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# Priming access to natural-object and trait category hierarchies on pronunciation, lexical decision, and category verification tasks

John F. Calabrese
*University of New Hampshire, Durham*

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Calabrese, John F., Ph.D.

University of New Hampshire, 1989

U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

# PRIMING ACCESS TO NATURAL-OBJECT AND TRAIT CATEGORY HIERARCHIES ON PRONUNCIATION, LEXICAL DECISION, AND CATEGORY VERIFICATION TASKS

by

John F. Calabrese
B.A. Plymouth State College, 1981
M.A. New York University, 1985
M.A. University of New Hampshire, 1987

DISSERTATION

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This dissertation has been examined and approved.

Dr. Victor A. Benassi,
Dissertation Director,
Chairman of the Department of Psychology,
Associate Professor of Psychology

Dr. John E. Limber
Associate Professor of Psychology

Dr. John A. Nevin
Professor of Psychology

Dr. Albrecht W. Inhoff
Associate Professor of Psychology at
State University of New York at Binghamton

Dr. Robert S. Miller
Professor of Psychology at
Plymouth State College

Date 10/10/89

# DEDICATION

This disseration is dedicated to my family,
my parents Florence and Alphonse,
my grandmother Helen,
my brothers and sisters,
and all of my nieces and nephews.

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ABSTRACT

PRIMING ACCESS TO NATURAL-OBJECT AND TRAIT HIERARCHIES ON PRONUNCIATION, LEXICAL DECISION, AND CATEGORY VERIFICATION TASKS

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Lexical decision, pronunciation, and category verification response times (RTs) to natural object and trait hierarchies were measured. Prime and target words consisted of both superordinate and subordinate object and trait category members. Trait words were categorized as desirable and undesirable (Hampson, et al., 1986). Subjects' RTs to object and undesirable trait words displayed similar patterns. In all experiments, RTs to natural-object subordinate target words were significantly more rapid compared to superordinate words. This same pattern also true for the undesirable traits, but reached significance in only the lexical decision task. The facilitation effect of the prime reached significance for the natural-objects in the category verification experiment and for the undesirable traits in the lexical decision experiment. This pattern of facilitation by the prime were consistent for natural-objects and undesirable traits across all experiments. In each experiment the opposite pattern of results were found for desirable traits. In the pronunciation and lexical decision experiments RTs to desirable superordinate trait words were significantly more rapid compared to desirable subordinate trait words. In all experiments the facilitation by desirable superordinate trait word primes was significantly greater compared to undesirable superordinate trait words. Post-experiment questionnaires indicated that subjects judgment of the logical hierarchy entailment asymmetries were highly consistent with the norms. Regression analysis of subjects' judgments of the logical entailment between category stimulus pairs indicated no significant systematic relationship. Implications for research on attribution, category memory, and clinical research on cognitive assessment are discussed.

# INTRODUCTION

This dissertation is about categorical memory. Categorical memory is a result of coding continuous stimuli into discrete groups that establish an equivalency between the group members. That process has probably been most researched in the areas of color and speech perception. Colors are composed of combinations of continuously varying physical wavelengths. People can separate colors into discrete categories by identifying the "apparent hue" of the wavelength. They can also discriminate two different hues of yellow as more alike than a third color that has a different dominant wavelength (Christman, 1971). Individuals also have the ability to categorize variable vocalizations (Miller, 1981). For example, the physical resonating frequency (formant) of the consonant "d" is different in the vocalization of "du" and "di". Yet, they are perceived as the same vocalized consonant. In each of these cases the established equivalencies constitute the categories. The present investigation is limited to semantic categories, rather than categories related to more rudimentary perceptual stimuli, imagery, or motors movements. However, the same concept of categorical organization can be applied when describing semantic categorical memory. Equivalency in semantic memory is conceived to be a function of the associative connections between category members. Just as different hues of yellow can be categorized together, some semantic category members may be more closely associated than others. Just as different hues of yellow can be discriminated, connections among members within a semantic categorical structure are not necessarily equal. Such asymmetries may be the result of direct experience with stimuli, the application of different combinatorial rules during the classification of stimuli, or the elaboration of previously stored mental representations. A common theme that emerges from the research on semantic category memory is the view that information may somehow be separated along an abstract-concrete dimension. This dissertation describes four experiments comparing the associative relationship within abstract-trait (abstract) and natural-object (concrete) category hierarchies. A category hierarchy refers to a particular association between category members. Category members whose meaning entails other members of the category are considered to be abstract reference points of the category. These abstract category members are referred to as superordinates. Members that are entailed by the superordinate are referred to as subordinates. For example, vehicle entails car, because all cars are vehicles but not all vehicles are cars. The specific intention of the experiments reported in this dissertation was to compare the within-category associative relationship of superordinate and subordinate category members of natural-object categories and abstract trait categories. The central issue was whether the associative relationships generated by a hierarchical category organization are constant. That is, although the information that is contained in natural-object and trait categories is qualitatively different, are within-category associations among superordinate and subordinate category members comparable?

Before addressing this specific question, I will discuss the philosophical thought and empirical work that forms the rationale for even postulating the existence of abstract and concrete categorical mental representations. Chapters I and II address two epistemic issues raised by the postulation of mental representation and mental categories and report empirical work supporting the theoretical concepts. In chapter I the reader is introduced to the term "mental codes" and to the assumption these mental codes imply biological states. This is followed in chapter II with a discussion of the utility of recoding information in memory. Chapter III reviews various properties of category memory that have been proposed. Chapter IV discusses the notion of hierarchical relations between discrete category members, and reports empirical research that has considered the implication of a strict logical classification scheme for information processing theories of category memory. It discusses research on memory for trait information and the normative trait categories that have been the subject of recent research. Finally, the rationale for the specific empirical work reported in this dissertation is presented along with an explanation and theoretical discussion each dependent measures employed. The results and discussion of the experiments follow in Chapter V. Chapter VI is a general discussion of the pattern of results across the experiments.

# CHAPTER I

# MENTAL CODES

## A. Introduction to Mental Codes

As long ago as 350 B.C. Aristotle believed that remembering was determined not only by the contents of information stored in memory, but by the arrangement of that information (Herrnstein & Boring, 1965). Aristotle believed that this arrangement was determined by the doctrine of association. Later theories of knowledge, developed by the British empiricists (e.g., Hobbes, 1651; Locke, 1700; Berkeley, 1709, as in Herrnstein & Boring, 1965), similarly held that the organization of knowledge strictly reflected the empirical facts of the environment. Hartley (1749, in Herrnstein & Boring, 1965) was the first of 18th century British empiricists to express the belief that some memory representations serve the function of organizing symbols. He stated that certain "ideas" are associated such that together they form a collective idea that "performs the office of a symbol to the rest, suggests them, and connects them together." This notion of converging associations was further stressed by James Mill (1829, in Herrnstein & Boring, 1965) when he stated: "that they appear not many ideas, but one idea, we owe, as I shall afterwards more fully explain, the power of classification, and the advantage of language." But it was John Stuart Mill (1843, in Herrnstein & Boring, 1965) who first explicitly emphasized the unique status of certain memory representations. He states: "it is proper to say that the simple ideas generate, rather than they compose, the complex ones." In contemporary cognitive theory, complex mental processes are assumed to involve the manipulation of symbols--mental codes of the objective world. These mental codes are viewed as the interface between the external environment and internal neural hardware. They are stored information that is assumed to underlie a perceiver's faculty for a diversity of complex cognitive operations involved in pattern recognition (Reed, 1972), object classification (Rosch, 1978), language comprehension (Slobin, 1979), and social categorization (Brown, 1986). Understanding the mental processes related to the organization and manipulation of these memory codes represents the fundamental challenge for cognitive psychology.

Most cognitive scientists agree that biological causes underlie behavior. This supposition acknowledges that all mental activity corresponds to the activity of the brain. Neural impulses received, integrated, and transmitted throughout the nervous system that correspond to the manipulation of information in memory are functionally conceived of as specialized memory codes. Therefore, memory is assumed ultimately to exist as neural activity.

Important research has been conducted that supports this assumption. Posner (1988) describes a general framework for understanding the connections between "cognitive systems and neurosystems." He places emphasis on the importance of understanding interactions between the different levels of neural activity that correspond to cognitive functions varying in complexity. He acknowledges that these interactions will be ultimately understood to the extent that measurements of cognitive operations can be related to changes in the activity of nerve cells. Significant progress in this area has been made in research on visio-spatial attention in animals, normal humans, and brain-injured patients (Berlucchi & Rizzolatti, 1987; Posner & Martin, 1985; Posner, Inhoff, Friedrich, & Cohen, 1987; Posner & Cohen, 1989). This type of convergence of neurological and cognitive sciences is seen by many as an "inescapable" (Gazzaniga, 1984) part of the effort to identify neurophysiological correlates of complex cognitive functions.

One very important theoretical convergence between cognitive and neurological approaches to the study of memory is the concept of hierarchical organization. For example, in neurology descriptions of cell assemblies and large neural networks are commonly conceived of as being composed of underlying subsystems from which information is abstracted through converging neural signals (e.g., visual system and the reticular activating system). According to cognitive theories, "mental codes" generated through the same process of abstraction, where complex mental operations entail peripheral subordinate levels of processing through which raw sensory data are reorganized (recoded) into in a more condensed form. Critical to the usefulness of the cognitive-functional description is the ability to experimentally isolate the functional codes that underlie memory and mental operations.

B. Isolating Mental Codes

The recognition of the peripheral independence of sensory data is the fundamental basis for postulating the independence of memory codes (e.g., acoustic, visual, etc.). Rudimentary sense data can be differentiated by the form of physical energy that stimulates the various sensory receptors. For example, the most basic differentiation between visual sense data and auditory sense data is the physical fact that the chemical alterations resulting from the bombardment of photons on the retina and the displacement of the tympanic membrane by sound waves represent mutually exclusive sensory stimuli. Memory codes can also be functionally discriminated. Internal codes may correspond to motor, imaginal, or symbolic (linguistic) functions (Posner, 1978). Probably the most obvious evidence that memory codes are discriminable beyond the peripheral sensory stages of processing are clinical observations of cognitive and linguistic deficits in brian-damaged patients, and in research on specialization of brain functions.

It has been long recognized that much language processing is separate from motor control of the facial muscles and speech structures. In his descriptions of memory deficits following head injury, Jackson (1878) pointed out that patients did not lose words following injury. Rather, they lost the ability to use those words to communicate meaning. By this he implied that linguistic ability did not only include one's memory for words and their meaning, but also included mental representations of abstract linguistic codes necessary to comprehend and produce language. Several recent studies supported the original insights of Jackson (1878) and further identified specific linguistic deficits associated with aphasias (Grossman & Habermas, 1982; Friederici, 1983; Swinney, Zurif, Rosenberg, & Nicol, 1984; Villardita, 1987). For example, it is currently believed that Broca's aphasia is associated with deficits in the interpretation of grammatical codes and Wernicke's aphasia with deficits in lexical access (Berndt and Caramazza, 1981).

Static anatomical descriptions and clinical observations are only indirect indicators of the isolability of mental codes. More compelling evidence is reported in research that utilizes on-line chronometric measurements to isolate distinct brain systems involved in the discrimination of different stimuli. Mental chronometric analyses have been frequently used in cognitive and neuropsychological research examining the specialization of brain functions. This research has lead to the widely accepted generalization that, for most individuals, the left cerebral hemisphere is functionally specialized for language processing and the right hemisphere is specialized for spatial processing. For example, Geffen, Bradshaw, and Nettleton (1972) found that on name-match tasks subjects' response times (RTs) were fastest when stimuli were presented to the left hemisphere. Similar findings were also found for the auditory system with tasks requiring phonetic processing (Kimura, 1967). Hemispheric specialization for processing particular types of stimulus information has also been demonstrated in chronometric studies of evoked potentials. In these studies evoked potentials are time-locked to specific perceptual and linguistic identification tasks. For example, Wood (1975) required subjects to perform a recognition task on phonetic information (place of articulation) in one condition, and in an other condition on physical aspects of stimuli (pitch). For judgments that required linguistic analysis left hemisphere evoked potentials were of significantly longer duration than right hemisphere evoked potentials (Wood, 1975) (see Donchin (1984) for a complete review of current the cognitive psychophysiological research with evoked potentials). Most compelling is recent positron emission typography (PET) research that has provided "on-line" discrimination of subjects physiological brain activity during tasks involving the presentation of linguistic stimuli through different sensory modalities (Petersen, Fox, Posner, Mintum, and Raichle, 1988).

Consistent with studies of brain functioning are cognitive data that demonstrate that peripherally independent codes (i.e., phonological, orthographic, etc.) are isolable at later stages of processing. Posner and Mitchell (1967) conducted a chronometric analysis that demonstrated the influence of both phonetic and orthographic codes. Subjects where required to indicate if two letter stimuli presented simultaneously had the "same" or "different" names. The researchers reported that RTs were longer for stimuli that shared a common name but were physically dissimilar (i.e., "A" and "a") compared to physically identical stimuli (i.e., "A" and "A"). It was interpreted that more rapid decisions were possible in the second case because physical stimulus information alone was necessary for a decision. For the physically different stimuli ("A" and "a"), the longer latency was interpreted to be due to the necessity of activating the linguistic names in order to make the decision, or at least the necessity of ignoring the obvious orthographic dissimilarity between stimuli. Thorson, Hochhaus, and Stanners (1976) demonstrated a time differential between the processing of visual letter stimuli and acoustic phonetic stimuli. They found that visual confusability of stimuli was evident in RTs less than one second and acoustic confusability affected RTs beyond a one second response delay. Van Orden (1987, 1988) recently reported more compelling evidence of the independence of orthographic and phonological codes at the word level of language processing. The study involved a categorization task using stimuli that consisted of letter homophones that were orthographically distinct (i.e., "Rose" and "Rows"). He was primarily interested in the time-course of phonological code activation compared to orthographic activation after the presentation of visual word stimuli. Van Orden (1987) reported data from three experiments supporting the view that phonological and orthographic codes are both involved in word identification. Importantly, the data indicated that phonological mediation extended beyond the pre-lexical stage of processing. Van Orden (1988) utilized a typical priming paradigm. Subjects were presented a pair of words in rapid sequence. They were required make a decision about the stimuli and respond vocally or by depressing a key to indicate their response. Latency of a response was the dependent measure. Van Orden (1988) was interested in determining if the orthographic similarity of a word to its homophonic category name would affect the frequency of false positive responses in a category verification task. In the first of four experiments, Van Orden (1988) compared homophones that were orthographically similar and orthographically dissimilar to their homophonic category name. A control condition included orthographically similar nonhomophones. The first word (prime) of the stimulus pair that subjects were presented was the category name, the second (target) was the homophone. Subjects were required to vocally indicate with a "yes" or "no" if the target word was a category exemplar of the first word. Results indicated that the mean percentage of false positive responses for both homophone conditions was significantly greater than that for the orthographically similar nonhomophone controls. The frequency of subjects false positive responses to the orthographically more similar homophone condition were significantly greater in comparison to the less similar homophone condition. Van Orden (1988) argued this as a demonstration that phonological activation can not be considered a "latecomer" to word identification processes. Moreover, the data argue for models of word activation that account for the influence of phonological codes on word identification.

C. Isolation of Concrete and Abstract Codes

The isolation of modality specific codes illustrates one dimension on which memory codes can be discriminated. There are, however, other qualitative differences between memory codes have been long recognized. Aristotle originally identified the "laws of association" that attempted to explain how different objective events affected associative connections in memory. The fact that humans can identify physical objects such as "chairs", or express an understanding of how it is that one behaves with "integrity", while only having been exposed to particular objects of instances of behaviors, has been cited as a problem for this simple associationist theory of memory. Contemporary theories echoing a theme similar to Plato's belief in "universals" have proposed "special" associative relationships to account for memory for recall and recognition performance with category information (Posner, 1978). Selz (in Mandler & Mandler, 1964) proposed a special superordinate associative relationship as a property of memory that accounts for recall and recognition performance with category information. This distinction has repeatedly emerged in theorizing on the underlying properties of word associations (Wundt, 1907; Jakabson, 1971; Desse, 1965, Coltheart, 1980). There is considerable clinical and experimental data supporting the idea that associative relationships between abstract and concrete representations reflect the organization of that information in memory. Clinical observation of linguistic output errors of patients with deep dyslexia indicate differential frequencies of retrieval of abstract and concrete (superordinate and subordinate) words (Coltheart, 1980). Specifically, the errors observed are related to the semantic similarities between the stimulus words a patient is asked to read and the patient's response. Superordinate errors refer to associative responses to stimulus words that are within-category word substitutions. Such errors represent abstractions from the entire category of which the stimulus word is a member. The superordinate substitution error, therefore, includes features of the stimulus word, plus other features that would be associated with other members of the category. For example, a patient might read the stimulus word "cattle" as "animal." Subordinate errors are the result of the patient substituting a words that is lower in the category hierarchy, and may be described as having discriminating features not specifically associated with the stimulus word. The superordinate type errors are by far more frequent (Coltheart, 1980). Recently, Kudo (1987) described these errors and other type of linguistic errors as reflecting a general loosening of the hierarchical organization of categories.

Experimental work in cognition has discriminated between abstract and concrete memory codes using chronometric paradigms. James (1975) conducted four experiments that examined the quality of information accessed during a lexical decision task when frequency, concreteness, and the type distractor used in the task were varied. The central interest of his research was to determine if semantic information was accessed during a lexical decision. Results showed that when pronounceable distractor words were used, concrete words were named faster than abstract word. In another lexical decision experiment

James (1975) used nonpronounceable letter stings as distractors. James argued that nonpronounceable distractors (i.e., "tnu"), compared to pronounceable nonword distractors (i.e., "tun"), encourage a less stringent decision criterion and result in a faster RT, since the nonpronounceable distractors could be rejected based on visual or phonological information alone. James' predictions were confirmed. Moreover, when nonpronounceable nonwords were used only word frequency affected RTs. The concreteness effect demonstrated in the previous experiments was eliminated. James (1975) concluded that when nonpronounceable nonword distractors are used in a lexical decision task semantic information is not accessed. This conclusion implies that the RT tasks that discriminated between abstract and concrete information were reflecting a property of semantic memory. Other researchers have attempted to explain the RT relationship of abstract and concrete words within the broader context of categorical memory.

Loftus and Bolton (1974) measured the latency to vocally produce the names of natural object category words after being exposed to a superordinate and subordinate primes (e.g., vehicle and car). Prime words were selected from Battig and Montague's (1966) norms. They found that subjects vocally produced subordinate category members faster than the superordinate members. They argued that the faster response times for subordinate responses reflect a general bias for unidirectional access of subordinate category members.

Bleasdale (1987) argued that abstract and concrete codes are separated in memory. He used a priming pronunciation task in his first experiment. Subjects were presented 117 abstract and 117 concrete object words taken from Pavio, Yuille, and Madigan's (1968) norms. Abstract and concrete primes and targets were orthogonally varied. Results indicated priming only for homogeneous pairs (i.e., abstract-abstract and concrete-concrete prime-target combinations). Bleasdale (1987) conducted another similar study only this time involving a lexical decision task. RTs on lexical decision task showed a priming effect for both homogeneous (Abstract-Abstract and Concrete-Concrete) and heterogeneous (Abstract-Concrete and Concrete-Abstract) prime-target conditions. The greatest amount of priming (viz., the most facilitation of RT through exposure to a prime) occurred when the prime was a concrete word and the target was an abstract word (Concrete-Abstract condition). The greatest amount of inhibition (viz., an attenuation of the priming effect) was found where abstract words were used as primes (Abstract-concrete and Abstract-abstract conditions). In another study Bleasdale (1987) was interested in determining attentional effects on subjects RTs. In a lexical decision task, a single letter mask followed the prime by 50 milliseconds (msec) and the target presentation followed the mask by 167 msec (Posner and Snyder, 1975, argue that attentional properties do not become evident until a stimulus onset asyncrony of about 300 msec). This manipulation was expected to eliminate any facilitation by the prime that was resulting from post-lexical attentional activation. The results showed no significant facilitation by the prime was for any of the conditions. However, the data did show a pattern of fastest RTs in the Concrete-Concrete and Abstract-abstract conditions. The data from these experiments were interpreted collectively to suggest a closer verbal associations between homogeneous prime-target pairs than heterogeneous pairs. This was attributed to the unique organizations of abstract and concrete information and the separation of these codes in memory.

