(b) A "priming" word (e.g. “beam”) was presented for 100 msec.

(c) The target word, that is, a word related in meaning to the prime (e.g. “light” or “plank” for “beam”) was presented for 300 msec.

Interstimulus intervals (ISIs) were 500 msec.

There were 60 lexically ambiguous primes, each paired with 1 non-word and 2 related words, which served as targets. Additionally, there were 60 non-ambiguous primes (shown in Appendix B), each paired with 1 non word and 2 real words (chosen from the list of related words which were paired with the ambiguous words above), which also served as targets. Non-words, shown in Appendix D, were constructed by combining one syllable from each of two primes into pronounceable letter strings. Words and non words were randomized for presentation.

This priming task was chosen to address the automatic levels of processing lexically ambiguous stimuli. The rationale for its use was to explore the pervasiveness of abstraction deficits on handling such material, i.e. levels of processing that are presumed to precede more conscious comprehension such as is required by a matching task. Thus, if patients with abstraction difficulties were found to have longer reaction times for lexically ambiguous material, then this would serve as evidence for impairment beyond the level usually tapped by studies of this topic.

Task Two (for both groups of subjects)

Task Two consisted of a word matching task that required subjects to determine whether 4 choices matched a target word in meaning. Stimuli consisted of a single target word printed at the top center of a 5 x 8 index card. Four other words were printed underneath this target word, spaced at regular intervals.

This task was introduced with the following instructions: "You will see a single target word followed by 4 other words. Circle those that are related to the target word in meaning. There may be more than one correct choice."

This matching task was designed to address conscious processing of lexically ambiguous material, and so, to provide converging evidence to data from the priming (automatic processing) task described above. In other words, the combination of the priming task with a matching task aimed to make the expected study findings more robust than if one or the other task were used.

Materials

For this study, the stimuli used to investigate the understanding of alternate meanings of words were of two types, as follows: (a) a priming word followed by target words of the following types: either of two of that (real word) prime's multiple meanings, unrelated words, or non-words, presented on a computer screen, and (b) a single target word or non-word followed by 4 choices, including two or three of that target's multiple meanings and unrelated words. Stimuli for part (b) were presented on 5 x 8 inch index cards, with words printed in black lettering.

The stimuli for Task One and Task Two are included in Appendices B, C, and D and consist of the following types: polysemous words, homonymous words, and metaphoric words; non-words; and unrelated words. There are a total of 20 primes for each

of the first three categories (homonymy, polysemy, metaphor)- totaling 60 ambiguous words. Additionally, there were 120 non words and 60 unrelated words which served as targets. Note that for the priming task, the words listed in Appendices B, C, and D served as the primes. For example, the target word "chicken" primed the target word "coward".

Most of the polysemous and homonymous words were selected according to a list provided by Durkin and Manning (1989), compiled from a variety of sources, mainly from previous norm-gathering studies (e.g. Gilhooly and Logie, 1989; Gorfein, Viviani, and Leddo, 1982; Nickerson and Cartwright, 1984), with the majority of words chosen from the Gilhooly and Logie (1980) list as this list contains the most extensive normative data about the frequency, imagery, age of acquisition, familiarity, and concreteness of each ambiguous word. Word choices for these were matched for part of speech, length, and frequency.

The metaphoric word list was generated by the investigator, along with two assistants (see acknowledgments) by using the concept of elliptical simile, described in chapter 2. Further, two normal subjects (matched for educational level and age) were asked to choose 20 metaphoric words from the total list of 60 lexically

ambiguous words, given instructions to "find those words in the "choices" column that can be used to stand for, or in place of, their corresponding targets". There was high interrater reliability: one rater correctly identified 19 items and the other, 17 items. One rater made 1 false positive response and the other, 0, while one rater made 1 omission and the other rater made 3 omissions.

Word lists were created according to the following rules for selection: All of the polysemous and homonymous words had at least one noun meaning and verb meaning each. For Task Two, four words in each of the polysemous and homonymous word lists had three choices that were potentially correct (i.e. matching in meaning); the remainder had only two potentially correct choices. For those that had a verb meaning as a correct choice, at least one foil was also a verb. Though many words in the total list had more than two meanings, viable synonyms were considered only those which were assigned a minimum relatedness score of 1.17 and a maximum relatedness score of 4.0 as assigned by Durkin and Manning (1989), where available. Eighty-five percent of the words used had this information available.

As the features (i.e. frequency, imagery, age of acquisition, familiarity, and concreteness) considered for matching homonymous

and polysemous words were not available for the metaphoric words, the latter category was treated as a separate category. Six of the metaphoric words had verb meanings. The metaphoric words as a group had two synonyms that were considered potentially correct choices for task two.

Neuropsychological Test Battery

Given the prediction that patients with abstraction difficulties (traditionally associated with frontal lobe impairment) will show less sensitivity to lexical ambiguity than normals, a neuropsychological test battery was used to assist in determining a possible correlation between these factors.

Patients with frontal damage, and thus, suspected abstraction deficits, typically have difficulty in forming concepts, in maintaining the use of the principle for forming concepts while it is in effect, or in shifting from one principle to another according to situational demands. These problems may occur together, or they may also exist separately (Lezak, 1995) and are easily assessed by neuropsychological testing.

The test battery described here was aimed at establishing

cognitive profiles for the patients tested. Patients' scores on each of the tests in the battery were compared against age-corrected norms. A statistical analysis was conducted to correlate factors derived from the neuropsychological battery with scores on Tasks One and Two.

Following is a list of the individual tests that made up the battery. Note also Appendix E, which classifies these tests according to the cortical site(s) which they purport to test.

Wisconsin Card Sorting Test (WCST) (Grant and Berg, 1948). The subject is given a pack of cards on which are printed one to four symbols, triangle, star, cross, or circle, in red, green, yellow, or blue. No two cards are identical. The subject's task is to place them one by one under four stimulus cards-one red triangle, two green stars, three yellow crosses, and four blue circles-according to a principle that the patient must deduce from the pattern of the examiner's responses to the patient's placement of the cards. This test was devised to study abstract behavior and shift of set (Lezak, 1995).

Trail Making Test (Trails) (Army Individual Test Battery, 1944). Given in two parts, A and B, the subject is first required to draw lines to connect consecutively numbered circles on one worksheet

(Part A) and then connect the same number of consecutively numbered and lettered circles on another worksheet by alternating between the two sequences (Part B). The subject is required to work as quickly as possible. This test is used to assess visual scanning and tracking, response to a visual array, mental sequencing, and dealing with more than one stimulus or thought at a time (Eson et al., 1978). It also indicates how flexible one is in shifting the course of an ongoing activity (Pontius and Yudowitz, 1980). Overall, this test measures the ease with which the subject can shift his or her perceptual set to conform to changing demands; it is also a test of concentration (Lezak, 1982).

The Stroop Test (Stroop, 1935). This test consists of three white cards, each containing ten rows of five items. Randomized color names-blue, green, red, and yellow-are printed in black on card A. Card B is identical, except each color name is printed in some color other than the color it names. Card C displays colored dots in the same array of four colors. There are four trials, each consisting of a different task. On trial one, the subject reads card A; on two, s/he reads card B and ignores the color of the print; for three, s/he names the colors on card C; and on four s/he names the colors of the print on card B. The subject is encouraged to work as quickly as possible. This test is sensitive to impairments in executive

functions-particularly those relating to mental control and response flexibility.