Kroll and Mervis (1986) used a lexical decision to compare RTs to abstract and concrete words. Their results were consistent with those reported by Bleasedale (1987). Namely, they found subjects' lexical decision RTs were faster for concrete than abstract words. This speed advantage was also demonstrated in an experiment which included blocked trials of lexical decision to abstract and concrete words. Under these conditions RTs were significantly longer for a block of lexical decisions trials with abstract words that were preceded by a block of lexical decision with concrete words (Concrete-abstract condition). This was not true when an abstract block preceded a concrete block (Abstract-concrete). Kroll and Merves (1986) concluded lexical decisions performed on concrete words somehow inhibited performance on the identical immediately following task with abstract words.

A similar finding was reported by Hines Czerwinski, Sawyer, and Dwyer (1986). The researchers used a pronunciation priming task. Prime and target words consisted of Battig and Montague's (1969) first and fifth category exemplars norms. The presentation order of the exemplars was varied. RTs were significantly faster in the condition where the first category exemplar was the prime.

This chapter reported data from neuroclinical, experimental neuropsychological, and cognitive research supporting the argument that memory codes underlying mental operations are discriminable. The codes were discriminated by sensory modality and by their within-category associative relationships. The following discussion in Chapters II and III assumes the existence of these mental codes and focus on the utility of categorical codes for cognition.

# CHAPTER II

# MEMORY CODES AS CATEGORICAL ORGANIZATIONS

## A. Utility of Categories in Cognition

The ability to discriminate between various environmental stimuli is basic to survival. The fact that the number of discriminably different stimuli in the environment is virtually infinite makes that a formidable task. Recognition of these facts and the knowledge that human information processing capacity is not infinite (Triesman, 1969; Johnson and Heinz, 1974; Posner and Boies, 1971; Broadbent, 1971; Heinemann, 1983; but see Neisser, 1967), has lead most cognitive researchers to conclude that not all information that is available to a perceiver is processed (MacArthur, 1981).

An organizing strategy is one means of overcoming a limited capacity. Miller (1956) coined the term "chunking" to describe the process of applying a principle of collectivity to stimuli, treating them as equivalent along a specified dimension. Central to Miller's (1956) concept of "chunking" refers to the ability of the perceiver to group bits of information. Miller (1956) demonstrated that errors in recall are significantly reduced if the stimulus information is "recoded" into an economical unit. In humans, for example, recoding numerical information from binary to octal representation is an economical means of maintaining large amounts of information in memory for recall (Miller, 1956). Theoretically, there are an infinite number of ways to recode stimulus information (see Crowder, 1976, p.67; Norman, 1976, p. 91). But it has been common to stress the mental economy of recoding. As Bruner, Goodnow and Austin (1956) did earlier, Rosch (1976) recognized the fundamental utility of a categorical representation in its cognitive economy. Rosch (1976) states that "what one wishes to gain from one's categories is a great deal of information about the environment while conserving finite resources as much as possible" (p.28).

Glanzer and Clark's (1963) verbal-loop hypothesis predicted that, for humans, recoding via a verbal labeling strategy increases the capacity to memorize and recall stimuli. In Glanzer and Clark's (1963) study, subjects were presented a binary series (i.e., 000110101110) for .5 seconds, half were simply asked to recall the sequence and the other half were asked to write a description of the sequence (i.e., "three oh's, two ones, two oh-one pairs"). Results indicated higher recall for the verbal condition. Moreover, within the verbal condition, a negative correlation was found between number of words used to describe the binary series and accuracy of recall. In other words, the organization of binary series into a sequence of categories of digits enhanced recall.

Research on category memory using linguistic stimuli and involving the recall of word lists indicates the use of a similar kind of organizing principle. Bousfield (1953) first identified it as "clustering". He demonstrated that subjects who are presented word lists typically recall the stimulus words in groups of meaningful units, regardless of the order of presentation of the words within the list. This grouping of stimuli into meaningful units has been shown to increase recall performance (Underwood, 1964; Tulving, 1962; Cofer, Bruce, & Reicher, 1966; Tulving & Pearlstone, 1966). Tulving (1962) identified what he termed "subjective clustering". He demonstrated that clustering even occurred on a test of list recall when the list of items to be recalled shared no apparent meaningful associations. Bousfield and Cohen (1953) suggested that the observed clustering phenomenon reflected a hierarchical organization of information in memory. Within such a hierarchy, categorized instances at subordinate levels have in common a superordinate category name that relates the subordinate representations. Later, Bower (1972) expressed a view quite consistent with Bousfield and Cohen's (1953).

In a review of research on recall memory, Bower (1972) concluded that category names function as organizing units that identify common relations among other members of the category. He described the enhanced recall observed in clustering as a function of subjects' ability to recall the category name that relates all of the list items. Tulving and Pearlstone's (1966) research speaks directly to this issue. In their experiment, subjects were given a list of either 12, 24, or 48 words. Within each of these conditions a second variable was the number of categories into which each item could be associated (one, two, or four). On the recall test half the subjects were given the category names as recall cues, the other half were not given any cues. Recall for subjects in the category cue group was significantly greater than the those in the no-cue group. Even more interesting was the fact that in the cued recall group the ratio of recalled items to the number of items in the list did not diminish as the number of items to be recalled increased. In other words, the increase in recall demand created by the larger word list was offset by the the categorizing strategy, so that performance remained essentially equivalent for the 12, 24, and 48 item cued recall lists. Recent findings related to category size effects are consistent with these results (Nelson, Canas, & Bajo, 1987; Homa & Cultice, 1984; Nelson, Bajo, & Casanueva, 1985). Numerous sources address the issues related to coding and category memory. The above research represents only a small sample. For comprehensive reviews of the literature consult Crowder (1976), Melton and Martin (1972), and Harnad (1988). All of these views of recoding are similar in two important ways. First, they assume that recoding produces a condensed form of the original information and that category memory involves the relation of information by a common representation. Secondly, information within a grouping is related to the extent that it shares common associative connections with this common superordinate symbol.

# CHAPTER III

## ORGANIZATIONAL PROPERTIES OF CATEGORIES

### A. Properties of Categories

Mental codes may correspond to sensory, motor, imaginal, or symbolic (linguistic) functions (Posner, 1978). Linguistic categorical codes have been proposed to be organized by sensory modality (Morton, 1979), frequency (Glanzer & Ehrenreich, 1979), taxomony (Tversky & Hemenway, 1984), grammatical class (Bradely, Garrett & Zurif, 1980), semantic relatedness (Collins & Loftus, 1975), etc. Within-category relationships have been proposed to be a function of prototypicality (Posner & Keele, 1968), stored exemplars (Hintzman & Ludlam, 1980), family resemblance (Rosch & Mervis, 1975), ideals (Barsalou, 1985, 1987), etc. Each of these properties, more or less, reflect an underlying identification with a more general classical or probabilistic theory of category memory. The classical view is founded in the same assumptions of the Aristotelian classification system. Smith and Medin (1981) identify three assumptions of the classical view: summary representation, necessary and sufficient defining features, logical entailment. This is best represented by the description below of taxonomic organization, but the grammatical and exemplar also display some of the same Aristotelian character. Probably the most significant difference of the probabilistic view from the classical view is the assumption that "features that represent concepts are salient ones that have a substantially high of probability occurring in an instance of a concept." (Smith & Medin, 1981). It is essentially a statistical account of associative connections. Classification is dependent on the weighted sum of features similar to all other category members. Prototype theory described below is the best example of a probabilistic theory of category memory.

Below is a brief review of some of the various organizational properties that have in the past been proposed.

1. Frequency. Frequency is probably the simplest organizing principle of the lexicon that has been proposed. Word frequency theories of lexical organization assigns priority to the simple frequency that a word occurs in common language usage. Frequency counts of words appearing in magazines and journals are common sources that are used for the generation of word frequency norms (Francis & Kucera, 1967, 1982). These types of norms have been employed in various types of recall, recognition and response time tasks. Early research that demonstrated the affects of word frequency on various types of tasks (Chambers & Foster, 1975; Raymond, 1969; Oldfield & Wingfield, 1965, Howes & Solomon, 1951) led Glanzer and Ehrenreich (1979) to review the literature and proposed a theory of lexical organization and processing based on word frequency. However, prior to Glanzer and Ehrenreich's (1979), Landauer and Streeter (1973) showed that common and rare words differ not only in frequency but also in their distributions of phonemes and graphemes. They argue that these and other differences account for some of the effects otherwise attributed to word frequency. More recent research has shown that at least some of the previously reported effects are in fact frequency effects (Gardner, Rothkopf, Lapan, & Lafferty, 1987). Some research has brought into questioned the strength of frequency

effects (Rosch, Simpon & Miller, 1976; Mervis, Catlin, & Rosch, 1976). Research has been reported that argues that "subjective" estimates of frequency (reported to be distinct from objective word count norms) called "familiarity", may be important variable affecting category organization. data). Recently, Chumbley (1988) has demonstrated, however, that familiarity is not a good predictor of prototypicality. He reasons that familiarity is more a cross-situational (uncategorical) association; where prototypicality relates to within-categorical associations. Therefore, indexes of familiarity may have little to do with how categorical organization occurs and have more to do with a broader cross-situational awareness of frequency of usage. The most compelling data against a frequency theory of lexical organization have demonstrated that frequency effects are task dependent. Balota and Chumbley (1984) have found that the effects of frequency is variable across different experimental tasks (viz., pronunciation, lexical decision, and category verification). They found the least indication of frequency effects in category verification and pronunciation tasks and the greatest indication of frequency effects in lexical decision tasks. Given that much of the research on word frequency has involved the lexical decision task a previous overestimation of it's role in lexical organization is not surprising.

2. Taxonomy. A taxonomy refers to an orderly organization of a set of elements. The elements may be anything form physical objects to abstract symbols. However, a taxonomic view of category organization is most like the classical Aristotlean view of natural object classification. In this view classification proceeded from the particular to the general. Category membership is supposed to be

determined by the identification of an absolute set of defining features that is shared by all members of a category. That is, all of the defining features of a category are essential for category membership. There is also a logical implication for objects that may be define as comprising a subset of a category. All features of a superset are nested within the category subset. For example, if the superset refers triangles (closed three sided geometric figures) a subset might be isosceles triangles (closed three sided figure with three equal angles). Within the subset are the defining features of the superset triangle, namely, three sided closed geometric figure. There are important criticisms of this theoretical classification scheme (Wittgenstein, 1953; Fodor, 1975) and empirical demonstrations of its failure to account for recognition and recall performance (Smith, Shoben, & Rips, 1974). Criticisms have been leveled at the way this classical view treats memory as a static structure. Taxonomic descriptions are seen as essentially descriptions of category structure and not process (Smith & Medin, 1981). These are important criticisms and will be addressed in more detail in Chapter IV.

3. Grammatical Class. It is generally accepted by linguistics that word meanings can be derived in more than one way. Meaning may be extracted from an utterance or written communication by encoding the linguistic code directly (e.g., auditory, visual). Meaning may be pragmatically inferred from a combination of the utterance and one's world knowledge. Meaning may also be derived from information in the linguistic environment in which the word is presented. The environment amounts to its position in a sentence relative to the other words. The processing of syntactic information is dependent on

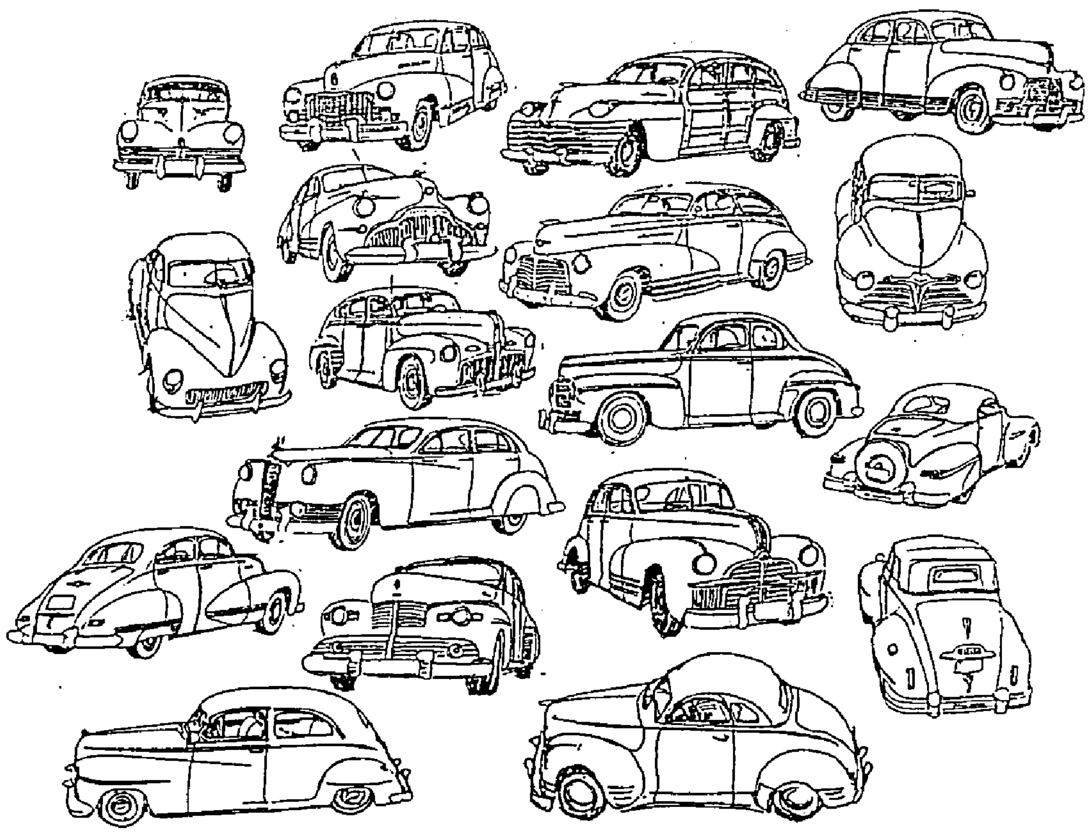
individuals' ability to discriminate (even if only implicitly) words by grammatical class. Deese (1965) has suggested that word associations are based on the linguistic environment in which they are found. By this Deese (1965) and others (Bradley, Garret and Zurif, 1980) suggest that an important part of lexical organization may be grammatical class. Some developmental data suggest that this may be true. Entwistle (1966) reported that on word association tasks, adults generate more paradigmatic responses (e.g., words from the same grammatical class, "good" in response to "bad"). In contrast, children are more likely to respond with associates that are syntagmatic (e.g., word from different grammatical classes, "good" in response to "boy"). However, children as young as two years have a functional knowledge of grammar (Huttenlocher and Lui, 1979). Huttenlocher and Lui (1979) reported data that suggest young childrens' sensitivity to grammatically categories (nouns and verbs) is comparable to adults and that differences between adults' and childrens' performance is related to information processing capabilities. They proposed that developmental changes reflect changes in the extent of spreading activation and not semantic organization. There are, however, some difficulties with a theory of lexical organization by grammatical class. The theory has difficulty with some of the same general criticisms that are leveled at taxonomic theories of organization. For example, is categorization by grammatical class an all or none process? If not, what attributes might identify a word as more or less fitting into a particular grammatical category?

4. Exemplars. According to this view, category organizations in memory are composed of stored representations of particular instances

previously experienced. However, all stored instances are not weighted equally within the category. Some memories (stored exemplar instances) are assumed to be "better" or more typical of the category in general. The classifications of novel objects is assumed to be a done by comparison of its similarity to a subset of stored exemplars or to a particular exemplar instance. Unique to exemplar view is the absence of any abstracted summary representation from category members. In this sense classification is disjunctive and subject to some of the same criticism as the taxonomic classification scheme. Also, the lack of a summary representation makes membership in a category a bit arbitrary. This poses a problem when trying to describe within-category relations.

5. Prototypicality. Prototype theories of category structure are similar to exemplar theories since representations may be identified as more or less typical of the category in general. Prototype theories, however, provide a more flexible alternative to categorization by strict classification rules. A prototype is a member of a category that represents a composite of the highly probable attributes existing across all category members. All of the attributes that the prototype entails are not necessary characteristics for membership in the category. According to this view clusters of attributes define a category member, with any member possibly having some unique characteristics as well. These category relations are referred to collectively as "family resemblance" (Rosch, 1975) (see Figure 1). Prototype based category classifications involve the comparison of a novel object with a prototypical representation that has been abstracted from many experiences with different members

Figure 1. Illustration of family resemblance.



of the category. There are two different ways that prototypes have been described. Posner and Keele (1968) used of the term to describe a central tendency or "best fit" among several category members. Mervis and Rosch (1981) use the term prototype to in a slightly different way. According to Rosch and Mervis (1975) the when categorizing stimuli, typicality of a potential category member may be determined both by an exemplar's similarity to other within-category members ("category resemblance", Tversky, 1977) and its dissimilarity to noncategory members ("cue validity", Beach, 1964; Reed, 1972). Category resemblance emphasizes the common featural similarities of category members and is defined as the "weighted sum of the measures of all common features within a category minus the sum of the measures of all distinctive features" (Rosch, 1978). On this dimension, the superordinate categories within the same level of the hierarchy, are more discriminable than lower subordinate categories, since they have fewer distinctive features. The value or strength of category resemblance is relative to the superordinate category member. It is essentially a hierarchically vertical comparison. A cue's validity or predictiveness of category membership is also probabilistically determined. The "predictiveness with which cue x is associated with category y decreases as the frequency with which cue x is associated with categories other than y increases" (Rosch, 1978). In this case, unique distinctive features are critical to the strength of cue validity. Cue validity is more relevant to hierarchically lower levels. Both of these indexes of category membership are essentially exclusive disjunction operations, differentiated by either an emphasis on a weighted sum of features (category resemblance) or the summing of the frequency a particular between category feature (cue validity).

Much of Rosch's (1976) research has been devoted to identifying the optimal level of natural object description. She proposes that the "basic-object" category level of abstraction which optimizes the discriminating information of the stimuli.

6. Ideals. Wertheimer (1938) suggested that perceptual stimuli are organized around "ideal types" that serve as perceptual anchoring points in the categorization of stimuli. A similar idea was proposed by Barsalou (1985, 1987) regarding linguistic categories. He identified category "ideals" as category members that represent the goal associated with category. For example, an ideal for the category things that conserve environmental resources might be "zero waste". Barsalou (1985) also points out that such "ideals" may exist in the periphery of a category. For example, "things to prevent hypothermia when SCUBA diving" might include things to wear that reduce the dissipation of body heat. However, the ideal would be to reduce heat loss to within an optimal range, not to stay as warm as possible. Too heavy a wet suit in warm water is not ideal, since it will cause hyperthermia. In this example, the goal of this category will not reflect its central tendency. This highlights an important difference between ideals and prototypes. Ideals as category reference points (such as prototypes) will not necessarily reflect the central tendency of the category as prototypes (Posner and Keele, 1968). The emphasis of this theory is on understanding peoples' ability to generate novel and goal directed categories. Baraslou (1985) concludes that "graded structures do not reflect invariant structures associated with categories but instead reflect peoples' dynamic ability to construct concepts."