Controlled Oral Word Association Test (FAS) (Benton and Hamsher, 1976). The examiner asks the subject to say as many words as s/he can think of that begin with a given letter of the alphabet, excluding proper nouns, numbers, and the same word with a different suffix. This test is widely used to assist in making a diagnosis of frontal lobe damage (Lezak, 1983).

Wechsler Adult Intelligence Scale-Revised (WAIS-R) (Wechsler, 1981).

1. Similarities: This is a test of verbal concept formation. The subject must explain what each of a pair of words (e.g. orange-banana) has in common.
2. Comprehension: This subtest includes two kinds of open- ended questions: 13 test common-sense judgment and practical reasoning, and the other three ask for the meaning of proverbs.
3. Vocabulary: This assesses the extent of recall vocabulary and the effectiveness of the subject's speaking vocabulary. This subtest has been identified as the single best measure of both verbal and general mental ability (Lezak, 1982).
4. Digit Symbol: This subtest consists of four rows containing, in

all, 100 small blank squares, each paired with a randomly assigned number from one to nine. Above these rows is a key that pairs each number with a different nonsense symbol. The subject's task is to fill in the blank spaces with the symbol that is paired to the number above the blank space as quickly as he can.

5. Information: This subtest tests general knowledge normally available to persons growing up in the United States.

6. Arithmetic: This subtest includes oral and written arithmetic problems ranging from simple one-digit addition problems to complex problem-solving.

7. Picture Completion: The subject is shown incomplete pictures of human features, familiar objects, or scenes, arranged in order of difficulty with instructions to tell what important part is missing.

8. Block Design: This is a construction test in which the subject is presented with red and white blocks, four or nine, depending on the item. The task is to use the blocks to construct replicas of two block constructions made by the examiner and seven designs printed on a smaller scale.

9. Picture Arrangement: This test consists of ten sets of cartoon pictures that make up stories. Each set is presented to the subject in scrambled order with instructions to rearrange the pictures to make the most sensible story.

10. Object Assembly: This subtest contains four cut-up cardboard

figures of familiar objects given in order of increasing difficulty. The subject is to rearrange the pieces in as quickly as possible.

11. Digit Span: This subtest evaluates digit span forward and digit span backward. Both tests consist of seven pairs of random number sequences that the examiner reads aloud at the rate of one per second, and the subject is asked to repeat these sequences.

Raven's Progressive Matrices (Raven, 1960). This test consists of a series of visual pattern matching and analogy problems pictured in nonrepresentational designs. It requires the subject to conceptualize spatial, design, and numerical relationships ranging from the very obvious and concrete to the very complex and abstract. Overall, it is a test of both visuoperception and abstract reasoning. It consists of 60 items grouped into five sets. Each item contains a pattern problem with one part removed and from six to eight pictured inserts of which one contains the correct pattern. The subject points to the pattern piece selected as correct.

Wechsler Memory Scale-Revised (WMS-R) (Wechsler, 1987). The Mental Control subtest requires the subject to say a series of numbers or letters. On Figural Memory, the subject looks briefly at abstract designs, and then must identify them from an array. Logical Memory I examines the ability to recall ideas in two orally

presented stories. On Visual Paired Associates I, the subject is shown six abstract line drawings, each paired with a different color, and is then asked to indicate the appropriate color associated with each figure. Verbal Paired Associates is similar. The subject is read a group of eight word pairs. Then, the first word of each pair is said by the examiner, and the subject must say the second of each pair. On Visual Reproduction I, the subject must draw geometric designs that are exposed briefly. Digit Span requires the subject to repeat digits forward and backward. The two parts of the Visual Memory Span subtest, tapping forward and backward, are administered separately. The examiner, using a card printed with colored squares, touches the squares in sequences of increasing length. The subject must reproduce the sequences, in forward and reverse order. Following administration of the above nine subtests, two verbal and two nonverbal subtests (Logical Memory II, Visual Paired Associates II, Verbal Paired Associates II, and Visual Reproduction II) are given a second time, thus providing 30-minute delayed recall measures.

Boston Naming Test (BNT) (Kaplan et al., 1983). This test consists of 60 ink drawings ranging in familiarity from such common ones as tree and pencil at the beginning of the test to sphinx and trellis at its end. When a patient is unable to name a

drawing, the examiner gives a stimulus cue; if he is still unable to unable to provide a correct name, a phonetic cue is provided. (Note that scores include the number correct prior to cueing.)

Boston Diagnostic Aphasia Examination (BDAE) (Goodglass and Kaplan, 1972). The reading comprehension subtest of this examination was administered to patients only. This subtest consists of simple passages followed by questions for comprehension.

CHAPTER 4

RESULTS

TASK ONE: Reaction Time Task

Prior to analyses, trials on which reaction time measures fell farther than 2 standard deviations from the group centroid (by computing Mahalanobis d-squared for all raw scores within each subject) were eliminated, as these were considered to represent lapses of attention (a common practice in studies using reaction times). Using the two standard deviation guide, no more than 2% of the total number of trials for any one subject were eliminated from the analysis.

The first step in the analysis of these data was to calculate the difference between the reaction times for the prime-target pairs, e.g. "chicken-coward" (metaphoric pairing) and "chicken-bird" (literal pairing). For the metaphoric word category, the order of subtraction was metaphoric minus literal values. As the two related homonymous and polysemous targets were matched for frequency, etc., the order of subtraction was random. The next step in the analysis was to obtain averages of the above calculations by

category (homonymy, polysemy, and metaphor) for each subject, followed by averages across subjects. These figures were used in all of the following analyses with the exception of the final analysis of variance (ANOVA).

Initial simple correlations of all reaction time scores showed an unexpected correlation between homonymy and metaphor. Such a correlation between variables violates the assumption of ANOVA with repeated measures and artificially inflates the chance of finding spurious significance. Therefore, the initial method of analysis was a Multivariate Analysis of Covariance (with age as a covariate), or the Hotelling's T-Squared, which takes into account the dependence between variables when evaluating differences between two groups. This is a stringent measure of the difference between groups (patients and normals) across the reaction time variables (homonymy, polysemy, and metaphor). The overall multivariate results were evaluated using Wilk's Lambda (df= 3,24) which resulted in a value of 0.761 with p=.024.

Since the previous analysis demonstrated differences between the groups, the next question of interest concerned which of the variables they differed on. Results of t-tests (displayed in Table 1) for each of the three variables (homonymy, polysemy, and metaphor)

are depicted in Figure 1. This figure shows a statistically significant difference between the groups for metaphors, with an apparent difference between mean difference for metaphors and the other two variables in the patient group, i.e., it suggests a significant slowing in responding to metaphoric prime-target pairs when compared to polysemous and homonymous pairs in patients but not in normals. In fact, when compared to the unrelated prime-target pairs, there was no priming of metaphoric prime-target pairs. In order to statistically examine this relationship between the means as seen in Figure 1, an ANOVA with planned comparison was performed (as it was hypothesized that responses to metaphoric pairs would be slower than the other two word categories): the mean differences for the metaphor category was compared with the combined means for the homonymy and polysemy categories since no difference was found between the latter two (cf. figure 1). The result of this analysis confirms the significance of the difference between metaphor and the other two variables {$F(df:1.36) = 4.16$, $p<.05$}. Actual reaction time values (means and S.D.) for patients and normals are shown in Table 2.

The next question for Task One concerned the relationship between performance on the neuropsychological battery and the reaction time data for the three variables (word categories). A

canonical correlation showed that they are significantly correlated with the following outcome: R= .987; chi-square (df=27) = 43.69, p=.022. A more specific question concerning the relationship between tests of abstraction and reaction time performance was investigated using Backward Stepwise Multiple Regression Analysis. In this analysis, reaction time differences for metaphors was used as the dependent variable with scores on the neuropsychological battery as predictors. The following tests were noted to contribute most to the prediction of reaction time data in the regression equation: WCST, Trails B, Verbal I.Q., Word Fluency (FAS), BNT, and Raven's. The results of this latter analysis with the standardized beta weights are presented in Table 3.

In order to determine the presence of overall priming, an ANOVA was performed and the results showed a main effect for relatedness of prime for the patients (F =4.92, p= .032), but no interaction, thus demonstrating the priming effect for patients but no difference for normals. As expected, the patients performed significantly slower than the normals with means as follows: TBI group: 764.04 and Normals: 612.72. Figure 2 illustrates the mean reaction times for patients and normals for unrelated words and the three target word types.

TASK TWO: Matching Task

In contrast to the reaction time findings, ANOVA showed no main effect for group for the matching task ($F = .93$, $p > .05$). On the other hand, significant differences were noted among categories for both groups ($F = 5.63$, $p = .01$), also unlike the reaction time task. Note that even though the differences are statistically significant, they appear to be relatively small. There was a statisically significant difference among the three categories for performance on the matching task, with performance on homonymous words more accurate than polysemous and metaphoric words, and no significant difference between metaphor and polysemy (See Table 4). However, this may be a spurious finding due to unknown variables, since this pattern was not revealed in the reaction time data, and since the actual differences are, indeed, small.

CHAPTER 5

DISCUSSION

The goal of this study was to determine the type of cognitive functions required for the successful interpretation of lexical ambiguity. The primary contention held that patients exhibiting problems with abstraction would demonstrate impairments in the sensitivity to alternate meanings of words and that this would be evident on both the lexical decision (reaction time) task and the matching task. Further, this was expected for the three categories of ambiguous words used: homonymy, polysemy, and especially for metaphor, given the greater demands on abstraction for this word type.

The experimental procedures were developed to evaluate the difference between brain-injured and normal subjects on these tasks, and were designed to allow analysis of any differential effect of word type (i.e. homonymy, polysemy, and metaphor) on lexical access and on a comprehension task.

There is sufficient evidence that questions the degree of right hemisphere involvement in lexical ambiguity interpretation (Winner

and Gardner, 1977; Gagnon et al., 1994) and other evidence that points to frontal lobe involvement in these types of tasks (Milberg et al., 1987). The results of this study support the latter, as is evidenced by the fact that tests of abstraction contributed much more weight than tests thought of as affecting right hemisphere function to predicting performance on lexical ambiguity tasks.

Task One

WAIS-R Verbal I.Q. scores contributed most heavily to predicting reaction time performance for metaphors, i.e. the higher the Verbal I.Q. score, the smaller the difference between the appreciation of concrete and metaphoric meanings of words in this category, indicating approximately equal facility of access of word meaning. The other tests found to correlate in this direction were WCST category subtest, Trails B, Word Fluency (FAS), BNT, and Raven's, with Raven's showing the lowest weight of this group of tests, which, save for the BNT are widely considered to be tests of abstraction. Note, however, that the standardized weight of the Raven's, while relatively small, was still in the same direction. It is notable that while the Raven's is a test of abstraction, it also requires intact visuo-spatial processing, and may thus also be considered a test of right hemisphere function.

Reaction time performance for polysemy was most related to performance on WMS-R Verbal subtests and Trails B, and to a lesser degree with the WCST Perseveration subtest, Stroop, and Raven's. For homonymy, reaction time performance was most related to Word Fluency, Verbal I.Q., and BNT, and to a lesser degree, WCST, Trails B and Stroop.

There was the expected finding that patients performed with longer response latencies on the reaction time task than did normals. Another expected finding was slower reaction times for words related to the target in meaning than for words unrelated to the target in meaning, for the patient group. The most striking finding on the reaction time task was that the patients evidenced significantly slower reaction times on metaphor than on polysemy and homonymy both within their own group and as compared to the normals.

Task Two

On the matching task, which used the same ambiguous words as the lexical decision task, patients performed at accuracy rates which were comparable to the normals. While this finding is surprising, it is important to note that the matching task involved

untimed multiple choice. The finding that patients' performance was comparable to normals' performance suggests relative intactness of the semantic representations of these words in spite of retrieval deficits. It is noteworthy that patients and normals showed higher accuracy for responding to homonyms than to polysemous or metaphoric words on the matching task, despite the fact that the homonymous and polysemous words were matched closely in terms of frequency, etc. This suggests relative ease in discerning discrete multiple meanings such as for homonymous words as compared to a relative deficit in fully appreciating the marginal meanings of the polysemous and metaphoric word stimuli. Recall that homonyms consist of only central meanings, while polysemous and metaphoric words consist of both central and marginal meanings, which, within categories, are not mutually exclusive.

General Issues

This study has revealed numerous methodological difficulties confronted in the field of lexical ambiguity. For example, divisions between polysemy and metaphor are somewhat blurred and often arbitrary-indeed, Brownell et al. (1990) investigated brain damaged patients' appreciation of alternative word meanings using a word list which consisted of "metaphoric polysemous" words. In

considering the above findings in light of the widely held definitions of metaphor, it would be prudent for researchers to clearly define the categories of lexically ambiguous words and to control for their individual parameters.

In the classical literature on this topic which dates back to Aristotle, metaphor is seen as an instance of novel poetic language in which words are not used in their normal everyday sense (Lakoff, 1989). In contrast to language as the central realm of metaphor, Ortony (1993) considers metaphor to be more in the domain of thought, or the mapping of conceptual domains. Thus, the locus of metaphor is in the way we conceptualize one mental domain in terms of another, i.e. cross-domain mapping. For example, metaphor can be seen in terms of mapping from a source domain (tabloid) to a target domain (rag). Here, there is a conceptual correspondence between one domain of objects (newspapers) and a very different domain of objects (cloth). Such cross-domain mapping requires cognitive operations which are necessary for tests of abstraction, namely, set-shifting (WCST, Trails B), flexibility of thought (Word Fluency), and conceptualization (Verbal I.Q.)-all of which were strongly related to performance on reaction time for metaphor. Generally, then, the same cognitive functions are necessary for metaphor and tests of abstraction.

To date, there is great variability in the methods used in studies on this topic, including subject selection, task requirements, and response mode. Aside from the obvious difficulties with issues such as these, they raise special concern with regard to the intention of this study. While the primary goal was to isolate the cognitive functions responsible for lexical ambiguity interpretation, an extension of this would involve identifying its neurological substrate.

Thus, it was presumed that patients who exhibited difficulties in abstraction would also evidence frontal lobe impairment, and thus, difficulty on the study tasks. While most authors claim to use patient populations with discrete right or left lesions, there may be an inherent bias toward selecting patients with anterior lesions, as a common exclusion criterion for right hemisphere patients is visual neglect-a symptom associated with right posterior damage. Further, most studies do not use the same lexically ambiguous stimuli over a variety of tasks, as this one did.