In sum, the evidence that retrieval tasks display only a modest amount of retrieval reliability (Bellezza, 1984a, 1984b) and that different measurement devices are sensitive to different properties of a category representation (Balota and Chumbley, 1984), suggests that there is not any one unitary property appropriate for describing all categories. Categorical memory may be more context dependent than the above individual organizational schemes have been inclined to suggest (Barsalou, 1987; Harnad, 1988). In spite of the differences between these above descriptions, at least common to each is the implicit assumption that there exists a dominant within-category "reference point" (Rosch, 1975) serving as an organizing unit within the category. For example, this might be the category member coded as most frequent, prototypical, best fitting, or ideal. All that is necessary in Rosch's theory of cognitive reference points is that the reference point is "shown to be one which other stimuli are seen in relation to". The important implication for empirical demonstration is that "in relation to" is operationally defined as an asymmetrical associative relation between category stimuli and the reference point. In conclusion, the cognitive reference point theory (Rosch, 1976) appears to be the most reasonable since it does not carry the theoretical baggage of logical inclusion relations implicit in the strict hierarchical model. Its only assumption is the asymmetrical associative relationship between category members. In this way, "reference points" describe functional organizing units that relate category members more heterarchically, where conservation of class-relations across levels of the structure is not a necessary assumption.

# CHAPTER IV

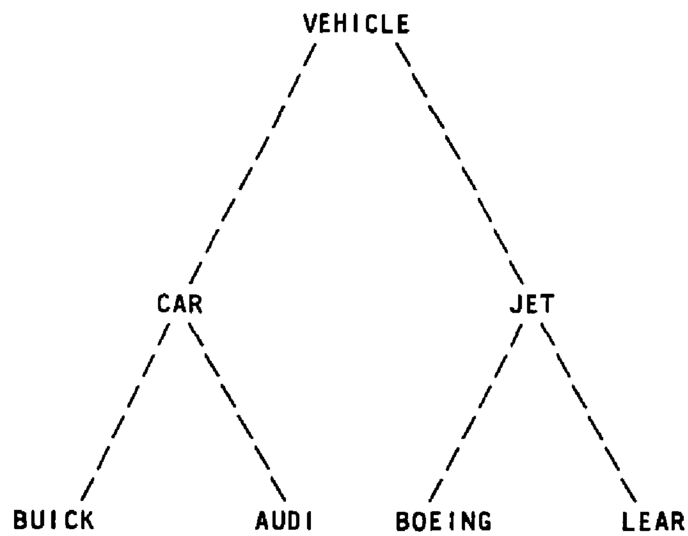
# PRESENT RESEARCH

## A. Rationale

Several theories of memory structure and information processing have maintained an emphasis on hierarchical organization (Bousfield & Cohen, 1953; Collins & Quillian, 1969; Rosch, 1976, Andersen & Reder, 1974). Some of the best support for hierarchical organization comes from demonstrations of mediated priming across the levels of a category hierarchy (Rips & Shoben, & Smith, 1973; Balota & Lorch, 1986; McNamara & Altarriba, 1988; McNamara & Healey, 1988). Data have also suggested asymmetrical associative strengths between different levels of an associative category hierarchy (Tulving & Pearstone, 1966; Loftus and Bolton, 1974; James, 1975; Bleasdale, 1987; Hines, et al., 1986; Coltheart, 1980, Barsalou & Ross, 1986; Loftus and Bolton, 1974; Rosch, 1974; Chumbley, 1986). Loftus and Bolton (1974) and Loftus (1973) suggested that this asymmetry may be an important aspect of the inference process. They suggest that hierarchical associative asymmetries reflect the logical class inclusion relations of the category (Loftus and Bolton, 1974). Loftus and Bolton (1974) measured response times to superordinates and subordinates from the same category of natural objects. For example, a hierarchy for "vehicle" (see Figure 2) might have as its subordinates: "car" and "buick". In this hierarchy, "car" represents a specific instance of a "vehicle", and "buick" represents a specific instance of "car". They found that subjects recalled subordinate category members faster than the superordinate members. They argued that faster response times for subordinate responses reflects a bias toward unidirectional access of subordinate category members and that this higher accessibility of subordinates is what preserves the logical class relationship of the category members. Smith and Medin (1981) described this as treating category structure as if it were essentially a pattern recognition device. That is, the process of searching through the category structure when discriminating stimuli automatically produces categorization and out of this same process the generation of inferences. For example, consider Figure 2. Lower levels of the hierarchy such as "buick" carries the logical implication that it is also a "vehicle". That is, as one's memory search descends a category structure, affirmation of features already present is not a necessary operation because it is assumed that all features existing within superordinate representations also exist in the subordinate representations. This has obvious similarities to the classical view of categories and the same criticisms also apply.

Considerable data have challenged the theories of pure logical class separation between levels of the hierarchy (Rosch, 1978; Collins & Quillian, 1971; Rips, Smith, & Shoben, 1975; Smith, 1974; Anderson & Bower, 1973; Glass, Holyoak, & O'Dell, 1974; Landauer & Meyer, 1972; Hampton, 1982). For example, in a reaction time study, Rosch (1978) examined the accessibility of prototypical category objects. This study involved a simple lexical decision task. Subjects were required to respond to statements such as: X is a member of Y category. Word frequency was controlled. Results indicated the most rapid response times were for object words which had been rated the most prototypical, regardless of their hierarchical position.

Figure 2. Example hierarchical structure of the concept vehicle.



This challenge was addressed in a later paper where Collins and Loftus (1975) proposed their "Extended Theory of Spreading Activation". They argued that the strict logical class inclusion interpretation ("strong" theory of mental economy) that is commonly made is incorrect. Collins and Loftus (1975) propose a "weak" mental economy interpretation. The "weak" theory simply allows for redundancy in memory. They state: "the strong theory requires erasing information whenever it applies to a more general level. If a person learns a robin can fly and later learns that birds fly, the strong theory implies that 'flying' must be erased from robin. The weak theory of economy merely assumes that every time one learns that X is a bird, one does not at that time store all the properties of bird with X in memory" (p. 409). This kind of classification redundancy may be due to classification of stimuli by function during early learning experiences. Developmentally early memory structures eventually may become inconsistent as later more diversified semantic categorical organizations developed with language skills. This developmental divergence would result in redundancy between categories. Markman, Horton, and Mclanahan (1980) demonstrated that children as old as 14 years tend to distort class inclusion relations into whole-part structural organizations. They concluded that whole-part relations are simpler to establish and maintain than logical class relations. Importantly, Magires and O'Toole (1980) reported that developmentally late conservation of class-inclusion is not related to differing superordinate class or category size. In sum, data do support the idea that between-category redundancy may be a consequence of developmental shift in coding. This explanation seems to account for the "typicality" results reported by Rosch

(1978). However, although the "weak economy" theory of category organization seems avoid the problems implied by strict logical entailment properties associated with hierarchical category organization, there is a downside to the "weak economy" modification. It simply reduces the predictiveness of the theory. Moreover, no method was given for accounting for this kind of variance within RTs measurements of hierarchical relation between category members. In that form "weak economy" may be another way of saying "weak theory." On the other side of the argument are recent empirical data that do not support the prototype theory either (Chumbley, 1986). Chumbley (1986) found category dominance to be a better predictor of RT to category hierarchies than prototypicality.

In sum, logical class relationships within object categories (e.g., such as entailment of the subordinate by the superordinate) that were assumed to be a feature of hierarchical memory structure have only inconsistently been demonstrated to be associated with RT asymmetry patterns on priming tasks. The data, however, do not preclude the idea that categories may be organized around a common abstracted representation. There are still considerable RT data that discriminate abstract and concrete memory codes (Fischler, 1981; Foss, 1983; Meyer & Schvaneveldt, 1971; Fisk & Schneider, 1983, 1984; Neely, Fisk, & Ross, 1983; Barsalou, 1982, 1983, 1986, Kroll & Mervis, 1986).

Personality researchers have long attempted to categorize people based constellations of personality attributes. One common method of generating personality categories was through the dimensional scaling of several trait attributes and the classification of people along these attribute continuum. Later research brought into question the utility of these traditional classification schemes in describing cross-situational behavior, suggesting that they over-estimate behavioral-consistency (Mischel, 1968, 1973; Fiske, 1974). However, there, recently has been a renewed interest in trait categorization. Researchers of personality and attribution have applied concepts of information processing commonly used in cognitive psychology in efforts to understand the storage and retrieval of person information. Hastie and Kumar (1979) were interested in the effect of an impression-formation on recall of the discrete trait descriptors information about a fictitious target person upon which the impression was based. Experimental conditions varied by the ratio of congruent, noncongruent, and neutral behavioral descriptions that were related to a superordinate trait associate presented in each condition. Results indicated higher recall for the behavioral descriptions that were congruent (related) or incongruent (unrelated) with a trait associate compared to neutral behavioral descriptions. For incongruent descriptions, this effect was directly related to set size. As the ratio of congruent items to incongruent items increased, the percentage of recall for incongruent items also increased. The percentage of recall for congruent items remained fairly constant as the number of congruent items in creased. These results suggest that recall was affected by the encoding strategy. Subjects were expecting to indicate their impression of the fictitious target person. The task required an integration of the items and not a verbatim recall. The results suggest that subjects recognized the categorical association of congruent behavioral descriptions to the trait associate provided, and as ratio of congruent to incongruent behavioral descriptions became greater (viz., incongruent items less frequent) the saliency of incongruent descriptions increased and they were more likely to be recognized as not categorically related to the trait associate. (These findings are consistent with data reported by Tulving and Pearlstone's (1966) where the encoding strategy of using a category name to associate discrete list items enhances recall; see Chapter 2).

Similar findings on impression-formation affects on recall have been reported by Higgins, Rholes, and Jones (1977), where trait descriptors were ostensibly unrelated to an impression-formation task. Higgins et al. (1977) reported that after an impression was formed later recall for the inference was maintained and its intensity augmented, where as recall for discrete information was increasingly lost over time. Higgins et al. (1977) reported that critical to producing this effect was the subjects' expectation that they were going to be making a judgment about the fictitious person being described.

Cantor and Mischel (1977) proposed that personality traits function as conceptual prototypes that are abstracted from a memory set in a process that is similar to the one described by Posner and Keele (1968). Within a recognition paradigm the researchers demonstrated an overall high level of accuracy in recognition for items that had been presented in an aquisition set. Significantly, subjects also displayed a tendency to falsely recognize traits that were thematically related to a prototype (viz., introversion or extroversion) but actually not presented in an aquisition phase of the experiment. This finding was further supported by subjects' higher confidence rating that traits that rated as highly and moderately related to the prototype had been presented in the aquisition phase as compared to items that were only minimally related to the prototype.

The researchers concluded that subjects' high recognition performance combined with their bias for false recognition of related traits was consistent with a model of category memory that describes a prototype as an abstraction from a memory set (Posner and Keele, 1968) rather than an impression-formation set.

In sum, the data suggest trait labels can function as organizing units of person information in the context of an impression-formation task. Although the impression-formation aspect of the Hastie and Kumar (1979) or Higgins et al.'s experiments may affect the later recall and the intensity of an impression previously formed, it does not appear to be necessary to activate thematically related associates (Cantor & Mischel, 1979). Simple exposure may automatically increase recognition threshold for global trait term that are thematically related to discrete experiences. This conclusion is consistent with data on natural-object categories (Balotoa & Lorch, 1988).

The apparently similar the findings in research on trait categories and natural-object categories in cognition has prompted researchers to initiate work on memory for traits that addresses some of the basic assumptions about category memory that were researched in the of early work on natural-objects. For example, can people categorize trait information in a logical hierarchical structure (Hampson, John, & Goldberg, 1986)? Is there a Roschian type of basic level of trait description (John, Hampson, & Goldberg, 1986)?

Hampson, et al. (1986) measured subjects' perception of a hierarchical relation among various traits. They demonstrated a high consensus of agreement among subjects' judgments of trait categories (e.g., aggressive) as being organized in a way that is logically similar to natural object hierarchies. The researchers used subjects judgments of category breadth and asymmetry relations. Their operationalization of breadth was similar to that of Buss and Craik (1983) who suggested that traits may vary in the number of acts that are associated with them. Buss and Craik (1983) originally proposed that "category volume" could be determined by counting the number of behavioral acts that subjects could generate in a period of time. Goldberg (1987) has since reported the validity of this method with natural objects. Hampson et al., (1986) had subjects make direct breadth judgments for 456 trait terms and also judge the traits' breadth in paired comparisons. Their instructions included the following sample description of category breadth:

> Broad traits are those that refer to a wide range of different types of behaviors, were as narrow traits are those that refer to a much more limited range of types of behaviors. For example, consider the two traits 'punctual' and 'dependable'. There are many types of behaviors referred to by the trait 'dependable', whereas there are only a few types of behaviors referred to by the trait 'punctual'. So, clearly 'dependable' is broader than 'punctual'.

Judges ratings of the trait terms were subjected to a factor analysis that produced an coefficient alpha reliability of .69. These findings were use to construct hierarchically related trait diads. A sample of 54 subjects' received 60 pairs of these traits (30 desirable and 30 undesirable) circled the broader of the two traits.

Asymmetry relations were operationalized as judgments of class-inclusion. Strict inclusion implies that subordinate category members are logically entailed by superordinates but the reverse is not true. Subjects were required indicate their the logical entailment relation of two traits. For example, subjects were given the following statements and asked to indicate which of the two makes more sense:

(a) "To be punctual is a way of being dependable."
(b) "To be dependable is a way of being punctual."

The same 60 pairs of traits that were used in the breadth judgments as well as 12 pairs of nouns, verbs, and adjectives were presented to subjects for asymmetry judgments. The results from both of these studies indicated a very high level of agreement with the breadth judgments and category inclusion relations expected. Interjudge correlations indicated that eighteen desirable and nineteen undesirable traits reach 70% agreement. There was even greater consensus in the asymmetry judgments were only 2 traits did not reach 70% agreement. An interesting finding was that desirable traits were judged to be broader than undesirable traits. A point-biserail correlation of .22, between breadth and dichotomized desirability, was reported to as highly significant for their sample size of N=443. In general these findings support the use of asymmetry judgments as measures of hierarchical relations. In three subsequent studies Hampson et al., (1986) examined the role of social desirability in trait ascriptions that was suggested as a possible confound, replicated the result with an increased sample size, and conducted a replication of the study employing a British population sample.

Hampson et al.'s, (1986) research was followed by a series of experiments conducted by John et al., (1986). These researchers examined subjects' possible preference for the use of particular level of trait abstraction when describing themselves and others. In the following experiments the researchers used the desirable and undesirable trait hierarchies established by Hampson et al., (1986). Subjects identified target persons by assigning traits that they judged as most characteristic of the target person. Target persons varied across three conditions. In a "Diary Condition" subjects rated themselves, a close friend, and two fictitious individuals. After reading a diary supposedly written by each of those targets subjects were instructed to write a free description of the target person who wrote the diary and then to describe that person using the a trait check list. In a second condition, the "Peer Condition", subjects described their conception of the ideal person and three other people who represented varing degrees of familiarity and liking. This included all four combination of unfamiliar, familiar, liked, and disliked target types. Finally, in a "Trait Inference Condition", subjects were presented with a middle level trait from a three tier hierarchy and asked to describe a fictitious person who personified that trait. Subsequently, they were given the other two members of the three tier trait hierarchy and asked to indicate which of the two better characterized the individual they just described.

The overall finding in these studies was a positivity bias displayed by subjects. Most often positive superordinate traits were chosen to describe the targets. There was, however, an interesting triple interaction of trait desirability x target likability x trait hierarchical level. For liked targets, more desirable superordinate and undesirable subordinate trait descriptors were chosen. The opposite pattern was displayed for trait descriptors chosen in the disliked target conditions.

In a second experiment the researchers interested in whether subjects' preferences for the superordinate traits could be shifted by priming with the subordinate traits prior to a similar impression-formation task. The priming manipulation involved the subjects to read a diary written by a fictitious person and then rate that person. In the "Superordinate Prime Condition" subjects were only given superordinate check list with which to rate the target person. In the Subordinate Prime Condition" subjects were only given subordinate traits with which to rate the target. All subjects were then given a behavioral description of another fictitious person and asked to form an impression of the target person. The results showed that subjects were not affected by the priming task. They maintained a bias for the use of superordinate traits descriptors. John et al. (1986) suggested that that subjects ability to reliably organized traits into logical hierarchies and subjects' robust preferences for superordinates may be reflection of their categorical organization in memory. They saw these findings as consistent with Collins and Quillian's (1969) theory which describes superordinates as highly accessible category members. There is some recent data that do indicate a automatic superordinate activation in the presence of the subordinate (Barsalou, 1986; Balota & Lorch, 1986). This is also consistent with a recent finding that category dominance was the best predictor of RT on a category verification task (Chumbley, 1988). In sum, there are two general findings. Individuals can generate trait categories (i.e., aggressive) that are hierarchically organized in a way that is logically similar to structure of natural-object hierarchies (Hampson, John, & Goldberg, 1986) and subjects display a robust preference for use of superordinate level traits when describing themselves and others (John, Goldberg, & Hampson, 1986). John et al. (1986) suggestion that subjects' ability to order traits hierarchically and their preferences for superordinates may be explained in terms of Collins and Quillian (1969) theory of category memory, where it is assumed that the "superset" (superordinate) is usually the most accessible member of a category. This interpretation implies that the accessibility of the superordinate is somehow determined by its hierarchical position within the category. Research in the cognitive domain, however, has already challenged that aspect of Collins and Quillian's (1969) theory (Loftus & Bolton, 1974; Bleasdale, 1987; Kroll & Mervis, 1986). According to several studies, the subordinate (concrete) representation is more accessible. The absence of any basic RT research on trait categories, makes any direct comparison between these findings impossible. Moreover, the data on traits has been in the context of impression-formation tasks. These trait data primarily reflect judgments of esthetics (impression-formations; judgments of desirability). Cognitive research on natural-objects has not involved qualitative evaluations within experimental tests of recall and recognition. They have primarily examined memory performance using RTs as a dependent measure on discrimination, recall, and recognition tasks. Information processing explanations have nevertheless been invoked in efforts to interpret data collected on impression-formation task with traits. There is an obvious need for basic priming research on trait categories.

The proposed research was a first step in generating RT data on trait categories. The specific empirical question raised by the present research was: are RTs patterns on priming tasks with trait and natural-object category stimuli similar, and are these RT patterns correlated with subjects' judgment of logical entailment between hierarchically related category members? Three priming tasks (e.g., pronunciation, lexical decision, and category verification) were employed for RT measurements and two questionnaires were used to determine subjects' judgment of logical entailment between category hierarchy members (e.g., superordinates and subordinates). Below is a description and brief theoretical discussion about the dependent measures that are employed in the present research.

B. Pronunciation, Lexical Decision, Category Verification, and Asymmetry Judgments

Mental chronometry assumes that "time is cognition" (Lachman et al., 1979, p. 133). Neurological facts form the basis for this assumption. The time that it takes for a stimulus signal to move from the peripheral nervous system to the brain has been measured at between 15 and 30 milliseconds (msec). A substantially longer time is required for a person to initiate a response to the presentation of a stimulus (e.g., between 150 and 450 msec). Further, response times (RTs) are known to vary a function of the task requirements (e.g., Posner, Klein, Summers, & Buggie, 1973), with complex tasks requiring longer RTs than simple tasks. The attractiveness of the RT method has been that it allows the researcher to monitor the "on-line" mental operations and to experimentally decompose those operations into their component stages.

Techniques to isolate different stages of information processing using RT as a dependent measure have existed for quite some time. Donders (1886, in Lachman et al., 1979) was the first to use this RT methodology to attempt to isolate different stages of information processing. His method was simple. Measure an individual's RT to one stimulus with only one possible response, to responses where there are multiple stimuli and multiple possible response, and to responses where there are multiple stimuli and only one possible response. By subtracting these RTs from one another one could infer that the mental operations were being separated. For example, stimulus categorization time could be calculated by subtracting the third measurement (described above) from the first. There are, however, problems with the subtraction method (see Lachman & Lachman, 1976). In cognitive research, the measurement of latency between onset of a stimulus and the initiation of a response (RT) is probably the most common dependent measure. This paradigm has been used to experimentally isolate mental codes (e.g., phonological, visual), stages of information processing (e.g., iconic, short-term memory), and discriminate between automatic and attended mental operations (e.g., automatic priming and memory search involving attentional processes).