A further methodological difference in the literature on this topic concerns the use of sentences vs. words as stimuli. Single words were chosen for this study as this would assist in eliminating the possible influences of impaired attention or memory in the TBI

subjects. Additionally, differences exist among priming studies which use sentences. For example, Onifer and Swinney (1981) showed differences in priming ability when word choices were presented immediately following the occurrence of the ambiguity in a sentence, contrary to when these word choices were presented 1.5 seconds following occurrence of the ambiguity.

Additionally, metaphoric target phrases require significantly longer processing times than literal target phrases if reading time measures are taken at the end of the target phrase rather than at the end of the target sentences in which the phrases are embedded.

Given that there were dissimilar findings for both tasks in this study, this causes one to question the validity of findings of studies which use one or the other type of task. Indeed, the matching data in this study revealed the relative facility of access even in the brain-injured population, while the reaction time data showed this population to be quite below normal levels of performance.

As there is some question as to the issue of how the number of meanings for lexically ambiguous words affects their comprehension, a sampling of performance of both patients and normals on the matching task was taken in order to see if accuracy

was affected by this parameter. Of the sixty target items, eight had three potentially correct matches, while the remainder had only two. A preliminary analysis of this data indicated that patients and normals performed at approximately equal accuracy rates (48% and 51%, respectively) for those items with three potentially correct matches, with much higher accuracies for those items with only two (92% and 94%, respectively). Though this study was not set up to address the question of selective vs. exhaustive access, this preliminary analysis would point in the direction of supporting selective access, whereby the access of two meanings of an ambiguous word may suppress the third. Certainly, this issue should be addressed in a more rigorous manner, as it raises important questions regarding the possible contributing factors to disambiguation.

Thus, in addition to providing support for the cognitive localization of lexical ambiguity to functions (such as abstraction) related to the frontal lobe, this study has highlighted some of the concerns related to other investigations of this topic. The literature is replete with studies on lexical ambiguity, particularly with normals, and it is evident that findings using the brain-injured population would add new perspective on the topic, when such studies are stringently controlled.

CHAPTER 6

CONCLUSIONS

The most common way of investigating sensitivity to lexical ambiguity is through the use of tasks which require conscious processing, such as the matching of words or phrases. The present study differed in that it used both a matching task and a priming (reaction time) task; the latter was included in an attempt to contribute to the robustness of the expected findings, i.e. worse performance for patients with abstraction difficulties. However, a discrepancy in performance on these tasks was found, with brain-injured subjects performing as well as normals on the matching task, though performing with much slower reaction times on the priming task. This is important in highlighting the stage of cognitive processing (automatic vs. conscious) at which disambiguation takes place, and also points to the necessity of careful design in studies on this topic.

Given the large discrepancies found in other studies of the topic of lexical ambiguity using brain-injured subjects, serious consideration was given to other possible confounding variables in the design of this particular study. These include subject selection,

task requirements, response mode, and selection of stimuli.

While this study set out to isolate the cognitive processes involved in lexical ambiguity comprehension, it did not rely on a patient population with clear-cut lesion sites. Instead, it used the procedure of evaluation to determine purported lesion site, and provide findings regarding right hemisphere and frontal involvement in lexical ambiguity. The findings provided support for the cognitive mechanisms underlying the comprehension of lexical ambiguity, all of which are traditionally assigned to the frontal lobes. These include the ability to simultaneously apprehend one or more item and to shift from one item (or mental set) to another. A natural progression in the study of this topic would be to attempt to localize the neurological underpinnings for these cognitive mechanisms, a task made simpler by the use of a population of subjects with focal brain damage, i.e. left, right, anterior, or posterior.

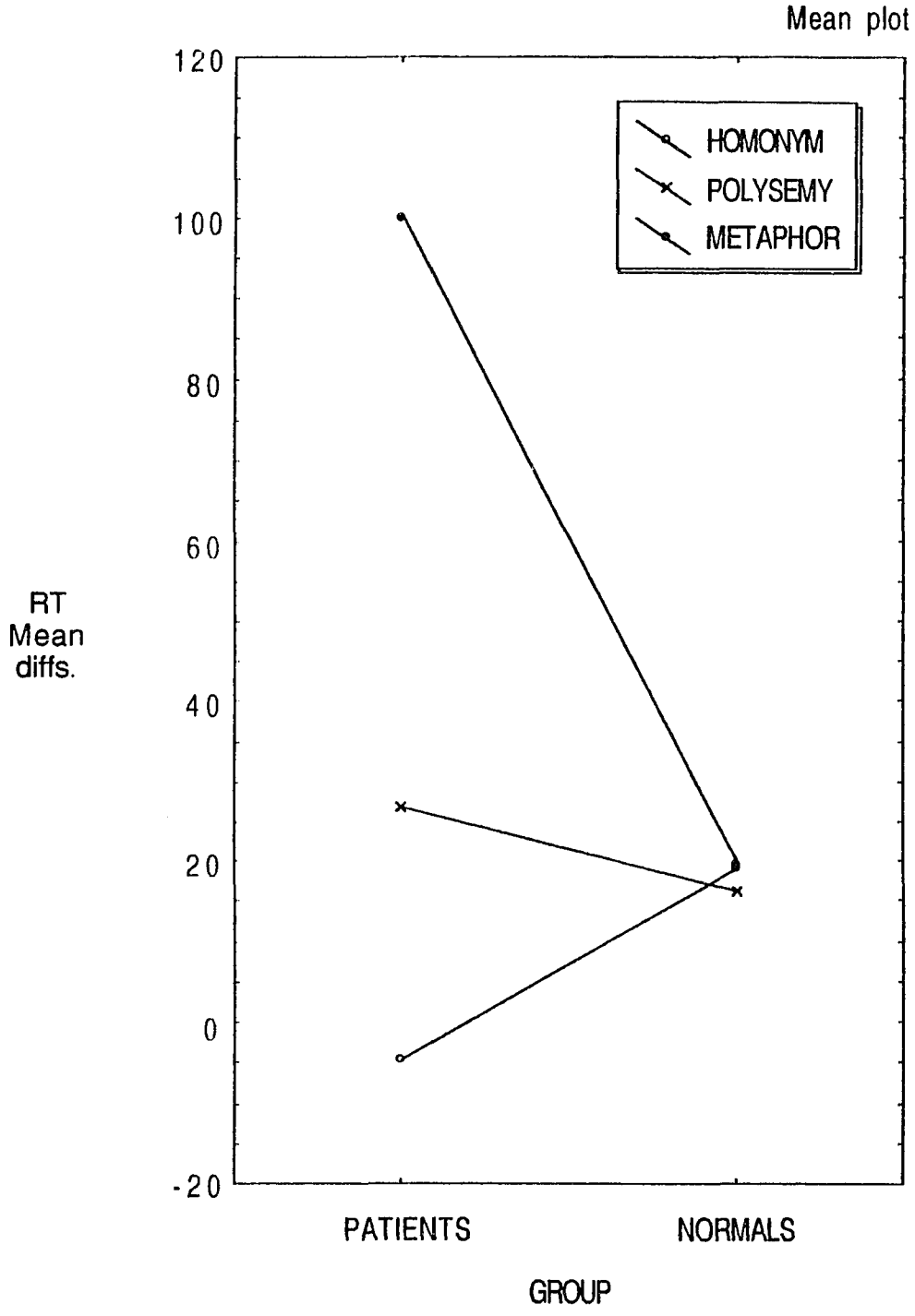

FIGURE 1. Mean differences in reaction times for three word types. For each prime, reaction times for two related targets were computed and average across trials and across subject groups. This depicts a statistically significant difference between metaphor and the other two variables, i.e. it shows significant slowing in responding to metaphoric prime-target pairs when compared to polysemous and homonymous pairs in patients but not in normals.

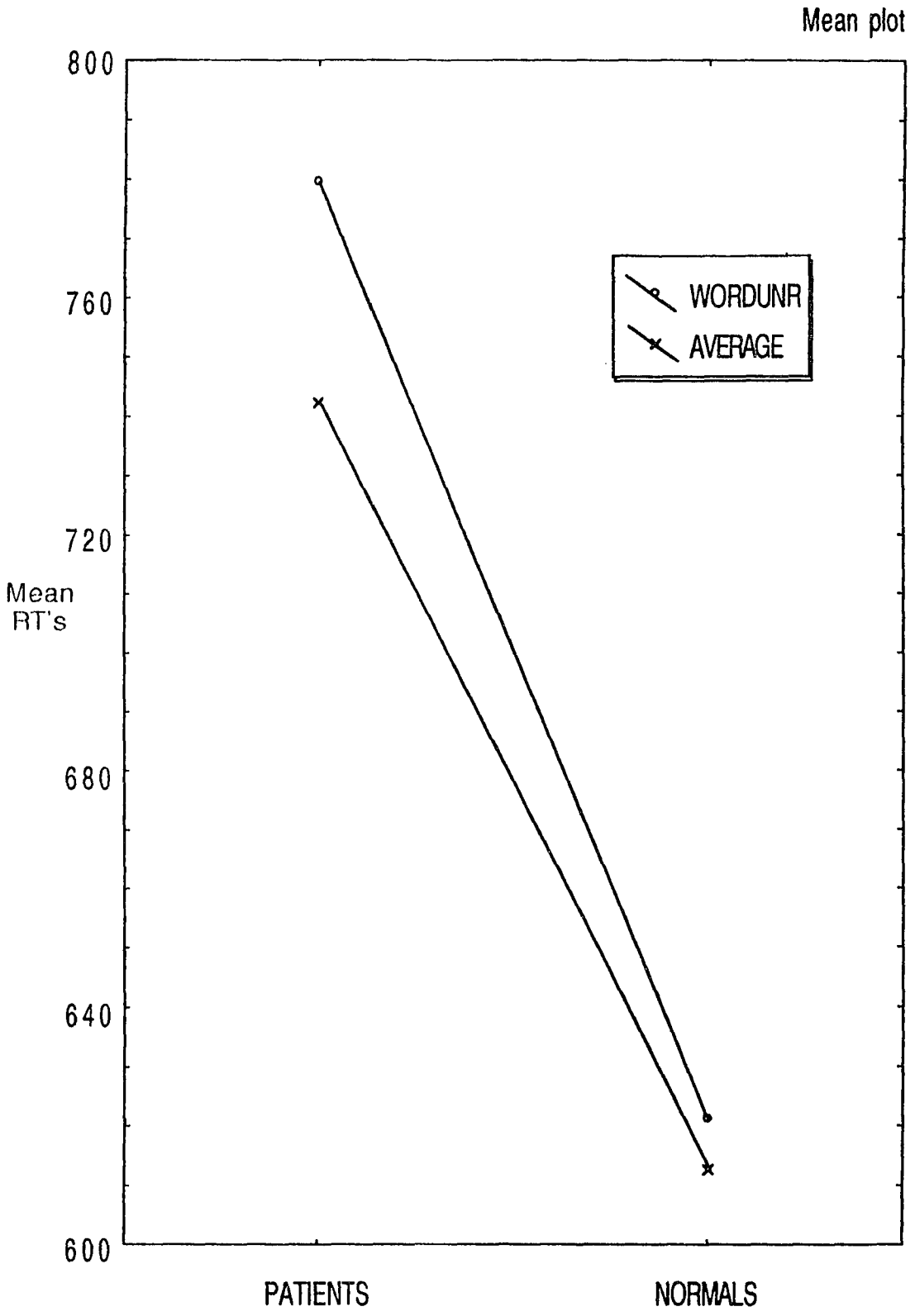

FIGURE 2. Mean reaction times for patients and normals for unrelated words (wordunr) and the average of the Three (prime) word types (homonymy, polysemy, and metaphor).

APPENDIX A

LIKERT SCALE FOR PROFICIENCY IN LANGUAGES OTHER THAN ENGLISH

Please rate your proficiency in the foreign language(s) that you think you know best, using the following scale of 0 (poor) to 4 (excellent).

1. Speaking

0 1 2 3 4

2. Listening comprehension

0 1 2 3 4

3. Writing

0 1 2 3 4

4. Reading

0 1 2 3 4

APPENDIX B

METAPHORIC WORDS

Primes (for RT Task	Targets (for RT Task)			
Targets (Matching Task)	Choices (Matching Task)			
BUG	INSECT	SNAKE	PESTER	RESERVE
BLUE	COLOR	SMELL	SAD	HAPPY
PIG	SLOB	FRUIT	COMEDIAN	ANIMAL
SHARK	BIRD	THIEF	SAILOR	FISH
RAG	CLOTH	PILLOW	TABLOID	CHECK
NUTS	VEGETABLES	CRAZY	RELAXED	SEEDS
DOUGH	BREAD	MEAT	TOWEL	MONEY
PEANUTS	SNACK	SMALL	WHEAT	LARGE
LEMON	FRUIT	FENCE	MINERALS	CAR
DOG	PURSUE	ANIMAL	PLANT	KNOW
BUTTERFLIES	INSECTS	FURNITURE	FUNNY	NERVOUS
SHADES	CURTAINS	SUNGLASSES	EAT	WATCH
EGG	INDUCE	FOOD	FURNITURE	GESTURE
FRESH	OPEN	NEW	FRAYED	BRAT
CHICKEN	BIRD	REPTILE	COWARD	LAZY
WHEELS	BUTTONS	HOUSE	TIRES	CAR
BOOT	CHAIN	KICK	GLUTTON	SHOE
TUBE	STEREO	TELEVISION	CYLINDER	STEM
BANANAS	CRAZY	SNEAKY	FRUIT	CRAZY
GREEN	COLOR	TEXTURE	OLD	NEW