Sternberg (1971) adopted this paradigm in his research on memory scanning and demonstrated that RT measures could be used to decompose complex mental processes. The task involved presenting subjects with small groups of numbers to memorize. Sternberg called these numbers the positive set. Subjects were then presented a single digit called the test digit. Subjects were to indicate by pressing one of two keys if the test digit (or target item) was a member of the positive set. The results indicated that RT was a positive linear function of the positive set size. Moreover, this was evidenced for negative set items as well as positive set items indicating that memory scanning was exhaustive. Sternberg (1971) included a condition in another experiment in which the stimulus was perceptually degraded. When the results were plotted with RT on the Y-axis and number of items in the positive set on the X-axis, only the Y-intercept showed the effect of the degraded stimulus on subjects' responses. The slope of the line was not significantly affected by degraded stimuli. Sternberg concluded that the manipulation isolated the encoding stage of processing and did not affect the scanning stage. This kind of chronometric methodology has frequently been used to isolate various levels of processing of linguistic stimuli.

Three tasks that are commonly employed in research using linguistic stimuli are the pronunciation task, lexical decision task, and category verification task.

1. Pronunciation. In the pronunciation task subjects simply pronounce a stimulus word. Compared to other tasks such as lexical decision or category verification, the pronunciation task does not require a word/nonword decision or a more complex semantic comparison. Therefore, a response on the pronunciation task does not necessarily require a semantic memory search. Data indicate that activation of the phonological code is primary to any semantic activation (Van Orden, 1987, 1988; James, 1975; Cole, Coltheart, & Allard, 1974). One robust finding that supports this is the "regularity effect" (Bauer and Stanovich, 1980). The effect is observed in the context of the lexical decision paradigm. Irregular words (e.g., island) are identified as words slower than regular words (e.g., won). More compelling evidence was reported by Van Orden (1987) indicating the independence of phonological codes in the process of accessing information from semantic memory. Van Orden (1987) demonstrated phonological interference in a category identification lexical decision task. Subjects were primed with a superordinate category member (i.e., FOOD). Following the prime, one of two targets were presented, either a homophone (e.g., MEET) or a noncategory member word (i.e., ROCK). Subjects' classification error rates were 25% for the homophone and only 10% for the noncategory member word. This

indicated that meaning was being accessed independent of the orthographic code. Van Orden (1988) proposed a verification model to account for his findings. The model identifies an intralexical process where phonological codes independently activate category exemplars which are in turn compared to the orthographic code (visual stimulus representation) for semantic comparison and word identification.

2. Lexical Decision. The lexical decision task typically involves the discrete presentation of word and nonword stimuli (i.e., ton, tun, tnu). Subjects are required to press one of two keys to indicate if a particular string of letters presented to them spells a word or does not spell a word.

There are a few different definitions of lexical access that appear in the literature. The most general definition describes lexical access as having occurred whenever information is retrieved from semantic memory. A more restricted definition describes lexical access as entailing only pre-lexical processes that retrieve information up to the access of the linguistic code representing only the word, with no access from semantic memory. Both of these levels of processing have been demonstrated by James (1975) Other theories of lexical access are even more restrictive, focusing on sublexical stages, as in Van Orden's (1988) verification model.

There are four major theoretical models of lexical access. They are the direct access model, serial search model, a combination parallel search model, and a verification model. The verification model represents refinement of the parallel search model, focusing on intralexical operations. Regarding visual information processing, the two former models essentially represent the same "top-down" versus "bottom-up" distinction made in perceptual feature discrimination models (Howard, 1983), or the template matching versus pattern recognition models (Smith, 1971).

The direct access models of visual word comprehension (Smith, 1971; Baron, 1973; Aaronson & Ferres, 1983, for a review see Forster, 1976) describe entrance into the lexicon as resulting from a direct stimulation of a neural representation of a word in a perceiver's memory. The access route can be described as a memory trace. All that a perceiver requires is the description under which a word is stored (i.e., spelling). Access is thought of as via direct-wiring (Foster, 1976) with no implication of the activation of other codes (e.g., phonological codes) prior to lexical access. The most general criticism of the direct access model is that under such a model one is forced to postulate multiple representation stores corresponding to independent codes that achieve lexical status (e.g., orthographic, phonological). A separate access path would have to be postulated for every entry in an individual's mental dictionary. The presence of such redundancy without postulating some sort of common lexical access route gives the theory an uneconomical feature.

One major empirical finding that is taken as evidence against a serial processing theory and as support for direct-access is the "word superiority effect". Simply stated, letters within words are identified better than in isolation (Reicher, 1969). For example, in the word "WORK", the letter "R" is identified faster and with greater accuracy when it is first presented within the word "WORK" rather than when it is first presented in isolation or imbedded in a nonword (i.e., "ORWK"). A serial scan model would not predict such an outcome. In a serial scan of the stimulus "WORK", letters would be processed sequentially and would require a longer period of time before a response could be initiated. The word superiority effect has been consistently replicated (Wheeler, 1970; Baron & Thurstone, 1973; Johnston & McClelland, 1974). However, data indicating overall RTs to nonword are longer than to words suggest that some sort of mental search is taking place for nonword stimuli too. According to a direct access model, since nonwords have no stored representations, no search should takes place. Lexical decision RTs should be faster for nonwords.

There are ways to patchup the direct-access theory (e.g., postulating a self-terminating search time limit for all words). However, Forster (1976) cites several other difficulties with the direct access model. Given the data one is forced to reject a pure application of the direct access model and consider a modified search model of lexical access.

The models of lexical access that presently best account for the data are the parallel search models. According to these models, word encoding operates on abstract representations of letter sequences processed in parallel with more fundamental processes of letter detection (McClelland & Rumelhart, 1981; Paap, Newsome, McDonald & Schvaneveldt, 1982). In such models, letter feature processing is viewed as a stage prior to word detection. However, word detection is postulated to be more rapid than letter identification (viz., word superiority effect). This seems counterintuitive, unless it is assumed that the word identification threshold is lower than letter identification threshold. The redundancy of letters in language allow a lower excitation level (e.g., below the threshold for letter identification) for any component letter of a word to be sufficient to cause the related word detector to cross threshold.

Research data describing the involvement of phonological codes in lexical access contribute to a more comprehensive understanding of lexical access. The data indicate that sound codes enter the lexicon via a parallel route. Supporting a theory of parallel phonological processing model is the "regularity effect" (Bauer & Stanovich, 1980) (see previous section describing phonological codes). It suggests that meaning is accessed independent of orthographic code. Van Orden (1988) proposed a verification model to account for his findings. The model identifies an intralexical process where phonological codes independently activate category exemplars which are in turn compared to the orthographic code (visual stimulus representation) for semantic comparison and word identification. In sum, lexical access of visual stimuli is the result of two systems operating in parallel. The physical features of the letter stimuli are processed in parallel with morphemic units of letter sequences that gain lexical status (Lima & Pollatsek, 1983). Importantly, visual activation is not the only access route to the lexicon. Phonological codes are activated and processed in parallel with orthographic codes. The phonological access route may be slightly slower when encountering a conflict in orthographic information, as in the case of irregular words (i.e., island). Nevertheless, they are independently sufficient to reach lexical status and further to access meaning from the lexicon. This interpretation is consistent with the dual-coding theory of lexical access where each coding system, each with its own component stages, operates in parallel.

3. Category Verification. The category verification involves the presentation of two stimulus words in rapid sequence. Subjects

are required to press one of two keys (or respond vocally) to indicate if the second stimulus word is a member of the same category as the first stimulus word. A correct response can only be made if the meanings associated with the prime word are perceived to be categorically consistent with meanings associated with the target word. There have been several theories of category verification process (see McCoskey & Glusksberg, 1979; Shoben, 1980; and Smith for reviews) and all agree that a correct response on the task involves post-lexical processing. The hierarchical associative relationship between category members (e.g., general category name and specific category exemplar) has special significance in category verification tasks. Loftus (1973) reported category verification task demonstrations of "category dominance" (the strength of relatedness of an instance to a general category) and "instance dominance" (the strength of relatedness of a category name to an instance of that category). Recently, Chumbley (1986) examined the variables "typicality" (Rosch, 1975), "instance dominance" (Battig & Montague, 1968), word frequency (Kucera & Francis, 1967), and "category selection time", and "difficulty at arriving at a category name, number of category names produce for a exemplar, number of subjects producing the target category name (each of the last three were compared to data collected by the researchers in earlier experiment) as predictors of RT on a various category verification tasks. A multiple regression analysis of the variables identified "category dominance" as the strongest predictor of RTs. Chumbley (1986) concluded that instance dominance and category dominance are two important factors in category verification. Moreover, that "it is no longer clear that typicality and exemplar/category similarity are the appropriate variables." Chumbley (1986) and Loftus (1973) both have suggested that search models (i.e., Collins & Loftus, 1975) best describe the associative process by which category dominance and instance dominance influence category verification.

spacing 2 4. Post-experiment entailment asymmetry questionnaires. The two post-experimental questionnaires were designed to assess subjects' judgment of the logical relationship between object a trait category pairs. Hierarchical asymmetry was operationalized by judgments of class-inclusion. Strict inclusion implies that subordinate category members are logically entailed by superordinates but the reverse is not true. Subjects were required indicate their the logical entailment relation of two traits. On one questionnaire, subjects were given the following statements and asked to indicate which of the two makes more sense:

(a) "To be punctual is a way of being dependable."
(b) "To be dependable is a way of being punctual."

On a second questionnaire all sentences, such as two above, were presented to subjects in a random order and subjects were asked to indicate on a 10 point scale the degree to which the sentence "makes sense".

# Chapter V

# EMPIRICAL RESEARCH

## Experiment 1: Lexical Decision

### Natural Object Category Stimuli

#### Method

Subjects. Eighty-eight undergraduate students received course credit in return for participation.

Stimuli and Apparatus. Stimuli consisted of 12 object hierarchy triads taken from Loftus and Bolton (1974), Rosch, et al., (1976), and Battig and Montague (1968) (see Appendix 1) and 14 normative trait hierarchy pairs taken from Hampson et al. (1986). According to Hampson et al.'s (1986) norms, half of the trait pairs chosen were judged to be "desirable traits" (e.g., friendly) and half "undesirable" (e.g., irritable) (see Appendix 3). For each of the prime-target word conditions an equal set of nonword stimuli pairs were used as distractors. Nonwords consisted of misspellings and orthographically correct nonwords. The mean length of nonwords closely matched the mean length of target words. In the selection of word stimuli, Kucera and Francis (1982) norms were consulted to control for word frequency. Stimuli were typed in capital letters and displayed on a standard Apple IIe green-screen cathode-ray tube, controlled by an Apple IIe microcomputer.

Procedure. Subjects were instructed to covertly read the prime word and to indicate whether target letters spelled a word or a nonword (e.g., house vs. souhe) by pressing a "yes" or "no" key. Subjects were positioned approximately 60 cm from the screen. A small cross prompt appeared in the center of the screen. After 300 msecs the cross was replaced by the prime word. After another 300 msecs interval the prime word was replaced by the target word. The subjects' response caused the offset of the target. The intertrial interval was 4 seconds. All subjects received 40 practice trials. Thirty-six subjects were included in an Object Group. Those subjects received all superordinate-middle-subordinate object pair combinations (e.g., SUP-SUB Condition, SUP-MID Condition, SUB-MID condition, MID-SUP Condition, MID-SUB Condition, and SUB-SUP Condition) and nonword distractors. A separate sample of fifty-two subjects were included in a Trait Group. The Trait Group received all desirable superordinate-subordinate trait pair conditions (DSUP-SUB and DSUB-SUP conditions), undesirable superordinate-subordinate trait pair conditions (USUP-SUB and USUB-SUP conditions), and nonword distractors. Prime-target pairs were orthogonally balanced with respect to hierarchical level. All trial presentations were randomized. Subjects that received the trait stimuli completed a post-experiment questionnaire designed to determine their individual level of agreement with the hierarchy asymmetry relationships of trait pairs used in the experiment (see Appendix 5, Part A).

## Results and Discussion

Subjects with error rates of less than 10 percent were included in the following analysis and RT outliers of greater than 1500 msecs were excluded. Repeated measures analysis of variance (ANOVA) was conducted on the subjects' RTs to natural-object stimuli indicated a significant difference between conditions $F(6,174) = 9.99, p < .001$. $t$-test comparisons indicated mean RT for nonwords (676 msec) were significantly longer than any of the word conditions $t = 3.52, p < .001$. The only significant comparison between word conditions was the SUP-SUB (593 msec) and SUB-SUP Conditions (628 msec) $t = 2.84$, $p < .01$. Subjects responses to subordinate targets were significantly faster compared to superordinate targets (see Table 2).

Analysis of RTs to trait stimuli indicated that mean RTs to nonwords (884 msec) were significantly longer than mean RTs to any word conditions $t = 5.14, p < .001$. A repeated measures ANOVA that included two within-subjects factors of "Direction" (SUP-SUB and SUB-SUP conditions) and "Desire" (desirable and undesirable trait conditions) was conducted. The analysis indicated a significant Direction by Desire interaction $F(1,41) = 6.28, p < .01$. Paired comparisons indicated that the mean RT in the USUB-SUP condition (775 msec) was significantly slower than the mean RT in the USUP-SUB condition (715 msec) ($t$ =3.70, $p$ =.001), however, there was no significant difference between the mean RTs in the DSUB-SUP (706 msec) and DSUP-SUB (700 msec) conditions (see Table 2).

The pattern of RTs suggest a bias for access of subordinate words compared to hierarchically related superordinate words. Subjects' mean RTs to object and trait words were fastest when target word was a subordinate and slowest when the target word was a superordinate. This effect, however, was not significant for the desirable traits (see Figure 3).

Table 2. Experiment 1: Subjects mean RT's to subordinate and superordinate prime and target conditions for natural-object and trait words

| | Prime-Target Condition | Mean RT msec | Standard Deviation |
|---|---|---|---|
| Natural objects | SUP-MID | 612 | 122.68 |
| | *SUP-SUP | 593 | 128.18 |
| | MID-SUP | 611 | 107.08 |
| | MID-SUB | 601 | 112.45 |
| | SUB-MID | 597 | 126.62 |
| | *SUB-SUP | 628 | 122.69 |
| | NWORDS | 676 | 112.72 |
| Traits | DSUP-SUB | 700 | 122.83 |
| | DSUB-SUP | 715 | 133.15 |
| | *USUP-SUB | 706 | 120.20 |
| | *USUB-SUP | 775 | 124.08 |
| | NWORDS | 884 | 152.93 |
| Data adjusted based on responses on post-experiment questionnaire | | | |
| Traits | DSUP-SUB | 704 | 127.86 |
| | DSUB-SUP | 704 | 138.66 |
| | **USUP-SUB | 721 | 141.25 |
| | **USUB-SUP | 764 | 124.26 |

* indicates paired comparison $p < .05$.
** indicates paired comparison $p < .08$.

Figure 3. Experiment 1 means.

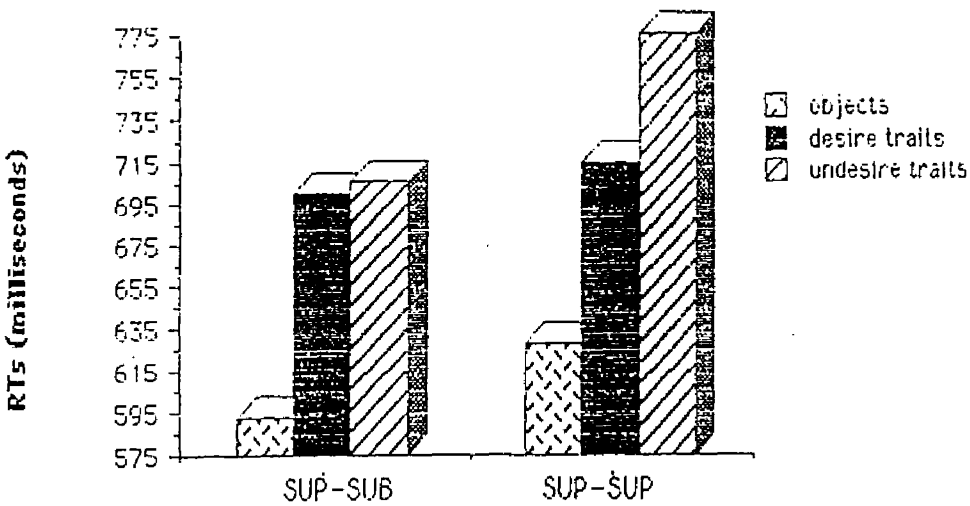
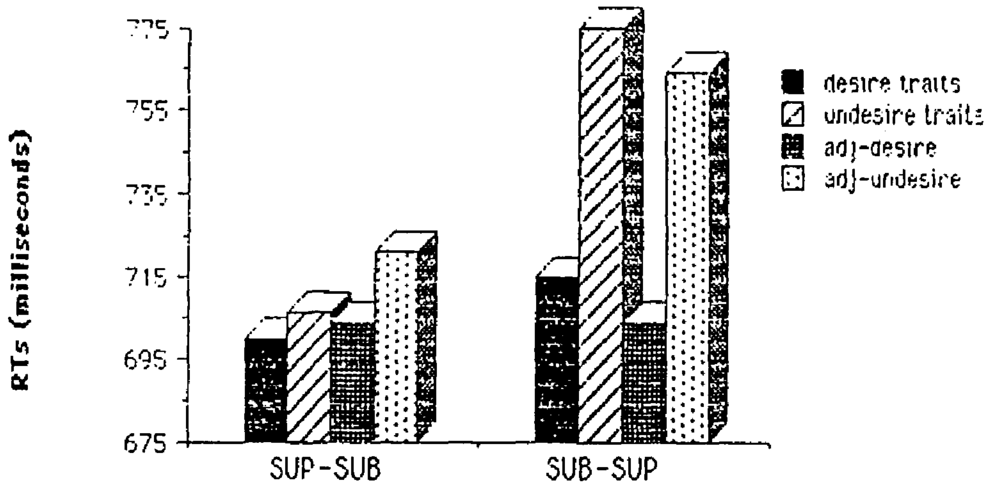


Figure 4. Experiment 1 adjusted means based on
--------- post-experiment questionnaire.



The data collected in the post-experimental questionnaire were used to construct subjects' individual trait hierarchies. A post hoc recoding of the trait stimuli conditions was conducted based on subjects' responses on these questionnaires. In comparison to the original findings, the recoding the data served to attenuate the original effect. The Direction by Desire interaction was only marginally significant $\underline{F}(1,37) = 2.63, \underline{p} < .11$. There was a significant main effect for Desire ($\underline{F} = 7.47, \underline{p} < .01$) Paired comparisons of means indicated that the mean RT in the USUB-SUP condition (764 msec) compared to the the USUP-SUB condition (721 msec) was only marginally significant ($\underline{t} = 1.78$, $\underline{p} = .08$). As in the original analysis, there was no significant difference between the mean RTs in the DSUB-SUP (704 msec) and DSUP-SUB (704 msec) conditions (see Table 2). The pattern of RTs in the adjusted data, however, was the same as the original findings. (see Figure 4).

The fact that RTs to desirable trait pairs were not the same as the undesirable traits or natural objects was an interesting finding. However, prior to speculating on what this finding might mean there are some criticisms of the present study that are necessary to address. In this experiment, comparisons were made between subjects' responses in the SUP-SUB and SUB-SUP condition for both objects and traits within in a lexical decision task. Consequently, there are two possible problems. First, the primes varied between the conditions being compared. For example, the SUP-SUB condition included the prime word "VEHICLE" and the target word "CAR", and in the SUB-SUP condition the prime word "CAR" and the target word "VEHICLE". The contribution of the prime word to any facilitation in RT can not be assessed without a neutral prime condition (see note 1). Second, because the experiment only involved a lexical decision task, the result may be specific to that task. These problems were rectified in the following three experiments. Three different RT experiments were conducted (pronunciation, lexical decision, and category verification tasks) with the inclusion of a neutral prime condition for all stimuli. Within these experiments, comparisons between conditions were made relative to the neutral prime condition.