APPENDIX B, Continued

HOMONYMOUS WORDS

Primes (for RT Task	Targets (for RT Task)			
Targets (Matching Task)	Choices (Matching Task)			
ROCK	MINERAL	GAME	SWEEP	SWAY
SCALE	FISH	LEAF	PAINT	BALANCE
PLANT	VEAL	FLOWER	BUILDING	CASTLE
FILE	WATER	TOOL	CABINET	BUSH
BAT	STOOL	VEGETABLE	CLUB	ANIMAL
BILL	TAIL	DOLLAR	SHOE	BIRD
STABLE	STEADY	KITCHEN	HORSE	FAST
POST	FLOAT	MAIL	AFTER	WOOD
BANK	FREEZER	VALLEY	MONEY	RIVER
DECK	ROLL	SHIP	CARDS	DOOR
BOLT	SCREW	SPOON	SWIM	RUN
BALL	DANCE	PARADE	CLOTHING	TOY
COUNT	ADDITION	NOBILITY	SING	NURSE
SEASON	TIME	BURN	PEACE	FLAVOR
DATE	TIME	FRUIT	CALENDAR	POEM
PUNCH	HIT	DRINK	READ	ROSE
SHIP	BOAT	TRACTOR	THROW	SEND
COACH	BUS	TEACH	HELICOPTER	PAINT
PORT	HARBOR	WINE	CITRUS	SUITCASE
PALM	HAND	CABIN	KNIFE	TREE

APPENDIX B, Continued

POLYSEMOUS WORDS

Primes (for RT Task	Targets (for RT Task)			
Targets (Matching Task)	Choices (Matching Task)			
HIDE	CONCEAL	SKIN	VENEER	RUB
PART	SECTION	STAPLE	ROLE	COIL
MOUTH	PEAK	FACE	RIVER	ROOF
LAP	SQUEEZE	PAGES	KNEES	LICK
CHOP	CLEAN	SKIRT	CUT	MEAT
STEP	WALK	DRIVE	RIBBON	STAIR
BOX	TYPE	CONTAINER	STEP	FLIGHT
LIGHT	CABOOSE	STEM	IGNITE	LAMP
SINK	RECEPTACLE	SHED	SUBMERGE	IRON
TRIP	FOUNTAIN	FALL	JOURNE	SIT
NOTE	MESSAGE	SEED	MUSIC	PLAY
CHARM	QUALITY	FLATTER	JEWELRY	DRESS
LETTER	ALPHABET	STAMP	SPOKE	OPERA
PLUG	STOPPER	PUMP	ELECTRIC	HOSE
STUMP	TREE	LEG	PUZZLE	JOKE
BEAN	LADDER	SMILE	PLANK	LIGHT
BLOCK	CUBE	WOOD	STOP	DIVE
SHEET	PAPER	UMBRELLA	BRAID	BED
FORK	ROAD	CLOUD	COMB	UTENSIL
MARCH	JUMP	PROTEST	MONTH	WALK

APPENDIX C

UNRELATED WORDS

KNOB	BUN	ROPE
CLOCK	LEAF	HAND
FERN	COCOON	STONE
CARD	PEPPERS	FISH
APPLE	NYLON	SCREW
PHONE	OAT	PETAL
TREE	PASTA	STOVE
GLASS	OAR	ROSE
TRUCK	TUG	FILTER
SNOW	ONION	RICE
PIT	RUG	BENCH
CUBE	CLOCK	FINGER
FERRY	METAL	CLIP
PEN	ANGEL	CAMEL
SHIRT	NOSE	COAT
BOOK	SCARF	TULIP
HILL	STOVE	COMB
CLOSET	DOOR	BUTTONS
TACK	LAMP	CLAW
PEEL	RING	SHELL

APPENDIX D

NON - WORDS

BLACH	MARST	MONUTS
TALIF	KNILP	PEAW
BANT	NOTUG	FLALS
PUMAR	TRIL	GRUS
POTE	SHIDE	BOUNT
BARCH	MEP	BATSTRO
SCANK	EBURG	LAPAT
COUBLE	GOCH	KNUG
PLALL	NART	TRILM
EBUR	SANIP	DEBLE
PALAP	EUNAB	BLATS
FILAT	CHOLT	BUTTILT
BOAP	SHIGHT	SHEP
EBIAL	KRATTUB	SCIWL
BIST	BLACH	COURF
BEMON	GUTTEL	EDALP
RUBE	TREAM	TRUP
GRUTS	TRALB	GREAM
CHOG	PLUE	BARG
BOOSH	NECKOD	BLARM
PINAS	GRUG	TRIL
WHEEMON	BANUTS	LETTUP
BLEELS	KRARM	BLEALE
BUTTARK	PILT	NOIP

APPENDIX D. Continued

NON-WORDS

FLADE	EDIRT	TALPOA
DEGG	APUNT	BOUTH
SHNUTS	POTEP	TERP
PEADES	THOUB	SCINTH
DOCKEN	CHICH	ARWL
PRAG	BEMAS	TOORF
GRUBE	DEFLA	COULAP
STURG	SCABLE	EDALF
STIDE	NOSAD	BANUTS
TRIDE	PULM	
TROP	RAMUP	
LETTUG	PLILE	
LICH	DEST	
BLART	TROBATS	
CHEAM	MOURT	
SHINK	CHEP	
PLINK	SHEAM	
COAMP	PIBE	
LIRT	BOOMON	
BEARK	SHAROUS	

APPENDIX E

CLASSIFICATION OF NEUROPSYCHOLOGICAL TESTS BY THE SITE PURPORTEDLY ASSESSED BY THESE MEASURES, i.e. LEFT HEMISPHERE, RIGHT HEMISPHERE, ANTERIOR REGIONS, AND POSTERIOR REGIONS

BOSTON DIAGNOSTIC APHASIA EXAMINATION (BDAE)...left, posterior

WISCONSIN CARD SORTING TEST (WCST)...anterior

TRAILS A+B...anterior

STROOP...anterior

FAS (CONTROLLED WORD FLUENCY)...left, anterior

WAIS-R, VERBAL SUBTESTS...left

WAIS-R PERFORMANCE SUBTESTS...right

RAVEN'S PROGRESSIVE MATRICES (RAVEN'S)...right, posterior

WECHSLER MEMORY SCALE (WMS-R), VERBAL SUBTESTS...left

WECHSLER MEMORY SCALE (WMS-R), VISUAL SUBTESTS...right

BOSTON NAMING TEST (BNT)...left

TABLE 1

T-Test values for Independent Samples comparing patients and normals on the three category types. These values correspond to Graph 1.

DEPENDENT VARIABLE	t	df	2-Tailed p
HOMONYM	-.606	36	.547
POLYSEMY	.462	36	.646
METAPHOR	2.905	36	.006

TABLE 2

Reaction Time performance (Mean and S.D.) for patients and normals on the following conditions: homonymous pairs (H), polysemous pairs (P), metaphoric pairs (M1)and literal (M) word pairs.

	PATIENT MEAN	PATIENT S.D.
H	721	269
P	746	281
M1	782	266
M	720	271

	NORMAL MEAN	NORMAL S.D.
H	597	111
P	610	86.8
M1	639	134
M	605	125

TABLE 3

Variable	Standardized Beta Values
VIQ	-1.836
BNT	1.151
TRAILS-B	.658
FAS	.506
WCST-C	.483
RAVEN'S	.377

TABLE 3 Results of the multiple regression analysis for neuropsychological tests and the "metaphor effect" ($F=3.887$, $df=6,8$, $p>.05$, Multiple $R=.863$). The metaphoric-prime target pairs minus the same prime-literal meaning pairs. This shows the significance of the combined performance on tests of abstraction in predicting reaction time differences for metaphoric and literal word pairs, i.e. performance on BNT contributed the most weight to reaction time performance.