## Experiment 2: Lexical Decision

### Method

Subjects. Twenty undergraduates received course credit in return for participation.

Stimuli and Apparatus. In each of the following experiments stimuli consisted of natural-object hierarchy pairs (superordinates and subordinates) taken from Loftus and Bolton (1974), Battig and Montague (1968), and Rosch, et al., (1976) (see Appendix 3) and desirable and undesirable hierarchy pairs (superordinates and subordinates) taken from Hampson et al., (1986) (see Appendix 2). A neutral prime condition was included for all hierarchy pairs. Neutral primes consisted of the word "BLANK". Stimuli were typed in capital letters and displayed on a standard Apple IIe green-screen cathode-ray tube, and were controlled by an Apple IIe microcomputer. In the present experiment, nonword distractors consisted of misspellings and orthographically correct nonwords. The mean length of nonwords closely matched the mean length of target words. The apparatus was the same as in Experiment 1.

Procedure. Procedure was identical to Experiment 1. Subjects were given instruction that stressed both accuracy and speed. They received 40 practice trials. Subjects received stimuli shown in appendices 2 and 3. Every subject then received all object superordinate-subordinate pairs (SUP-SUB Condition and SUB-SUP condition), all desirable superordinate-subordinate pairs (DSUP-SUB condition and DSUB-SUP condition), all undesirable superordinate-subordinate pairs (USUP-SUB condition and USUB-SUP conditions), the corresponding neutral pairs for objects and traits

(BLANK-SUP and BLANK-SUB conditions), and all nonword distractor trials. In each of the following experiments subjects completed a post-experiment questionnaire designed to determine each subject's individual level of agreement with the hierarchical relationship of object and trait word pairs used in the experiment and their confidence in those ratings (see Appendix 4 and 5).

Results and Discussion

For each of the following conditions RT distributions for each condition were examined. All outliers greater than two standard deviations from the mean were not included in the analysis. Means, standard deviations, error rates for conditions, $t$-values and significance levels for word condition paired comparisons are reported in Tables 5, 6, and 7 for the present Experiment 2, and Tables 8-13 for Experiments 3 and 4. Analysis of errors indicated an overall error rate of 5.1% for to natural-objects and 5.7% for traits.

Repeated measures ANOVA on the subjects' RTs to natural-object stimuli indicated RTs to nonwords did not significantly vary across conditions ($F(1,19) = .38, p < .55$). An ANOVA that included all nonword and word conditions reached significance $F(4,76) = 16.85, p < .001$. Paired comparisons of words and nonwords indicated that nonwords (649.47 msec) produced significantly longer RTs ($t = 31.86, p < .001$) compared to the word conditions. Repeated measures ANOVA that included only the natural-object word conditions was significant $F(3,57) = 4.37, p < .008$. Paired comparisons of mean RT in the BLANK-SUB condition (557.90 msec) with the BLANK-SUP condition (600.68 msec) reached significance ($t = 12.79, p < .002$) (see Figure 5 and Table 3).

Table 3. Means, error rates, standard deviations, and t-test significance levels of paired condition comparisons for RTs to natural-objects in the lexical decision experiment.

OBJECTS

| Prime-Target Conditions | Mean RTs (msec) | Error Rate | Standard Deviation | t value | t-test Significance Level |
|---|---|---|---|---|---|
| BLANK-SUB | 557.90 | .03 | 52.51 | | |
| WITH | | | | | |
| BLANK-SUP | 600.68 | .05 | 72.60 | 12.52 | p < .002 |
| BLANK-SUB | 557.90 | | | | |
| with | | | | | |
| SUP-SUB | 566.95 | .02 | 90.82 | .53 | p < .47 |
| BLANK-SUP | 600.68 | | | | |
| with | | | | | |
| SUB-SUP | 585.81 | .02 | 72.76 | 1.61 | p < .22 |
| SUP-SUB | 566.95 | | | | |
| with | | | | | |
| SUB-SUP | 585.81 | | | 1.48 | p < .23 |
| FACILITATION EFFECT | | | | | |
| SUP-SUB | -9.04 | | 55.56 | | |
| with | | | | | |
| SUB-SUP | 14.86 | | 52.47 | 1.82 | p < .19 |

Figure 5. Experiment 2 object means.

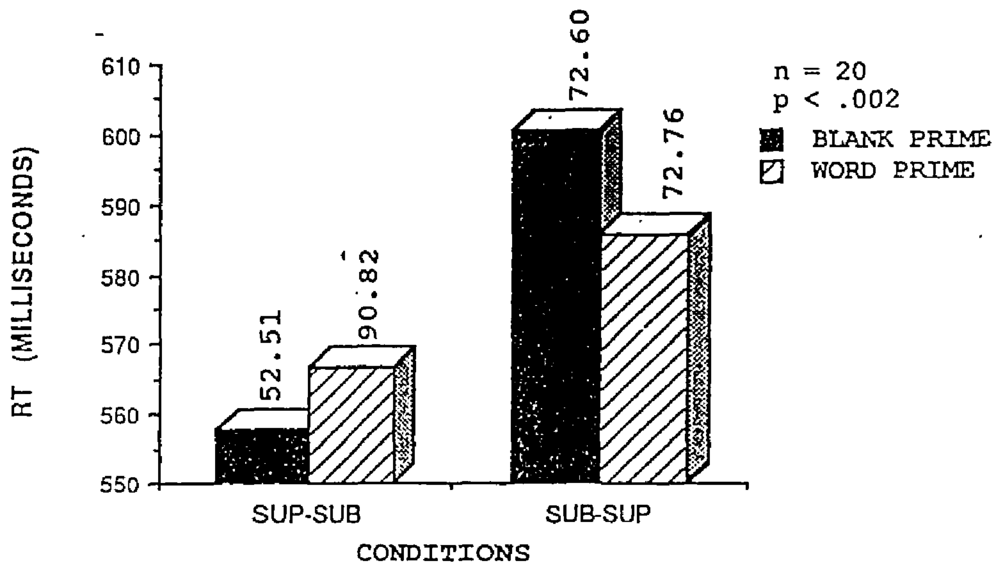
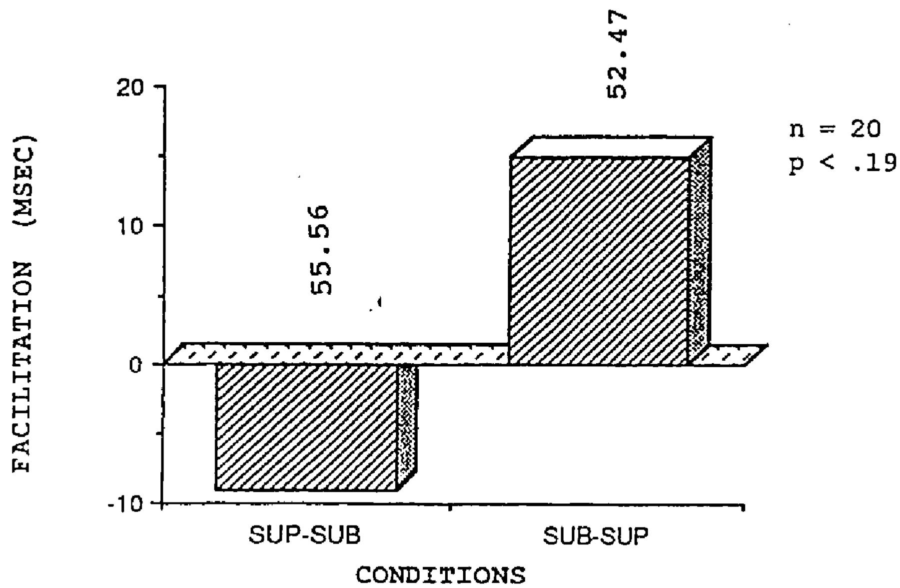


Figure 6. Experiment 2 object facilitation effect.



The facilitation effect was calculated for each of the following experiments by subtracting the RT on the word prime conditions (e.g., SUP-SUB and SUB-SUP) from their corresponding neutral conditions (e.g., BLANK-SUB and BLANK-SUP). This served as an indicator of the priming advantage gained by having a been exposed to a superordinate or subordinate word as a prime. Comparisons of the facilitation effects in the SUB-SUP condition and the SUP-SUB condition was not significant ($\underline{t}$ = 1.82, $\underline{p}$ < .19) (see Figure 6 and Table 3).

RTs to trait stimuli indicated that RTs in one nonword condition (705.90 msec) was significantly more rapid than the other nonword conditions $\underline{F}(3,48)$ = 3.30, $\underline{p}$ < .02). Nevertheless, it was still 40 msecs longer than the word condition with the longest RT. A repeated measures ANOVA performed on word and nonword conditions indicated a significant difference between conditions $\underline{F}(8,152)$ = 15.83, p < .0001. Nonwords (755.79 msec) produced the significantly longest RTs ($\underline{t}$ = 22.56, p < .0001). Repeated measures ANOVA that included the only the word conditions indicated a significant difference between trait word conditions $\underline{F}(7,133)$ = 2.74, $\underline{p}$ < .01 (see Figure 7). Paired comparisons indicated that for undesirable traits mean RTs in the BLANK-SUB condition (608.09 msec) were faster than mean RTs in the BLANK-SUP condition (646.97 msec) ($\underline{t}$ = 11.96, $\underline{p}$ < .003) (see Table 4). The opposite pattern was found for desirable traits. The RTs to desirable traits in the BLANK-SUP condition (622.66 msec) were significantly more rapid than RTs in the BLANK-SUB condition (663.28 msec) $\underline{t}$ = 8.36, $\underline{p}$ < .009 (see Figure 7). The facilitation effect was calculated exactly as it was for RTs to natural-objects.

Table 4. Means, error rates, standard deviations, and t-test
-------- significance levels of paired condition comparisons for
RTs to traits in the lexical decision experiment.

DESIRABLE TRAITS

| Prime-Target Conditions | Mean RTs (msec) | Error Rate | Standard Deviation | t value | t-test significance level |
|---|---|---|---|---|---|
| BLANK-SUB | 663.28 | .08 | 100.38 | | |
| With | | | | | |
| BLANK-SUP | 622.66 | .04 | 92.94 | 8.36 | $p < .009$ |
| BLANK-SUB | 663.28 | | | | |
| with | | | | | |
| SUP-SUB | 617.95 | .03 | 101.51 | 6.67 | $p < .01$ |
| BLANK-SUP | 662.66 | | | | |
| with | | | | | |
| SUB-SUP | 639.05 | .03 | 87.79 | 1.19 | $p < .28$ |
| SUP-SUB | 617.95 | | | | |
| with | | | | | |
| SUB-SUP | 639.95 | | | 2.23 | $p < .14$ |

UNDESIRABLE TRAITS

| Prime-Target Conditions | Mean RTs (msec) | Error Rate | Standard Deviation | t value | t-test significance level |
|---|---|---|---|---|---|
| BLANK-SUB | 608.09 | .03 | 86.18 | | |
| WITH | | | | | |
| BLANK-SUP | 646.97 | .04 | 73.94 | 11.96 | $p < .003$ |
| BLANK-SUB | | | | | |
| with | | | | | |
| SUP-SUB | 632.13 | .04 | 79.13 | 3.12 | $p < .09$ |
| BLANK-SUP | 646.97 | | | | |
| with | | | | | |
| SUB-SUP | 634.84 | .05 | 97.85 | .61 | $p < .45$ |
| SUP-SUB | 632.13 | | | | |
| with | | | | | |
| SUB-SUP | 634.84 | | | .03 | $p < .86$ |

Table 5. Means, standard deviations, and t-test
-------- significance levels of paired condition comparisons for
trait facilitation effects in the lexical decision experiment.

FACILITATION EFFECT

| Prime-Target Conditions | Mean (msec) | Standard Deviation | t value | t-test significance level |
|---|---|---|---|---|
| DSUP-SUB | 45.66 | 79.05 | | |
| with | | | | |
| DSUB-SUP | -16.39 | 67.11 | 6.82 | $p < .01$ |
| DSUP-SUB | 45.66 | | | |
| with | | | | |
| USUP-SUB | -24.03 | 60.82 | 8.15 | $p < .01$ |
| USUP-SUB | -24.03 | | | |
| WITH | | | | |
| USUB-SUP | 12.13 | 69.63 | 3.97 | $p < .06$ |
| DSUB-SUP | -16.39 | | | |
| with | | | | |
| USUB-SUP | 12.13 | | 2.40 | $p < .13$ |

Figure 7. Experiment 2 Trait means

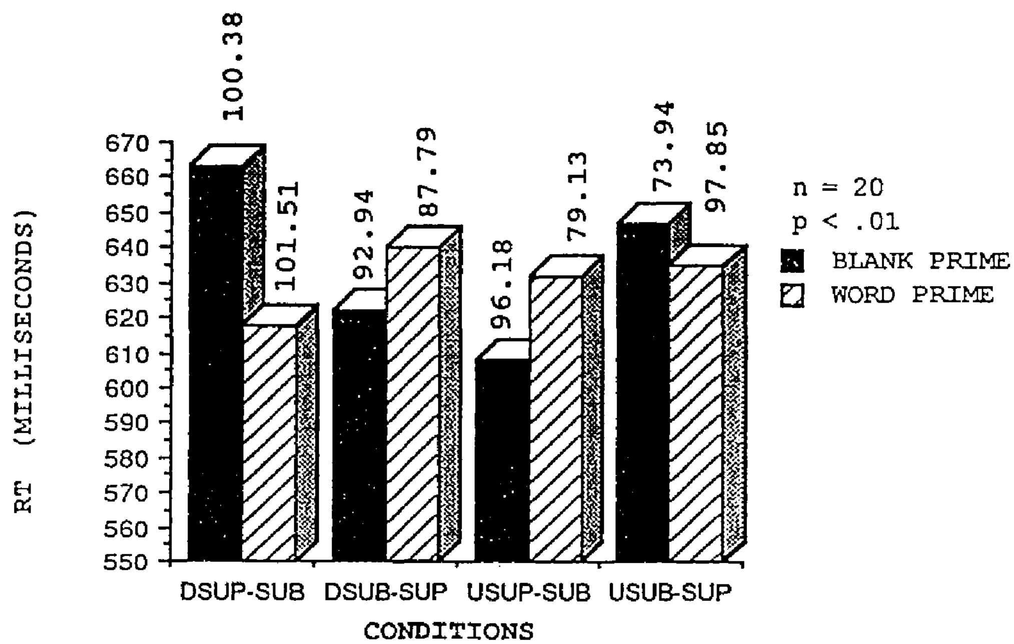
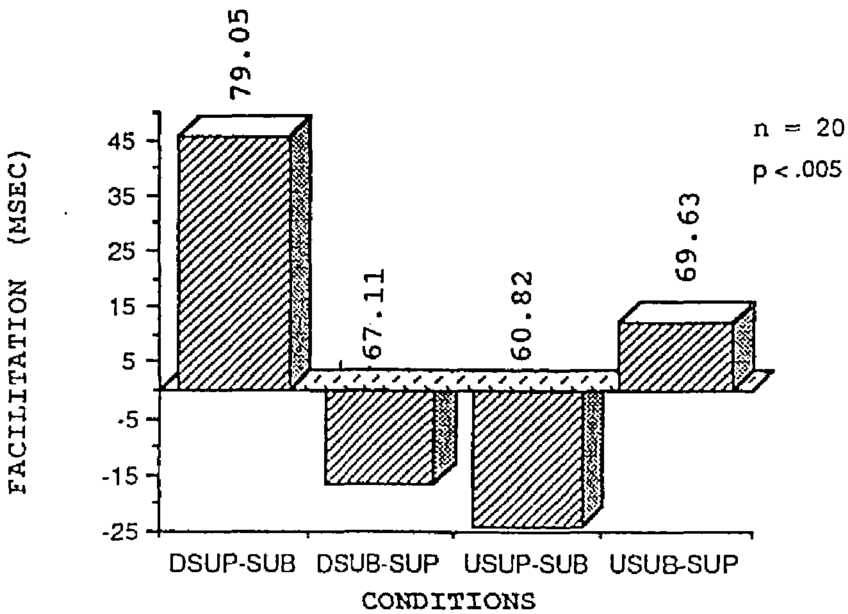


Figure 8. Experiment 2 trait facilitation effect



A repeated measures ANOVA that included two within-subjects factors of "Direction" (SUP-SUB and SUB-SUP conditions) and "Desire" (desirable and undesirable trait conditions) was conducted. The analysis indicated a significant interaction effect of Desire by Direction $\underline{F}(1,19) = 8.23$, $p < .01$. This indicated that facilitation effect varied with the hierarchical level and desirability of the prime and target. The DSUP-SUB condition produced significantly more facilitation compared to the DSUB-SUP condition ($\underline{t} = 6.82$, $\underline{p} = .01$) (see Table 5 and Figure 8). The pattern of the facilitation effect for undesirable traits was opposite to that displayed by the desirable traits (see Figure 8). In sum, desirable superordinate traits were responded to faster as targets than desirable subordinate traits and they also served as better primes than desirable subordinates traits. Undesirable traits displayed the opposite priming pattern (see Figure 8).

To assess the variability of RTs to each word pair within conditions, in each of the following experiments an ANOVA of RTs to items by conditions was conducted. The ANOVA of RTs across items within each word prime condition did not reached significance for any of the natural-object conditions. However, the SUB-SUP condition ($\underline{F}(10,199) = 1.72$, $\underline{p} = .07$) was marginally significant. Analysis of trait items indicated a significant amount of variance in the DSUB-SUP ($\underline{F}(6,117) = 3.29$, $\underline{p} = .004$), USUP-SUB ($\underline{F}(6,115) = 6.24$, $\underline{p} = .0001$). The USUB-SUP condition was marginally significant ($\underline{F}(6,112) = 1.88$, $\underline{p} = .08$). This indicated a significant amount of variability in the priming effect across items. In order to evaluate priming effects for items independently, facilitation effects were calculated for each item. Facilitation indices in the SUP-SUB and SUB-SUP conditions were then compared. For the objects, six of the eleven items displayed facilitation consistent with the previous analysis by condition (viz., greatest facilitation in the SUB-SUP condition). For the traits, six of the seven items in the DSUP-SUB condition and five of the seven items in the USUB-SUP condition displayed facilitation consistent with the previous analysis by condition (Table 6).

In the present experiment and for each of the following experiments subjects' responses on the post-experiment questionnaires are reported in Tables 7 and 8. Subjects judgment of hierarchy asymmetries indicated a high level agreement with the object and trait hierarchy norms that were used. Moreover, subjects rating of their certainty of the entailment relationship between the superordinate and subordinate category items were consistently very high (see Tables 7 and 8).

In the present experiment and in each of the following experiments, a linear regression analysis was conducted to assess the correlation between RT facilitation and subjects' judgment of the logical entailment relationship between stimulus pairs. All regression analyses indicated no significant systematic relationship between RTs and entailment certainty judgments (see Table 9). However, two of the analyses in the pronunciation and one in the category verification experiment were marginally significant.

Table 6. Tally of items that displayed facilitation
-------- effects consistent with the analysis by condition.

| | Object item # | Trait item # | |
|---|---|---|---|
| Task | | Desirable | Undesirable |
| Pronunciation: | 1,2,3,7,8,11 | 2,4,6,14 | 1,5,7,13 |
| Lexical Decision: | 5,6,8,9,10,11 | 2,6,8,10,12,14 | 1,3,5,7,13 |
| Category Verification: | 2,3,4,5,6,8,11 | 2,6,10,12 | 5,7,9,13 |

Table 7. Descriptive Statistics from Post Experiment
-------- Questionnaires: Asymmetry Judgments.

Objects

| n | Mean # Items Correct | % | # of Correct Items | # Subjects | % Subjects |
|---|---|---|---|---|---|
| 12 | 10.88 | 91% | 11 | 72 | 90% |
| | | | 10 | 7 | 9% |
| | | | 9 | 1 | 1% |
| | | | 8 | 0 | 0% |

Desirable Traits

| n | Mean # Items Correct | % | # of Correct Items | # Subjects | % Subjects |
|---|---|---|---|---|---|
| 7 | 5.58 | 80% | 7 | 18 | 21% |
| | | | 6 | 34 | 39% |
| | | | 5 | 21 | 24% |
| | | | 4 | 11 | 12% |
| | | | 3 | 2 | 3% |
| | | | 2 | 0 | 0% |
| | | | 1 | 1 | 1% |
| | | | 0 | 0 | 0% |

Undesirable Traits

| n | Mean # Items Correct | % | # of Correct Items | # Subjects | % Subjects |
|---|---|---|---|---|---|
| 7 | 5.24 | 75% | 7 | 10 | 12% |
| | | | 6 | 28 | 32% |
| | | | 5 | 31 | 36% |
| | | | 4 | 9 | 10% |
| | | | 3 | 9 | 10% |
| | | | 2 | 0 | 0% |

Table 8. Descriptive Statistics from Post Experiment
-------- Questionnaires: Entailment Certainty Ratings.

Objects

| Sentence Type | Mean Rating | # Subjects Rate SUB-SUP > SUP-SUB | % Subjects Rate SUB-SUP > SUP-SUB |
|---|---|---|---|
| SUP-SUB | 2.99 | 0 | 0% |
| SUB-SUP | 6.51 | 80 | 100% |

Desirable Traits

| Sentence Type | Mean Rating | # Subjects Rating SUB-SUP > SUP-SUB | % Subjects Rate SUB-SUP > SUP-SUB |
|---|---|---|---|
| DSUP-SUB | 3.37 | 6 | 7% |
| DSUB-SUP | 6.99 | 81 | 93% |

Undesirable Traits

| Sentence Type | Mean Rating | # Subjects Rate SUB-SUP > SUP-SUB | % Subjects Rate SUB-SUP > SUP-SUB |
|---|---|---|---|
| USUP-SUB | 3.14 | 7 | 8% |
| USUB-SUP | 6.04 | 80 | 92% |

Table 9. Regression Analyses of Post-Experiment Entailment
-------- Certainty Ratings vs. Facilitation Effect

Lexical Decision Experiment:

| Objects | R | Intercept | Slope | Significance of Slope |
|---|---|---|---|---|
| SUP-SUB | .27 | 1.70 | .024 | .38 |
| SUB-SUP | -.02 | 8.75 | -.0001 | .95 |
| **Desirable Traits** | | | | |
| DSUP-SUB | -.37 | 3.53 | -.009 | .41 |
| DSUB-SUP | .09 | 7.05 | .002 | .84 |
| **Undesirable Traits** | | | | |
| USUP-SUB | -.05 | 3.22 | -.001 | .90 |
| USUB-SUP | -.48 | 5.87 | -.019 | .26 |

Pronunciation Experiment:

| Objects | R | Intercept | Slope | Significance of Slope |
|---|---|---|---|---|
| SUP-SUB | .28 | 0.69 | .043 | .39 |
| SUB-SUP | .44 | 8.64 | .011 | .17 |
| **Desirable Traits** | | | | |
| DSUP-SUB | -.32 | 4.10 | -.029 | .47 |
| DSUB-SUP | -.31 | 7.24 | -.020 | .48 |
| **Undesirable Traits** | | | | |
| USUP-SUB | .67 | 3.09 | .04 | .09 |
| USUB-SUP | -.71 | 6.24 | -.06 | .06 |

Category Verification Experiment:

| Objects | R | Intercept | Slope | Significance of Slope |
|---|---|---|---|---|
| SUP-SUB | -.13 | 1.75 | -.008 | .69 |
| SUB-SUP | .57 | 8.50 | .003 | .06 |
| **Desirable Traits** | | | | |
| DSUP-SUB | -.31 | 3.44 | -.004 | .48 |
| DSUB-SUP | .15 | 5.85 | .003 | .73 |
| **Undesirable Traits** | | | | |
| USUP-SUB | .28 | 3.18 | .002 | .53 |
| USUB-SUP | .08 | 6.02 | .0008 | .85 |

## Experiment 3: Pronunciation task

### Method

Subjects. Thirty-two undergraduate students received course credit in return for participation.

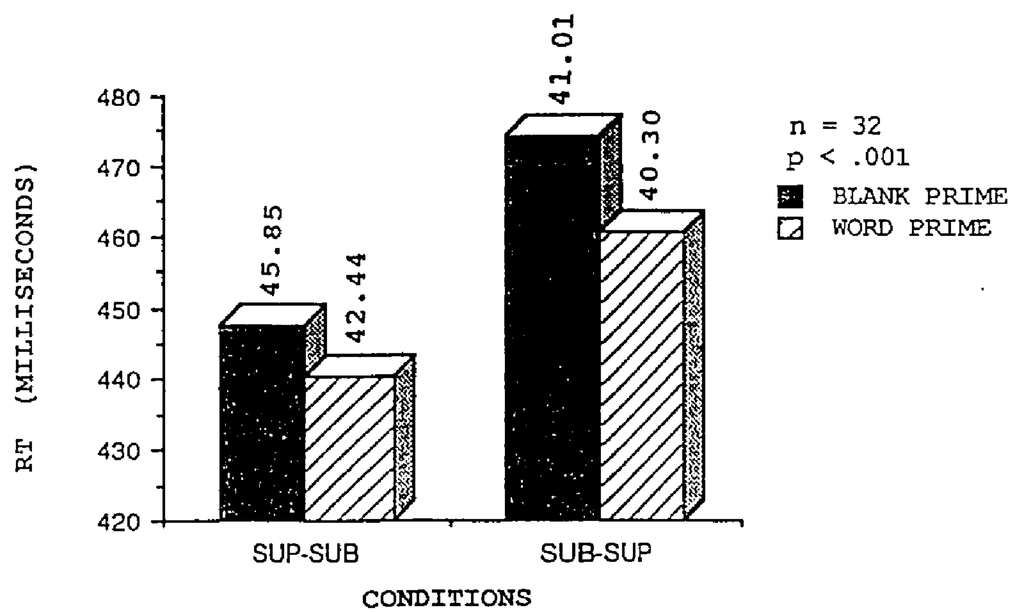
Stimuli and Apparatus. Stimuli were identical previous experiments. The apparatus in the present experiment, however, included a voice activated relay.

Procedure. Presentation of stimuli was identical to previous experiments. Subjects were instructed to covertly read the prime word and pronounce the target words. Subjects received 40 practice trials then either all of the object stimuli followed by the trait stimuli, or all trait stimuli followed by the object stimuli. Every subject received all combinations of the superordinate-subordinate object pairs (SUP-SUB condition and SUB-SUP condition), the desirable superordinate-subordinate trait pairs (DSUP-SUB condition and DSUB-SUP condition), the undesirable superordinate-subordinate trait pairs (USUP-SUB condition and USUB-SUP conditions), and all corresponding neutral pairs for objects and traits (BLANK-SUP and BLANK-SUB conditions). Subjects were given instructions that stressed accuracy and speed. Subjects completed the post-experiment questionnaire.

### Results and Discussion

Repeated measures ANOVA indicated a significant difference between all natural-object conditions $F(1,31) = 48.58, p < .0001$ (see Figure 9).

Figure 9. Experiment 3 object means



Paired comparisons indicated that RTs were the most rapid in conditions where the target word was a subordinate. That is, the SUP-SUB condition (440.547 msec) was significantly more rapid than the SUB-SUP (460.548 msec) $\underline{t}$ = 35.88,$\underline{p}$ <.0001 and the BLANK-SUB condition (447.604 msec) was significantly faster than the BLANK-SUP condition (474.576 msec) $\underline{t}$ = 70.97,$\underline{p}$ < .0001. Priming was demonstrated in the SUP-SUB condition (440.547 msec) relative to its corresponding neutral BLANK-SUB condition (447.604 msec) $\underline{t}$ = 6.61,$\underline{p}$ <.01. The same was true for the SUB-SUP (460.548 msec) and the BLANK-SUP (474.576) conditions $\underline{t}$ = 26.10,$\underline{p}$ <.0001 (see Table 10). The facilitation effect for SUP-SUB (7.057 msec) and SUB-SUP (14.028 msec) was marginally significant ($\underline{t}$ = 2.80,p < .10) (see Table 10). The pattern, however, was consistent with experiment 2. RTs showed more facilitation when the prime was a subordinate compared to when the prime was a superordinate (see Figure 10). In sum, subordinates targets produced the more rapid RTs than superordinate targets and as primes they produced more facilitation than superordinates.

Repeated measures ANOVA indicated a significant difference between trait conditions $\underline{F}$(7,210) = 8.74,$\underline{p}$ < .0001 (see Figure 11). Paired comparisons indicated that for undesirable traits mean RTs in the BLANK-SUP condition (489.49 msec) were significantly faster than the mean RT in the BLANK-SUB condition (502.70 msec) ($\underline{t}$ = 5.50,$\underline{p}$ < .02). The same pattern was found for desirable traits. RTs in the BLANK-SUP condition (509.15 msec) were significantly more rapid than RTs in the BLANK-SUB condition (525.46 msec) ($\underline{t}$ = 8.75,$\underline{p}$ < .006) (see Table 11). The facilitation effect was calculated exactly as it was for the object conditions. A repeated measures ANOVA that included two within-subjects factors of "Direction" (SUP-SUB and SUB-SUP

Table 10. Means, standard deviations, and t-test significance levels
-------- of paired condition comparisons for RTs to natural-object in the pronunciation experiment.

OBJECTS

| Prime-Target conditions | Mean RTs (msec) | Standard Deviation | t value | t-test significance Level |
|---|---|---|---|---|
| BLANK-SUB | 447.60 | 45.85 | | |
| with | | | | |
| BLANK-SUP | 474.57 | 41.01 | 70.97 | p < .0001 |
| BLANK_SUB | | | | |
| with | | | | |
| SUP-SUB | 440.54 | 42.44 | 6.61 | p < .01 |
| BLANK-SUP | 474.57 | | | |
| with | | | | |
| SUB-SUP | 460.54 | 40.30 | 26.10 | p < .0001 |
| SUP-SUB | 440.54 | | | |
| with | | | | |
| SUB-SUP | 460.54 | | 38.88 | p < .0001 |

FACILITATION EFFECT

| | | | | |
|---|---|---|---|---|
| SUP-SUB | 7.05 | 15.52 | | |
| with | | | | |
| SUB-SUP | 14.02 | 15.53 | 2.80 | p < .10 |

Table 11. Means, standard deviations, and t-test significance levels
--------- of paired condition comparisons for RTs to traits in the pronunciation experiment.

DESIRABLE TRAITS

| Prime-Target Conditions | Mean RTs (msec) | Standard Deviation | t value | t-test significance level |
|---|---|---|---|---|
| BLANK-SUB | 525.46 | 42.01 | | |
| with | | | | |
| BLANK-SUP | 509.15 | 41.90 | 8.75 | $p < .006$ |
| BLANK_SUB | | | | |
| with | | | | |
| SUP-SUB | 505.95 | 45.01 | 15.58 | $p < .0001$ |
| BLANK-SUP | 509.15 | | | |
| with | | | | |
| SUB-SUP | 499.53 | 44.25 | 4.50 | $p < .04$ |
| SUP-SUB | 505.95 | | | |
| with | | | | |
| SUB-SUP | 499.53 | | 1.78 | $p < .19$ |
| UNDESIRABLE TRAITS | | | | |
| BLANK-SUB | 502.70 | 41.59 | | |
| with | | | | |
| BLANK-SUP | 489.49 | 47.35 | 5.50 | $p < .02$ |
| BLANK-SUB | | | | |
| with | | | | |
| SUP-SUB | 503.33 | 42.51 | .01 | $p < .91$ |
| BLANK-SUP | 489.49 | | | |
| with | | | | |
| SUB-SUP | 486.33 | 40.20 | .23 | $p < .63$ |
| SUP-SUB | 503.33 | | | |
| with | | | | |
| SUB-SUP | 486.33 | | 10.41 | $p < .003$ |

Figure 10. Experiment 3 object facilitation

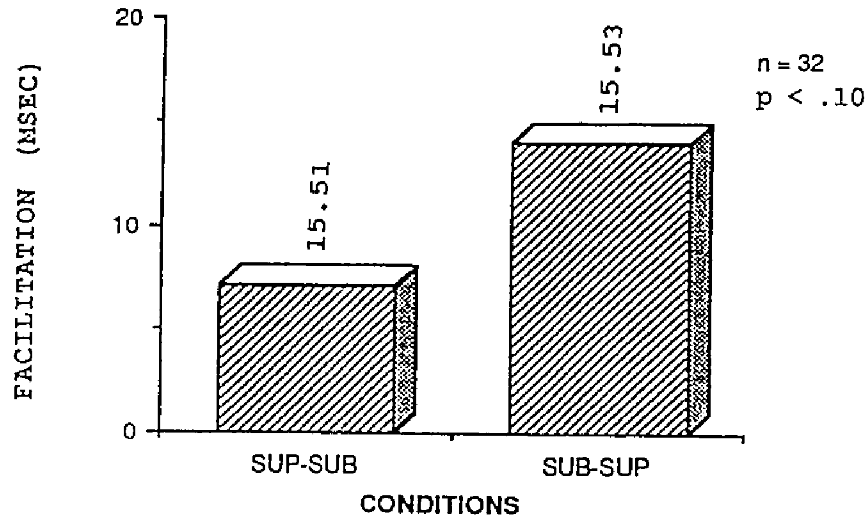
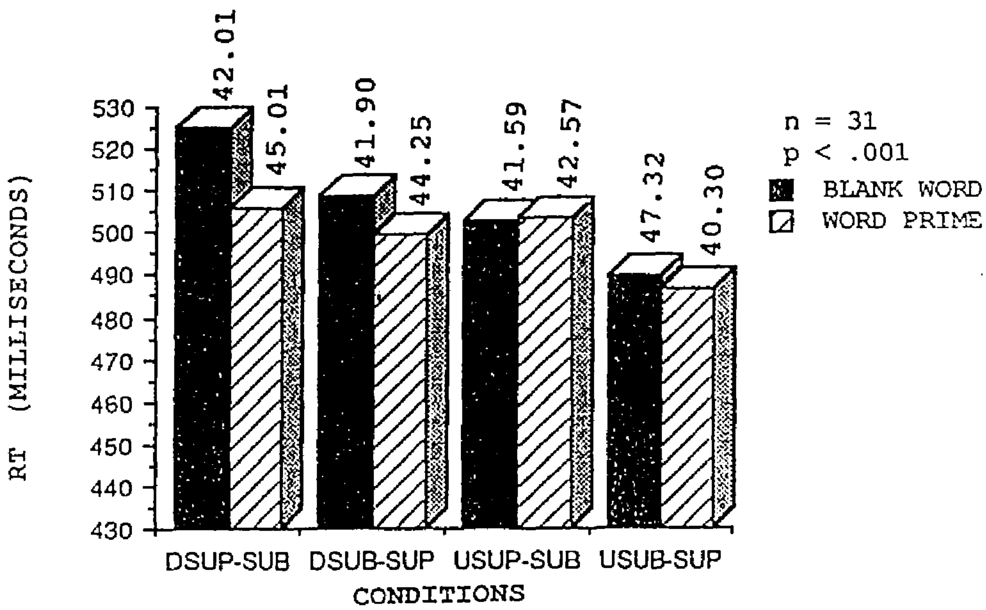


Figure 11. Experiment 3 trait means



conditions) and "Desire" (desirable and undesirable trait conditions) was conducted. The analysis indicated a significant main effect for Desire $\underline{F}(1,30) = 5.30$, $p < .01$ (see Figure 12). Paired comparisons indicated that facilitation was significantly greater in the DSUP-SUB condition (19.50 msec) compared to the USUP-SUB condition (-.63) ($\underline{t} = 33.56$, $\underline{p} < .01$) (see Table 12). The pattern of the facilitation effect for undesirable traits was opposite to that displayed by the desirable traits (see Figure 12).

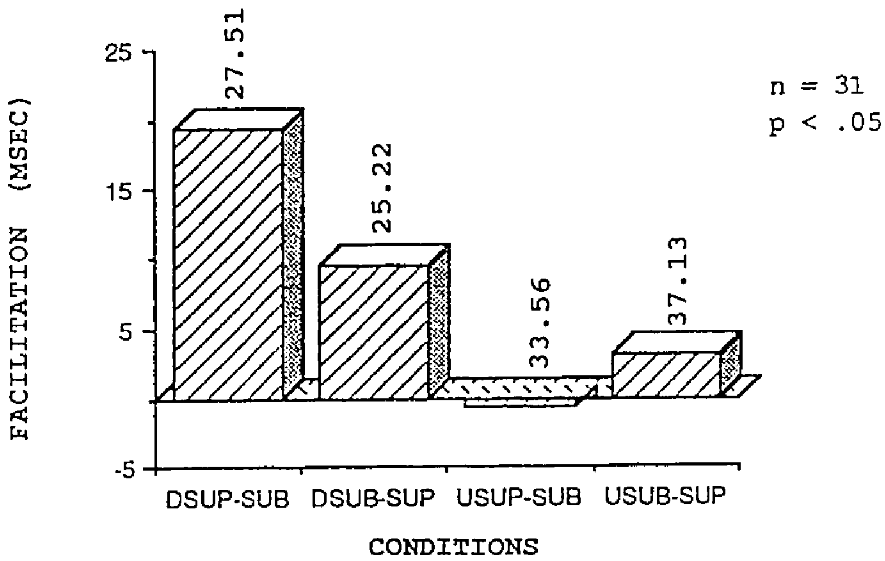
To assess the variability of RTs to item within conditions, an ANOVA of items by conditions was conducted. For natural-objects this analysis did not reached significance. For traits, significance was reached in the DSUB-SUP ($\underline{F}(6,181) = 3.93$, $\underline{p} < .001$), USUB-SUP ($\underline{F}(6,167) = 5.14$, $\underline{p} < .0001$), and USUP-SUB ($\underline{F}(6,186) = 3.74$, $\underline{p} < .001$) conditions. This indicated a significant amount of variance in the effect of the prime across items within these conditions. In order to evaluate items independently, facilitation effects (calculated in the same manner as they were in the condition analysis) were calculated for each item. Facilitation indexes in the SUP-SUB and SUB-SUP conditions were then compared. This indicated the number of items that displayed the same pattern of facilitation displayed in the previous analysis by condition. For the objects, six of the eleven items displayed facilitation consistent with the previous analysis by condition (viz., greater facilitation in the SUB-SUP condition. For both desirable and undesirable traits, four of the seven items showed facilitation consistent with the previous analysis by condition (viz., greater facilitation in the DSUP-SUB and USUB-SUP conditions) (see Table 6).

Table 12. Means, standard deviations, and t-test significance levels of trait facilitation effect in the pronunciation experiment.

FACILITATION EFFECT

| Prime-Target Conditions | Mean (msec) | Standard Deviation | t value | t-test significance level |
|---|---|---|---|---|
| DSUP-SUB | 19.50 | 27.51 | | |
| with | | | | |
| DSUB-SUP | 9.61 | 25.22 | 2.17 | $p < .15$ |
| DSUP-SUB | | | | |
| with | | | | |
| USUP-SUB | -.63 | 33.56 | 7.47 | $p < .01$ |
| USUP-SUB | -.63 | | | |
| with | | | | |
| USUB-SUP | 3.16 | 37.13 | .22 | $p < .63$ |
| DSUB-SUP | 9.61 | | | |
| with | | | | |
| USUB-SUP | 3.16 | | .57 | $p < .45$ |

Figure 12. Experiment 3 trait facilitation effect.