TABLE 4

Results of the Analysis of Variance for Matching Performance

	df:	MS_{effect}:	F:	p-level:
Group:	1,36	88.81	1.88	0.18
Word Category:	2,72	29.09	5.63	0.01
Interaction:	2,72	04.82	0.93	0.40

Means of percent correct for patients and normals, by categories:

	Homonymy	Polysemy	Metaphor
Patients:	93.9	92.1	93.2
Normals:	95.6	94.2	94.2

Table 4. ANOVA results for matching performance showed no main effect for group, though significant differences were noted among categories for both groups.

BIBLIOGRAPHY

Army Individual Test Battery, Manual of directions and scoring (1944). Washington, D.C.: War Department, Adjutant General's Office.

Beardsley, M.(1962) The metaphorical twist. Philosophy and Phenomenological Research 22 (3), 293-307.

Benton, A. L. and Hamsher, K.deS. (1978) Multilingual Aphasia Examination, revised manual. Iowa City: University of Iowa.

Brown, J.W. (1995) Process and Creation. In: Sahlin, N.-E. and Andersson, A. (Eds.) Cognition and Creativity

Britton, B.K. (1978) Lexical ambiguity of words used in English text. Behavior Research Methods and Instrumentation, 10, 1-7.

Brownell, H.H., Potter, H.H., Michelow, D., and Gardner, H. (1984) Sensitivity to lexical denotation and connotation in brain damaged patients: a double dissociation? Brain and Language 100, 717-729.

Brownell,H.H., Gardner, H., Prather, P., and Martino, G. (1994) Language, communication, and the right hemisphere. In: Handbook of Neurological Speech and Language Disorders, pp. 325-349. New York: Marcel Dekker.

Brownell, H.H., Simpson, T.L., Bihrle, A.M., Potter, H.H., and Gardner, H. (1990) Appreciation of metaphoric alternative word meanings by left and right brain damaged patients. Neuropsychologia, vol. 28, no.4, 375-383.

Burgess, C. and Simpson, G.B. (1988) Cerebral hemispheric mechanisms in the retrieval of ambiguous word meanings. Brain and Language 33, 86-103.

Burgess, C, Tannenhaus, M.K., and Seidenberg, M.S. (1989) Context and lexical access: implications of non-word interference for lexical ambiguity resolution. Journal of Experimental Psychology:Learning, Memory, and Cognition, 15, 620-632.

Cairns, H.S. and Hsu, J.R. (1980) Effects of prior context upon lexical access during sentence comprehension: A replication and reinterpretation. Journal of Psycholinguistic Research, 9, 1-8.

Cairns, H.S. and Kamerman, J. (1975) Lexical information processing during sentence comprehension. Journal of Verbal Learning and Verbal Behavior 14, 170- 179.

Caramazza, A. and Grober, E. (1976) Polysemy and the structure of the subjective lexicon. In C. Rameh (Ed.), Georgetown University Roundtable on Language and Linguistics Washington, D.C.: Georgetown University Press.

Carpenter, P.A. and Daneman, M. (1981) Lexical retrieval and error recovery in reading: A model based on eye fixations. Journal of Verbal Learning and Verbal Behavior, 20, 137-160.

Chiarello, C. (1988). Semantic priming in the intact brain: Separate roles for the right and left hemispheres? In C. Chiarello (Ed.), Right hemisphere contributions to lexical semantics. New York: Springer-Verlag.

Colombo, L. and Flores d'Arcais, G.B. (1984) The meaning of Dutch prepositions: A psycholinguistic study of polysemy. Linguistics 22, 51-98.

Conrad, C. (1974) Context effects in sentence comprehension: a study of the subjective lexicon. Memory and Cognition, 2, 130-138.

Deane, P.D. (1988) Polysemy and cognition. Lingua 75, 325-361.

Durkin, K., Crowther, R.D., and Shire, B. (1986) Children's processing of polysemous vocabulary in school. In: K. Durkin (Ed.), Language development in the school years (pp. 77-94) London: Croom Helm.

Durkin, K. and Manning, J. (1989) Polysemy and the subjective lexicon: semantic relatedness and the salience of intraword sentences. Journal of Psycholinguistic Research vol. 18, no. 6, 577-612.

Eson, M.E., Yen, J.K., and Bourke, R.S. (1978) Assessment of recovery from serious head injury. , Journal of Neurology, Neurosurgery, and Psychiatry 41, 1036-1042.

Forster, K.I. (1979) Levels of processing and the structure of the language processor. In W.E. Cooper and E. Walker (Eds.) Sentence Processing: Psycholingustic studies presented to Merrill Garrett (pp. 27-85). Hillsdale, NJ: Erlbaum.

Forster, K.I. (1981) Priming and the effects of sentence and lexical contexts on naming time: Evidence for autonomous lexical processing. Quarterly Journal of Experimental Psychology, 33A, 65-495.

Foss, D.J. (1970) Some effects of ambiguity upon sentence comprehension. Journal of Verbal Learning and Verbal Behavior, 9, 699-706.

Frost, R., Feldman, L.B., and Katz, L. (1990 Phonological ambiguity and lexical ambiguity: effects on visual and auditory word recognition. Journal of Experimental Psychology vol 16, 569-580.

Gagnon, L., Goulet, P., Joanette, Yves. (1994) Semantic processing of ambiguous words after a right hemisphere lesion. Poster presented at the International Neuropsychological Society. Angers, France.

Gardner, H., Brownell, H., Wapner, W., and Michelow, D. (1983). Missing the point: the role of the right hemisphere in the processing of complex linguistic materials. In E. Perecman (ed.), Cognitive Processes in the Right Hemisphere, 169-191.

Gardner, H. (1994). The stories of the right hemisphere. In W. Spaulding (Ed.) , Forty-first Nebraska symposium on motivation, 1992-1993. Lincoln, NE: University of Nebraska Press.

Gazzaniga, M.S. (1983) Right hemisphere language following brain bisection: A 20-year perspective. American Psychologist, 38, 525-537.

Gernsbacher, M.A. (1984) Resolving 20 years of inconsistent interactions between lexical familiarity and orthography, concreteness, and polysemy. Journal of Experimental Psychology:General, vol. 113, no. 2, 256-281.

Gilhooly, K.J. and Logie, R.H. (1980) Meaning-dependent ratings of imagery, age of acquisition, familiarity, and concreteness for 387 ambiguous words. Behavior Research Methods and Implementation. 2, 428-450.

Glucksberg, S. Kreuz, R.J., and Rho, S.H. (1986) Context can constrain lexical access: Implications for models of language comprehension. Journal of Experimental Psychology: Learning, Memory, and Cognition. 12, 323-335.

Grober, E. (1976) Polysemy: Its implications for a psychological model of meaning, Unpublished Ph.D. dissertation, Johns Hopkins University.

Goldstein, K. (1948) Language and Language Disturbances Grune and Stratton, New York.

Gorfein, D.S., Viviani, J.M., and Leddo, J. (1982) Norms as a tool for the study of homography. Memory and Cognition, 10, 503-509.

Grant, D.A. and Berg, E.A. (1948) A behavioral analysis of degree of reinforcement and ease of shifting to new responses in a Weigl-type card-sorting problem. Journal of Experimental Psychology, 38, 404-411.

Harris, A.J. (1958). Harris Tests of Lateral Dominance. Manual of directions for administration and interpretation (3rd ed.,). New York: The Psychological Corporation.