## Experiment 4: Category Verification

### Method

Subjects. Twenty-five undergraduates received course credit in return for participation.

Stimuli and Apparatus. Stimuli consisted of the same object and trait hierarchies as used in the previous experiment. (see Appendix 2 and 3). In the present task all "BLANK" primes were treated as unrelated words (out-of-category) words. Therefore, to insure that subjects performed the category verification task, it was necessary to include sematically unrelated (out-of-category) word distractors. These distractor words consisted of words that were semantically unrelated to the prime and target category words in the experiment. The mean length of the unrelated words closely matched the mean length of the other target words. Apparatus was exactly the same as in Experiment 2.

Procedure. The procedure was identical to previous experiments, except in the category verification task subjects were instructed to covertly read the prime word and to indicate whether target word was or was not a member of the same category as the prime word by pressing a "yes" or a "no" key. Prior to beginning a session subjects were given a verbal description, including an example, of typical type of category in the experiment. Task instructions stressed both accuracy and speed. Subjects received 40 practice trials. Every subject then received all object superordinate-subordinate pairs (SUP-SUB condition and SUB-SUP condition), desirable superordinate-subordinate pairs (DSUP-SUB condition and DSUB-SUP condition), undesirable superordinate-subordinate pairs (USUP-SUB condition and USUB-SUP conditions), unrelated prime-target pairs (UNRELATED condition), and all the corresponding neutral prime conditions for objects and traits (BLANK-SUP and BLANK-SUB conditions). Subjects completed the same post-experiment questionnaire as in Experiments 2 and 3 (see Appendix 4 and 5).

Results and Discussion

Analysis of errors indicated an overall error rate of 5.1% for responses to natural-objects and 18.7% for traits.

Repeated measures ANOVA indicated a significant difference between object conditions $F(3,72) = 32.96$, $p < .0001$ (see Figure 13). Paired comparisons indicated that mean RT in the unrelated prime condition (UNSUP-SUB condition) (604.14 msec) was more rapid than in the unrelated prime condition (UNSUB-SUP condition) (637.36 msec) ($t = 25.38$, $p < .0001$) (see Table 13). Significant priming was shown in the SUP-SUB condition (543.05 msec) relative to its unrelated prime condition UNSUP-SUB (604.14 msec) ($t = 36.74$, $p = .0001$) and in the SUB-SUP condition (549.39 msec) relative to its unrelated prime condition UNSUB-SUP (637.36 msec) ($t = 62.77$, $p = .0001$) (see Table 12). Facilitation effect was calculated by subtracting subject's mean RT on related prime conditions (SUP-SUB and SUB-SUP) mean RT from mean RTs on their corresponding unrelated conditions (UNSUP-SUB and UNSUB-SUP). A comparison of the facilitation effect in the SUB-SUP condition compared to the SUP-SUB condition reached significance ($t = 7.90$, $p < .01$) (see Table 13). The pattern of facilitation between these two conditions indicated that subject's gained a greater advantage in response time, relative to an unrelated prime condition, when the

Table 13. Means, standard deviations, and t-test significance
--------- levels of paired condition comparisons for RTs to
natural-objects in the category verification experiment.

OBJECTS

| Prime-Target Conditions | Mean RTs (msec) | Error Rate | Standard Deviation | t value | t-test significance Level |
|---|---|---|---|---|---|
| Unrelated-SUB | 604.14 | .04 | 80.97 | | |
| with | | | | | |
| Unrelated-SUP | 637.36 | .03 | 75.64 | 25.38 | p < .0001 |
| Unrealted-SUB | | | | | |
| with | | | | | |
| SUP-SUB | 543.05 | .06 | 83.55 | 36.74 | p < .0001 |
| Unrelated-SUP | 637.36 | | | | |
| with | | | | | |
| SUB-SUP | 549.39 | .05 | 64.90 | 62.77 | p < .0001 |
| SUP-SUB | 543.05 | | | | |
| with | | | | | |
| SUB-SUP | 549.39 | | | .26 | p < .60 |

| FACILITATION EFFECT | | | | | |
|---|---|---|---|---|---|
| SUP-SUB | 61.09 | | 50.40 | | |
| with | | | | | |
| SUB-SUP | 87.97 | | 55.51 | 7.79 | p < .01 |

Figure 13. Experiment 4 object means

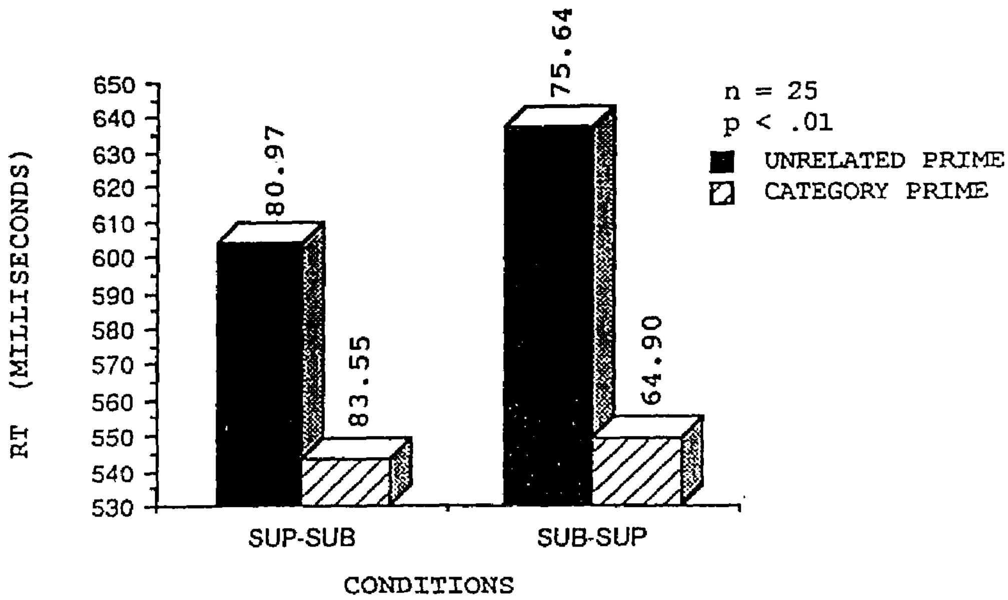
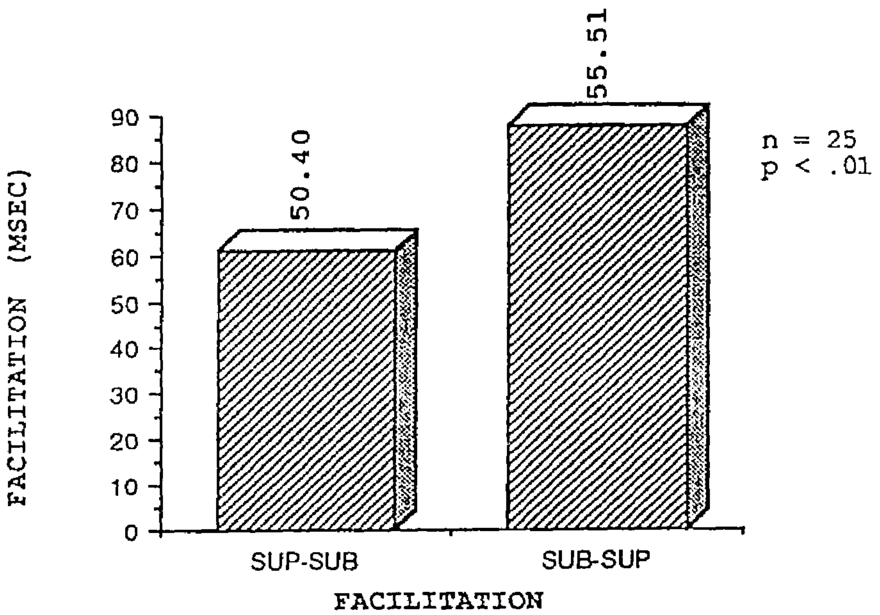


Figure 14. Experiment 4 object facilitation



prime was a subordinate as opposed to a superordinate (see Figure 14). In sum, subordinates were responded to faster as targets and served as better primes than superordinates.

Repeated measures ANOVA indicated significant differences between trait conditions $F(7,147)=4.48, p < .0001$ (see Figure 15). Paired comparisons indicated significant priming for desirable traits in the SUP-SUB condition (706.67 msec) relative to its unrelated prime condition UNSUP-SUB (798.71 msec) ($t = 13.69, p = .001$), and in the SUB-SUP condition (711.84 msec) relative to its unrelated prime condition UNSUB-SUP (781.53 msec) ($t = 8.32, p < .009$). Comparison of undesirable traits indicated a marginally significant difference between the mean RTs in the related prime condition SUB-SUP (717.45 msec) and the mean RT in the unrelated prime UNSUB-SUP condition (765.09 msec) ($t = 2.71, p < .11$) (see Table 14).

The facilitation effect was calculated exactly as it was for the objects. A repeated measures ANOVA that included two within-subjects factors of "Direction" (SUP-SUB and SUB-SUP conditions) and "Desire" (desirable and undesirable trait conditions) was conducted. The analysis indicated a significant Desire by Direction interaction ($F(1,21) = 6.44$, $p < .01$) (see Figure 16). This showed that the amount of facilitation varied with both hierarchical level and desirability of the prime and target. Paired comparisons indicated that RTs to desirable traits in the DSUP-SUB condition produced significantly more facilitation compared to the undesirable traits in the USUP-SUB condition ($t = 18.46$, $p < .0001$) (see Table 15). The pattern of the facilitation effect for undesirable traits was opposite to that displayed by the desirable traits (see Figure 16). In sum, desirable superordinates traits were responded to faster as targets than desirable subordinate traits and compared undesirable superordinates, as primes they facilitated RT to a greater degree than undesirable superordinates. Undesirable traits displayed the opposite priming pattern (see Figure 16).

ANOVA of RTs across items within each word prime condition reached significance for objects in the SUB-SUP condition ($F$(10,232) = 2.66, $p$ = .004) and for the traits in the DSUB-SUP ($F$(6,95 = 3.87, $p$ = .001) and USUB-SUP ($F$(6,83) = 2.37, $p$ = .03) conditions. This indicated a significant amount of variance in the effect of the prime across items. In order to evaluate items independently, facilitation effects for items were calculated as in previous experiments. Facilitation indexes in the SUP-SUB and SUB-SUP conditions were then compared. For the objects, seven of the eleven items displayed facilitation consistent with the previous analysis by condition (viz., greater facilitation in the SUB-SUP condition. For both desirable and undesirable traits, four of the seven items showed facilitation consistent with the previous analysis by condition (viz., greater facilitation in the DSUP-SUB and USUB-SUP conditions) (see Table 6).

Table 14. Means, standard deviations, and t-test significance levels of paired condition comparisons for RTs to traits in the category verification experiment.

DESIRABLE TRAITS

| Prime-Target Conditions | Mean RTs (msec) | Error Rate | Standard Deviation | t value | t-test significance level |
|---|---|---|---|---|---|
| Unrelated-SUB | 798.71 | .06 | 91.97 | | |
| with | | | | | |
| Unrelated-SUP | 781.57 | .11 | 120.94 | .91 | $p < .35$ |
| Unrelated_SUB | 798.71 | | | | |
| with | | | | | |
| DSUP-SUB | 706.67 | .25 | 130.19 | 13.69 | $p < .001$ |
| Unrelated-SUP | 781.57 | | | | |
| with | | | | | |
| DSUB-SUP | 711.84 | .22 | 89.97 | 8.32 | $p < .009$ |
| DSUP-SUB | 706.67 | | | | |
| with | | | | | |
| DSUB-SUP | 711.84 | | | .04 | $p < .84$ |

UNDESIRABLE TRAITS

| Prime-Target Conditions | Mean RTs (msec) | Error Rate | Standard Deviation | t value | t-test significance level |
|---|---|---|---|---|---|
| Unrelated-SUB | 762.19 | .07 | 86.93 | | |
| with | | | | | |
| Unrelated-SUP | 765.09 | .31 | 85.68 | .04 | $p < .84$ |
| Unrelated-SUB | 762.19 | | | | |
| with | | | | | |
| USUP-SUB | 793.76 | .05 | 147.66 | 1.74 | $p < .20$ |
| Unrelated-SUP | 765.09 | | | | |
| with | | | | | |
| USUB-SUP | 717.45 | .29 | 143.44 | 2.71 | $p < .11$ |
| USUP-SUB | 793.76 | | | | |
| with | | | | | |
| USUB-SUP | 717.45 | | | 7.10 | $p < .01$ |

Table 15. Means, standard deviations, and t-test significance
--------- levels of paired condition comparisons for RTs to traits in the category verification experiment.

FACILITATION EFFECT

| Prime-Target Conditions | Mean (msec) | Standard Deviation | t value | t-test significance level |
|---|---|---|---|---|
| DSUP-SUB | 92.04 | 116.66 | | |
| with | | | | |
| DSUB-SUP | 69.72 | 113.39 | .53 | $p < .47$ |
| DSUP-SUB | 92.04 | | | |
| with | | | | |
| USUP-SUB | -31.57 | 112.38 | 18.46 | $p < .0001$ |
| USUP-SUB | -31.57 | | | |
| with | | | | |
| USUB-SUP | 47.64 | 135.85 | 7.21 | $p < .01$ |
| DSUB-SUP | 69.72 | | | |
| with | | | | |
| USUB-SUP | 47.64 | | .39 | $p < .53$ |
| DSUP-SUB | 92.04 | | | |
| USUB-SUP | 47.46 | | | |

Figure 15. Experiment 4 trait means

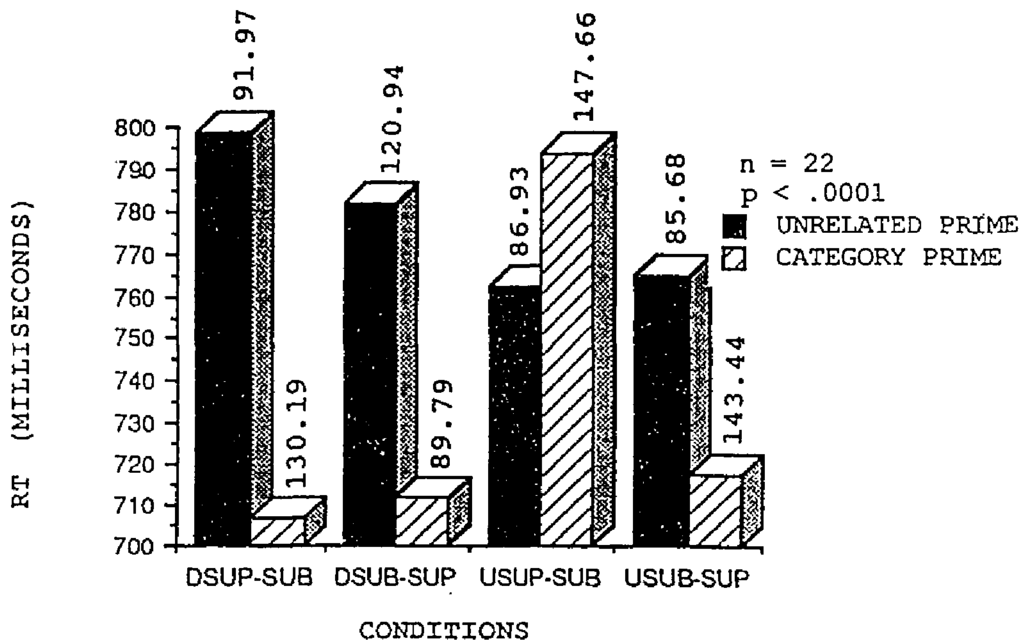
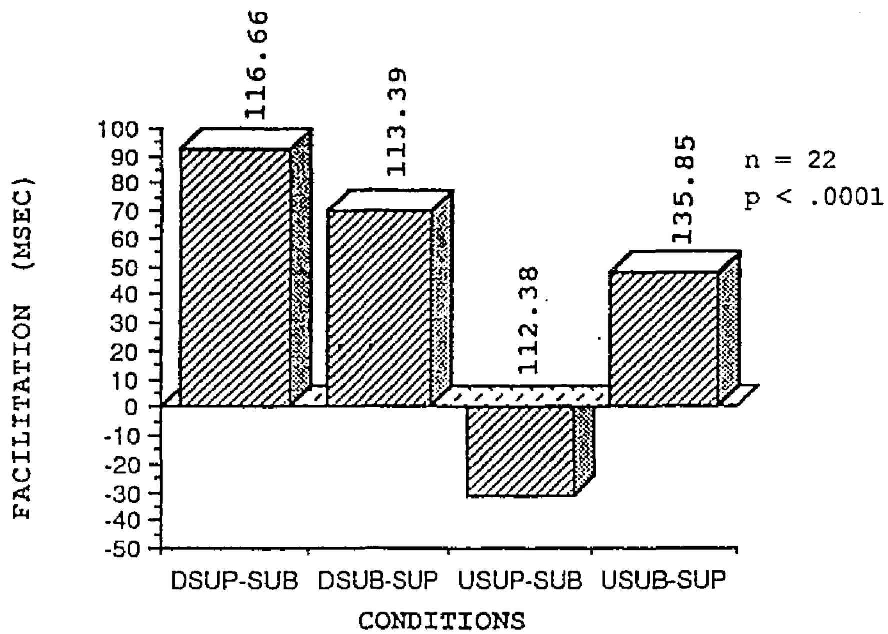


Figure 16. Experiment 4 trait facilitation



# CHAPTER VI

## General Discussion

The pattern of RTs to natural-objects across the three experiments was identical. In each experiment subjects' RTs were more rapid when targets were subordinates compared to when they were superordinate. These results are consistent with the previous research on natural-objects that has demonstrated that concrete words are more rapidly accessed from memory than abstract words. In the category verification task subordinate primes produced a greater amount of facilitation than superordinate primes. Although only marginally significant, the pattern of facilitation was the same on the lexical decision and pronunciation tasks. The pattern of facilitation across all experiments is consistent with previous data that has demonstrated an associative asymmetry pattern from the subordinate category member to the superordinate category member. Loftus (1973) called this "category dominance." The findings in Experiments 2-4 underscore the importance of neutral prime condition. If RTs to natural-objects in the neutral conditions are ignored, it appears as if the facilitation by superordinate primes is greater than that produced by subordinate primes (viz., instance dominance). That is, superordinates appear to be better primes than subordinates. A comparison of the results in Experiment 1 with Experiments 2-4 illustrates this point. The pattern of results for objects and desirable traits in Experiment 1 are identical to the patterns of RTs in the word conditions in Experiments 2-4. It is only when facilitation is evaluated relative to a neutral prime, where the target remains constant, is it clear that in fact the subordinate prime actually facilitates RTs to a greater degree than the superordinate prime.

One reason that the "apparent instance dominance" pattern emerged in some of the previous research on natural-objects may be a function of the method by which norms used in those experiments were generated. The stimuli chosen from standard category norms of Battig and Montague (1968) and Rosch (1976) were generated in a way that by the nature of task required a pattern of association from the category name to the instance. Battig and Montague (1968) norms were defined as the frequency with which an instance of a category is generated in response to a category name (instance dominance). Rosch's (1976) category norms are organized by "typicality", and Chumbley (1986) reported that typicality is highly correlated with instance dominance. In the present research some stimuli were taken from RT research of Loftus and Bolton (1974). The RT paradigm used by Loftus and Bolton (1974) was simply a speeded response measure of instance dominance (see Loftus, 1973). Given these considerations, it is surprising that the "apparent" priming by the superordinate (when the neutral condition is ignored) is not even more pronounced. In sum, the findings for natural-objects underscore the importance of the use of a neutral prime condition. They suggest that measurements of instance dominance may only be a reflection of the overall accessibility of the target.

The pattern of RTs to desirable and undesirable traits were dissimilar. RTs to undesirable traits across experiments was not as consistent as the desirable traits. The only significant finding was in the lexical decision task where, as already reported for natural-objects, the RTs to subordinate targets were faster than to superordinate target. The pattern of facilitation for undesirable traits across the experiments was the same as that displayed for natural-objects. The pattern of RTs to desirable traits across experiments was strikingly consistent and exactly opposite to that pattern reported for the natural-objects and undesirable traits. For the desirable traits superordinate targets were responded to faster than subordinate targets. This pattern was significant for both the pronunciation and lexical decision tasks. Most striking was the consistency in the pattern of the facilitation. In all three experiments, significant facilitation was produced by desirable superordinate primes relative to the undesirable superordinate primes. In each experiment, desirable superordinate primes produced the greatest amount of facilitation and undesirable superordinate primes displayed no priming at all.

With the traits it is also informative to consider the method by which the sample of trait hierarchies were originally generated. Hampson, et al., (1986) evaluated category breadth of natural-objects by a direct measure of breadth and paired comparisons (see Chapter IV for detailed a description of both). The direct measurements of breadth were essentially the same type of nonspeeded category generation tasks employed by Battig and Montague (1968) and Rosch (1976) for natural-objects. That is, Battig and Montague (1968) required subjects to generate as many instances of a category when given a general category name and Rosch (1976) required subjects to rate "how many different attributes a word contains." Hampson et al.,'s (1986) subjects performed an analogous task with traits.

Subjects were required to rate the number of behaviors associated with particular personality traits. This method appears to have the same built-in bias, as with the natural-objects stimuli, for generating a set of items that are likely to display "instance dominance." Considering the present findings with the natural-objects, it is interesting that for desirable trait pairs the RTs to desirable superordinate targets were significantly faster than RTs to desirable subordinate targets in the pronunciation and lexical decision experiments. RTs to undesirable traits displayed a significant effect in the opposite direction on the lexical decision task. This divergence is even more pronounced when facilitation in the desirable and undesirable conditions is considered. In all three experiments desirable superodinates primed desirable subordinate traits to a significantly greater degree than undesirable superordinate traits primed undesirable subordinate traits. There is no previous RT data that provide a basis for predicting this divergent RT pattern between traits dichotomized by desirability. In fact, these data argue against "context-dependent" theories of priming (see Bleasdale, 1986) that describe subordinate (concrete word) primes as providing the "context" information that reduces the ambiguity of the more vague superordinate (abstract word). The present results demonstrate that desirable superordinates traits (abstract) serve as better primes than the desirable subordinate traits (concrete). In sum, the present trait data demonstrate that desirable superordinate primes produce greater facilitation than desirable subordinate primes and they are responded to faster as targets. The opposite pattern is displayed by the undesirable traits.

The present RT data also argue against a "generally higher accessibility of superordinate" explanation to account for superordinate trait ascription preferences reported by John, et al., (1986), because undesirable traits displayed the opposite pattern. It is interesting, however, that divergence between undesirable and desirable trait preferences was reported in one of John et al.'s (1986) context conditions (viz., social context: describing a "liked" or "disliked" target person; see Chapter IV for details of this experiment). This is especially interesting, because, in the present study, this effect was displayed independent of any experimentally manipulated social context. The present findings suggest that although the greater preference by subjects for desirable superordinate trait descriptors was displayed in only one of John et al.,'s (1986) experimentally manipulated contexts conditions, the result may not be trivial.

Why are desirable superordinate traits more accessible than desirable subordinate traits? Deese's (1962) investigation of the grammatical class determinants of association may provide some insight. Deese (1962) showed that for adjectives (which modify relations, e.g., the demonstrator "passively" resisted arrest) there was a negative correlation between the number of syntagmatic associations and frequency of usage. This suggests that functional use of adjectives may affect their associative organization. In a similar way, the functional use of trait labels in the context of person description may be an important determinant of the traits enduring associative organization. It has already been suggested in research on memory for person information (discussed in Chapter IV; Cantor & Mischel, 1979) that traits are organizing units for person information. It is possible that the frequency with which traits are used as descriptions of persons and their tendency to be paradigmatically clustered may be correlated. Indeed, it is the high frequency of use of the desirable traits that operationally defines the "positivity bias" (bias for use of positive traits) reported by John, et al. (1986). Superordinate desirable traits may be more accessible in memory because in the social context of person attribution they, more often than subordinates, function as person descriptors. There may be social psychological reasons that determine this differential frequency of desirable and undesirable superordinate and subordinate trait usage in descriptions of persons. One possibility may be that there is higher social pressure to be specific when describing another person in negative terms. In contrast, there may be less pressure to be specific in one's praise of another. The result may be more differentiation within negative trait categories. In the case of desirable trait there is no social pressure to generate more descriptive terms. For example, it is acceptable to say that "Joe is a good person", but less so to say "Joe is a bad man", without a more detailed explanation. Rothbart and John (1985) reported that traits with few concrete behavioral referents are more difficult to disconfirm. In other words, when a person is described in global terms it more difficult to disconfirm that description. Possibly cooperative social interaction then is served well by the some cultural norm that implicitly limits the frequency with which people ascribe personality labels that imply enduring global negative attributions. There also seems to be a a self-serving utility in the relatively lower capacity to disconfirm desirable as opposed to undesirable personality trait ascriptions. This is, of course, conjecture but there are implications for empirical work on attributional processes (e.g., judgments of cause, self-concept). For example, it is possible that something similar to Tversky's and Kahneman (1982) "availability heuristic" is operating in the context of person trait ascription. The availability heuristic is a rule of thumb stating that what comes to mind quickly is perceived as valid. It may be that differences in the availability of abstract and concrete positive and negative trait labels affect their perceived validity and consequently how they are weighted in an attributional judgment. That is, attributions may be affected by the level of abstraction of the trait information supplied about the person being judged.

Another interesting finding related to the pattern of divergent RTs displayed by the desirable traits is the fact that these RT asymmetries were not reflected in the subjects post-experiment questionnaire data. The pattern of responses on the post-experiment questionnaire were the same for natural-objects, undesirable, and desirable traits across all experiments. They were strikingly consistent with the objects and trait hierarchy norms that have already been established in the literature (i.e., Battig and Montague, 1968; Rosch, 1975; Hampson,et al., 1986). Subjects indicated that they perceived the category words to be hierarchically related as expected and that they were very confident in their asymmetry judgments. The fact that the regression analysis of asymmetry judgments and facilitation indicated no systematic relationship between the two measurement devices is an important finding. The divergence between RT asymmetries and the hierarchical asymmetries generated in the post-experiment questionnaire suggest two points to consider. It stresses the importance of attaching caveats to theoretical interpretations of questionnaire data that invoke "accessibility of information" explanations. It also provides an argument against Loftus and Bolton's (1974) suggestion that hierarchical associative asymmetries serve to maintain logical class relations during the inference process. The findings based on the regression analysis in the present experiments, argue that inference judgments (viz., asymmetry and certainty judgments) were not related to any brief (300 msecs) spreading activation between hierarchically related associations that was presumably involved in the priming RTs. The two types of dependent measures are not measuring the same cognitive operations.

The present results also have implications for clinical research on the assessment of memory deficits. Neuropsychology assessment relies on precise descriptions of memory processes when describing language and memory disorders (e.g, dyslexia) associated with traumatic head injury and neuropathologies. As mentioned earlier, neuroclinical observation has identified linguistic production errors that relate to the level of a word's abstraction. The present data suggest that the process of accessing hierarchically structured associations from memory may vary as a function of the type and concreteness of the information being accessed. Careful attention to these qualitative aspects of the linguistic information being used to test for deficits may allow greater discrimination between deviations of underlying normative patterns of association. For example, Coltheart (1980) has described clinical observation of superordinate substitution errors as "production errors". It is implied that somehow the ability to verbally produce visually presented word is reduced and the within-category superordinate associate is apparently activated and automatically produced. These superordinate substitution errors represent the majority compared to subordinate substitution errors. Based on the findings for natural-object, the normative associative pattern appears be intact in the case of the superordinate substitution errors, but a disrüption of the normative pattern may be indicated by the subordinate substitution errors.

A concern for careful attention to the stimuli used in assessment procedures resonates with a more general point made by Clark (1973). Clark (1973) discusses common fallacy of assuming linguistic stimuli as fixed-effects. He argues that the generalizability of linguistic stimuli is an important consideration. When linguistic stimuli are used in experiments, Clark (1973) suggests remedies that included particular statistical sampling procedures, experimental design, and the appropriate inference test that simultaneous generalize across both subjects and word items used in an experiment. It should be noted, however, that Mosteller and Tukey (1968) have argued that:

> "there is danger in any statistical procedure that uses variability within the sample materials to generalize the results to other samples. Variability may be much less than within the total population. As a consequence it has frequently been found that significant effects (measured by within variance) are not replicated when different samples are used. (in Anderson & Reder, 1974, p. 666)"

It is generally agreed (Clark, 1973; Anderson and Reder, 1974; Mosteller and Tukey, 1968) that using large heterogeneous samples is the best solution. The item analyses in the present study confirms the seriousness of this consideration. In some trait conditions, three of seven items did not display the same facilitation effect indicated by the analyses of facilitation by condition. Future work should be concerned with the generalizability of items and carefully consider the method by which stimuli used in the research were generated.

In general, the present data have interesting implications for cognitive research on category memory. They suggest that the associative structure of abstract categories (i.e., conceptual information) may be more structured than that of concrete categories. Moreover, that the functional use of certain information (e.g., as determined by cultural norms) may determine its associative organization. Further research might include similar experimental examinations of abstract categories other than traits (e.g., freedom, beauty, pleasure, etc.) or categories constructed of arbitrary geometric figures.

In conclusion, possibly the most useful way of interpreting the data may be to simply describe RTs to targets as indicators of overall accessibility, and facilitation of RTs as indications of the prime's capacity as a facilitator of access to category information. In this sense, natural-object subordinates and desirable trait superordinates appear to be dominant. That is, they display both greatest accessibility and priming capacity. Moreover, it appears that hierarchical level does not determine accessibility. These data support an argument that a hierarchical model of category structure does not describe a pattern of associative asymmetry that uniformly determines accessibility to category information across qualitatively different linguistic stimuli. The data, however, do not preclude the possibility that in general abstract and concrete information may be related in memory by a sort of category reference point, which does not necessarily function to conserve class-inclusion relations.

# Notes

1. The use of various types of control conditions in priming experiments has raised the issue of what is the most appropriate type of neutral prime stimuli. Several researchers have used a row of asterisks as a control condition (e.g., Neely, 1977; Becker, 1980; Kiger & Glass). The goal of a neutral prime condition is to provide a baseline measure from which relative comparisons of facilitation and inhibition in experimental conditions can be made. Therefore, a control condition should produce the least amount of facilitation and inhibition. Algarabel, Pitarque, Soler, Ruiz, Baixauli, and Dasi (1987) have shown that a row of asterisks produce strong inhibitory effects on RTs to a target relative to a control condition where the word "neutral" was the target. The use of a row of asterisks as a neutral condition is not recommended. A word such as "blank" or "neutral" is more appropriate.

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# APPENDICES

# APPENDIX 1

## Experiment 1 Natural object Stimuli
## Mean Word Frequency and Length

| | Superordinate | Middle level | Subordinate |
|---|---|---|---|
| 1. | beverage | soda | cola |
| 2. | arm | hand | fingers |
| 3. | food | vegetable | corn |
| 4. | fabric | clothing | shirt |
| 5. | vehicle | car | toyota |
| 6. | sentence | word | noun |
| 7. | university | college | school |
| 8. | politician | president | carter |
| 9. | animal | mammal | dog |
| 10. | activity | sport | tennis |
| 11. | metal | mineral | sodium |
| 12. | plant | flower | rose |

| | Mean Word Frequency | |
|---|---|---|
| 102 | 207 | 108 |

| | Mean Word Length | |
|---|---|---|
| 5.8 | 5.9 | 5.0 |

# APPENDIX 2

## Experiments 2-4 Natural object Stimuli
## Mean Word Frequency and Length

| Superordinate | Subordinate |
|---|---|
| 1. beverage | cola |
| 2. food | corn |
| 3. clothing | shirt |
| 4. vehicle | toyota |
| 5. sentence | noun |
| 6. university | school |
| 7. politician | carter |
| 8. animal | dog |
| 9. activity | tennis |
| 10. metal | sodium |
| 11. plant | rose |

Mean Word Frequency

| | |
|---|---|
| 102 | 108 |

Mean Word Length

| | |
|---|---|
| 7.2 | 5.0 |

# APPENDIX 3

## Experiment 1-4
## Trait Stimuli Mean Frequency and Length

| Undesirable Traits | | Desirable Traits | |
|---|---|---|---|
| Superordinate | Subordinate | Superordinate | Subordinate |
| 1. tempermental | erratic | 2. talented | artistic |
| 3. introverted | silent | 4. confident | assertive |
| 5. unhappy | pessimistic | 6. extroverted | talkative |
| 7. unkind | stingy | 8. competent | methodical |
| 9. naive | gullible | 10. worldly | polished |
| 11. unstable | irritable | 12. organized | precise |
| 13. insecure | jumpy | 14. reliable | punctual |
| Mean Word Frequency | | | |
| 11.5 | 13.0 | 9.5 | 11.0 |
| Mean Word Length | | | |
| 8.7 | 8.6 | 7.4 | 7.7 |

# APPENDIX 4

## Post-Experiment Questionnaire: Natural-objects

PART A. On the following page you will find a series of sentence pairs. Your task is to choose which sentence in each pair is more meaningful, in other words, which makes the most sense to you.

The sentences will look like this:

1. (A) An apple is a type of fruit.
   (B) A fruit is a type of apple.

In these examples, "An apple is a type of fruit" makes more sense than "A fruit is a type of apple".

Please indicate your choice by circling the (A) or (B) beside the more meaningful statement in each pair.

1. (A) A beverage is a type of cola.
   (B) A cola is a type of beverage.

2. (A) An arm is part of a finger.
   (B) A finger is part of an arm.

3. (A) Food is a type of corn.
   (B) Corn is a type of food.

4. (A) A shirt is a type of clothing.
   (B) Clothing is a type of shirt.

5. (A) A vehicle is a type of Toyota.
   (B) A Toyota is a type of vehicle.

6. (A) A noun is a part of a sentence.
   (B) A sentence is a part of a noun.

7. (A) A university is a type of school.
   (B) A school is a type of university.

8. (A) Carter was a type of president.
   (B) The president was type of Carter.

9. (A) An animal is a type of dog.
   (B) A dog is a type of animal.

10. (A) Activity is a type of tennis.
    (B) Tennis is a type of activity.

11. (A) Sodium is a type of metal.
    (B) Metal is a type of sodium.

12. (A) A plant is a type of rose.
    (B) A rose is a type of plant.

PART B. On the following pages are sentences. For each sentence your task is to indicate your personal level of certainty that the statement
makes sense to you. Below each of the statements is a 10 point scale on
which you should indicate your personal level of certainty about the statement. A 1 indicates low certainty and a 10 indicates high certainty.

1. A beverage is a type of cola.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

2. A finger is a part of an arm.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

3. Food is a type of corn.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

4. A shirt is a type of clothing.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

5. A is vehicle is a type of Toyota.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

6. A noun is a type of sentence.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

7. A university is a type of school.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

8. Carter is a type of president.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

9. An animal is a type of dog.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

10. Activity is a type of tennis.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

11. Sodium is a type of metal.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

12. A plant is a type of rose.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

13. The president is a type of Carter.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

14. A sentence is part of a noun.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

15. Clothing is a type of shirt.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

16. An arm is a part of a finger.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

17. Metal is a type of sodium.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

18. Cola is a type of beverage.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

19. Corn is a type of food.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

20. A Toyota is a type of vehicle.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

21. A school is a type of university.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

22. A dog is a type of animal.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

23. Tennis is a type of activity.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

24. A rose is a type of plant.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

# APPENDIX 5

## Post-Experiment Questionnaire: Traits

On the following page you will find a series of sentence pairs. Your task is to choose which sentence in each pair is more meaningful--in other words, which makes the most sense to you.

The sentences will look like this:

1. (A) An apple is a type of fruit.
   (B) A fruit is a type of apple.

2. (A) A vehicle is a type of car.
   (B) A car is a type of vehicle.

In these examples, "An apple is a type of fruit" makes more sense than "A fruit is a type of apple", and "A car is a type of vehicle" makes more sense than "A vehicle is a type of car".

The above example used nouns, but the differences in meaningfulness also occur with verbs and adjectives:

3. (A) To run is a way to sprint.
   (B) To sprint is a way to run.

4. (A) To be dirty is a way of being stained.
   (B) To be stained is a way of being dirty.

3(B) is more meaningful than 3(A), and 4(B) is more meaningful than 4(A).

Finally, this principle can be applied to personality traits, the adjectives we use to describe ourselves and others:

5. (A) To be witty is a way of being intelligent.
   (B) To be intelligent is a way of being witty.

5(A) is more meaningful than 5(B).

On the following pages you will find pairs of statements containing personality traits. For each of the pairs your task is to choose the statement which makes the most sense to you. Please indicate your choice by circling the (A) or (B) beside the more meaningful statement in each pair.

1. (A) To be erratic is a way of being theatrical.
   (B) To be theatrical is a way of being erratic.

2. (A) To be artistic is a way of being talented.
   (B) To be talented is a way of being artistic.

3. (A) To be introverted is a way of being silent.
   (B) To be silent is a way of being introverted.

4. (A) To be confident is a way of being assertive.
   (B) To be assertive is a way of being confident.

5. (A) To be unhappy is a way of being pessimistic.
   (B) To be pessimistic is a way of being unhappy.

6. (A) To be talkative is a way of being extroverted.
   (B) To be extroverted is a way of being talkative.

7. (A) To be stingy is a way of being unkind.
   (B) To be unkind is a way of being stingy.

8. (A) To be competent is a way of being methodical.
   (B) To be methodical is a way of being competent.

9. (A) To be gullible is a way of being naive.
   (B) To be naive is a way of being gullible.

10. (A) To be worldly is a way of being polished.
    (B) To be polished is a way of being worldly.

11. (A) To be irritable is a way of being unstable.
    (B) To be unstable is a way of being irritable.

12. (A) To be precise is a way of being organized.
    (B) To be organized is a way of being precise.

13. (A) To be insecure is a way of being jumpy.
    (B) To be jumpy is a way of being insecure.

14. (A) To be reliable is a way of being punctual.
    (B) To be punctual is a way of being reliable.

On the following pages you will find sentences containing personality traits. For each sentence your task is to indicate your personal level of certainty that the statement makes sense to you. Below each of the statements is a 10 point scale on which you should indicate your personal level of certainty about the statement. A 1 indicates low certainty and a 10 indicates high certainty.

1. To be erratic is a way of being tempermental.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

2. To be artistic is a way of being talented.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

3. To be introverted is a way of being silent.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

4. To be confident is a way of being assertive.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

5. To be unhappy is a way of being pessimistic.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

6. To be talkative is a way of being extroverted.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

7. To be stingy is a way of being unkind.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

8. To be competent is a way of being methodical.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

9. To be gullible is a way of being naive.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

10. To be worldly is a way of being polished.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

11. To be irritable is a way of being unstable.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

12. To be precise is a way of being organized.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

13. To be insecure is a way of being jumpy.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

14. To be reliable is a way of being punctual.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

15. To be tempermental is a way of being erratic.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

16. To be talented is a way of being artistic.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

17. To be silent is a way of being introverted.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

18. To be assertive is a way of being confident.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

19. To be pessimistic is a way of being unhappy.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

20. To be extroverted is a way of being talkative.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

21. To be unkind is a way of being stingy.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

22. To be methodical is a way of being competent.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

23. To be naive is a way of being gullible.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

24. To be polished is a way of being worldly.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

25. To be unstable is a way of being irritable.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

26. To be organized is a way of being precise.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

27. To be jumpy is a way of being insecure.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY

28. To be punctual is a way of being reliable.

How certain are you that this statement makes sense?
LOW CERTAINTY 1 2 3 4 5 6 7 8 9 10 HIGH CERTAINTY