Holley-Wilcox, P., and Blank, M.A. (1980) Evidence for multiple access in the processing of isolated words. Journal of Experimental Psychology: Human Perception and Performance, 6, 75-84.

Holmes, V.M., Arwas, R., and Garrett, M.F. (1977) Prior context and the perception of lexically ambiguous sentences. Memory and Cognition, 5, 103-110.

Holmes, V.M.(1979) Accessing ambiguous words during sentence comprehension. Quarterly Journal of Experimental Psychology, 44, 13-35.

Jastrzembski, J.E. and Stanners, R.F. (1975) Multiple word meanings and lexical search speed. Journal of Verbal Learning and Verbal Behavior 14, 534-537.

Jastrzembski, J.E. (1981) Multiple meanings, number of related meanings, frequency of occurrence, and the lexicon. Cognitive Psychology, 13, 278-305.

Kaplan, E., Goodglass, H., and Weintraub, S. (1983) Boston Naming Test. Pa: Lea and Febiger.

Katz, W.F. (1988) An investigation of lexical ambiguity in Broca's aphasics using an auditory lexical priming technique. Neuropsychologia vol. 26, no 5, 747-752.

Kertesz, A. (1982) Western Aphasia Battery. Ontario: The Psychological Corporation.

Krashen, S.D. (1976) Cerebral asymmetry. In H. Whitaker and H. Whitaker (Eds.) Studies in Neurolinguistics New York: Academic Press. Vol. 2, 157-191.

Lakoff, G. (1993) The contemporary theory of metaphor. In: Ortony, A. (Ed.) Metaphor and Thought Cambridge University Press: New York.

Lezak, M.D. (1995) Neuropsychological Assessment, second edition, Oxford University Press: New York.

Luria, A.R. (1966) Higher Cortical Functions in Man, Basic Books, New York.

Meyer, D.E. and Schvaneveldt, R.W. (1971) Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. Journal of Experimental Psychology, 90, 227-234.

Milberg, W., Blumstein, S.E., and Dworetzky, B. (1987) Processing of lexical ambiguities in aphasia. Brain and Language 31, 138-150.

Millis. M.L. and Button, S.B. (1989) The effect of polysemy on lexical decision time: now you see it, now you don't. Memory and Cognition, 17(2) 141-147.

Miyake, A., Just, M.A., and Carpenter, P.A. (1994) Working memory constraints on the resolution of lexical ambiguity: maintaining multiple interpretations in neutral contexts. Journal of Memory and Language 33, 175-202.

Nickerson, C.A. and Cartwright, D.S. (1984) The University of Colorado meaning norms. Behavior Research Methods, Instruments, and Computers, 16, 355-382.

Oden, G.L. and Spira, J.L. (1983) Influence of context on the activation and selection of ambiguous word senses. Quarterly Journal of Experimental Psychology 35A, 51-64.

Olsen, J.N. and MacKay, D.G. (1974) Completion and verification of ambiguous sentences. Journal of Verbal Learning and Verbal Behavior, 13, 457-470.

Onifer, W. and Swinney, D.A. (1981) Accessing lexical ambiguities during sentence comprehension: Effects of frequency of meaning and contextual bias. Memory and Cognition, 9, 225-236.

Pontius, A.A. and Yudowitz, B.S. (1980) Frontal lobe system dysfunction in some criminal actions as shown in the Narrative Test. Journal of Nervous and Mental Disease 168, 111-117.

Raven, J.C. (1960) Guide to the Standard Progressive Matrices. London: H.K. Lewis.

Rubenstein, H., Garfield, L., and Millikan, J.A. (1970) Homographic entries in the internal lexicon. Journal of Verbal Learning and Verbal Behavior 9, 487-494.

Rubenstein, H., Lewis, S.S., and Rubenstein, M.A. (1971) Homographic entries in the internal lexicon: Effects of systematicity and relative frequency of meanings. Journal of Verbal Learning and Verbal Behavior 10, 57-62.

Schuberth, R.E., Spoehr, K.T., and Lane, D.M. (1981) Effects of stimulus and contextual information on the lexical decision process. Memory and Cognition, 9, 68-77.

Schvaneveldt, R.W., Meyer, D.E., and Becker, C.A. (1976) Lexical ambiguity, semantic context, and visual word recognition. Journalof Experimental Psychology: Human Perception and Performance, 2, 243-256.

Searleman, A. (1977) A review of right hemisphere linguistic capabilities. Psychological Bulletin vol. 84, no. 3, 503-528.

Seidenberg, M.S., Tanenhaus, M.K., Leiman, J.M., and Bienkowski, M. (1982) Automatic access of the meanings of ambiguous words in context: Some limitations of knowledge-based processing. Cognitive Psychology, 14, 489-537.

Simpson, G. B. (1981) Meaning dominance and semantic context in the processing of lexical ambiguity. Journal of Verbal Learning and Verbal Behavior, 20, 120-136.

Simpson, G.B. (1984) Lexical ambiguity and its role in models of word recognition. Psychological Bulletin vol. 96, no. 2. 316-340.

Simpson, G.B, and Burgess, C. (1985) Activation and selection processes in the recognition of ambiguous words. Journal of Experimental Psychology: Human Perception and Performance, 11, 8-39.

Simpson, G.B., Burgess, G.B., and Peterson, R.R. (1988) Human comprehension processes and the indeterminacy of meaning. Cognitive Systems Vol. 2 (2), 213-232.

Stroop, J.R. (1935) Studies of interference in serial verbal reactions. Journal of Experimental Psychology, 18, 643-662.

Swinney, D.A. (1979) Lexical access during sentence comprehension: (Re)consideration of context effects. Journal of Verbal Learning and Verbal Behavior, 18, 645-659.

Swinney, D.A. and Hakes, D.T. (1976) Effects of prior context upon lexical access during sentence comprehension. Journal of Verbal Learning and Verbal Behavior, 15, 681-689.

Swinney, D.A. (1982) The structure and time-course of information interaction during speech comprehension: Lexical segmentation, access, and interpretation. In: J. Mehler, E.C.T. Walker, and M. Garrett (Eds.) Perspectives on Mental Representation: Experimental and Theoretical Studies of Cognitive Processes and Capacities, Hillsdale, N.J.: Lawrence Erlbaum.

Tompkins, C. (1990) Knowledge and strategies for processing lexical metaphor after right or left hemisphere brain damage. Journal of Speech and Hearing Research, vol. 33, 307-316.

Tsuzuki, T. (1993) Effects of context-dependent and context-independent associative strength between prime and target words the processing of lexical ambiguity. The Japanese Journal of Psychology, vol. 64, no. 3, 191-198.

Underwood, G. (1980) Stimulus encoding and memory. Journal ofExperimental Psychology, 94, 90-100.

Wechsler, D.(1981) WAIS-R manual. New York: Psychological Corporation.

West, R.F. and Stanovich, K.E. (1982) Source of inhibition in experiments on the effect of sentence context on word recognition. Journal of Experimental Psychology: Learning, Memory, and Cognition, 8, 385-399.

Winner,E. and Gardner, H. (1977) The comprehension of metaphor in brain-damaged patients. Brain 100, 719-727.

Zachary, R. (1991) Shipley Institute of Living Scale Manuel. CA: Western Psychological Services.

Ziff, P. (1967) Some comments on Mr. Harmon's confabulations. Foundations of Language, 3, 403-408.