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EFFECTS OF REFERENTIALLY REDUNDANT VERBAL MESSAGES AND INTERPOLATED DISTRACTORS ON RECOGNITION MEMORY

by

Marjorie Ann Bernstein Platt

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Psychology)
in The University of Michigan
1977

Doctoral Committee:

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To My Parents

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While my name appears as the sole author of this project, this dissertation, like many others, was a joint venture between myself and a committee of highly qualified men and women. I would like to take this time to express my gratitude and thanks to my chairman, Mel Manis, who, throughout four years of association, has taught me the ways of careful scientific inquiry and investigation. I have certainly appreciated the time and interest he has taken in my career and development as a social psychologist. His astute criticism has guided my thought, his kind friendship has been a great support.

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CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

One of the major functions of redundancy is to protect against undue distortion when information is transmitted through "noisy" channels. Redundancy safeguards against communication loss by providing the receiver with a set of rules which help him to construct the original message from the fragmented informational components that survive the "noise" in the communication channel. The rules that are referred to above are, of course, the grammatical and semantic rules which are well-knowm (implicitly) by the adult who is competent in his native language.

In a sense, redundancy is the degree to which an outcome is predictable from (or correlated with) other known events. Consider the case in which there are only two sets of available events, X and Y. X and Y are redundant if one can predict Y given that X is known. In this case, Y does not provide additional information beyond what was already known on the basis of X alone. Conversely, X and Y are nonredundant if knowing X does not help in predicting Y. When the two events are nonredundant, then, Y provides <u>additional</u> information which cannot be inferred

from X alone. In this case, when considered together, X and Y convey more information than does either component, considered separately.

The redundancy between X and Y may not only affect the transmission of information, but it may also affect the receiver's ability to retain information, once it has been processed. Consider the case in which a redundant message is transmitted through a somewhat distorted channel. The receiver will most likely not receive the message in its original form; that is, certain, possibly significant, parts may have been either distorted or lost completely. In order to make sense out of the components that are received, our receiver will doubtless apply certain strategies (implicit rules) in an attempt to fill in the missing or distorted elements. And, given sufficient redundancy, the major idea or gist of the original message might be effectively recovered. In the case of a less redundant message, on the other hand, there is less likelihood that the receiver will be able to correctly infer the missing elements, since there would be a greater degree of independence between the component units of the passage.

Because of the consistent relationship between two redundant messages, the information contained in redundant messages may be easier to organize or integrate, such that more efficient encoding of the information may

be achieved than if the two messages were less redundant. More efficient encoding should enable the subject to retain the information more effectively. If this is indeed the case, then, it is reasonable to assume that non-redundant messages should be forgotten more rapidly than redundant messages.

While there has been a considerable body of research dealing with the effects of redundancy on memory, in most studies, redundancy has typically been defined either as (a) repetition, or (b) as the degree to which the component words in a list are associatively related. However, very little work has focused on the redundancy between discursive messages. This dissertation is designed to examine the effect of redundant information on retention, using discursive, "real world" messages as the to-be-remembered input material.

A second aspect of this study concerns the functional representation of the information that is conveyed by the discursive passages. Recently, there has been considerable interest in the representational coding schemes that are evoked by verbal stimuli as contrasted with visual, or more spatially-oriented stimuli. Paivio (1971) has argued that pictures are remembered longer and more faithfully than verbal stimuli, since they evoke two representations (visual and verbal), while words usually evoke just one representation (verbal). Paivio refers to this

coding strategy for visual stimuli as the dual encoding hypothesis.

The question of present interest is to determine which type of coding scheme is generally used by subjects when attempting to remember verbal passages that describe a concrete referent (e.g., a person's face). Since the information in the study reported below was presented by means of verbal descriptions, it may be that most subjects will encode the input information verbally. However, it is also possible that they may transform the verbal information into a visual memory code.

In order to determine the type of encoding that is typically utilized in the retention of verbal passages, the effects of two interference tasks were compared. One task required the subjects to work on verbal problems during the course of the retention interval, while the other focused the subjects' attention on visual problems. The task that produced the most interference, as indexed by its impact on retention, would presumably be the one that was most closely related to the respondents' normal encoding strategy.

The following sections of this chapter review two bodies of literature. First, we will consider the effects of redundancy on retention; this will be followed by a discussion of different representational coding schemes, and their relation to memory.

The Effect of Redundancy on Memory

Referential Redundancy

While the effect of redundant information on memory is a topic of interest in its own right, the present study was primarily stimulated by a set of results that were recently reported by Manis and Platt (1976). In two studies, these investigators examined the impact of redundancy on referential communication. Referential communication is usually studied by asking a speaker to describe some target object (referent) such that a listener, upon hearing the description, could accurately choose the target object from a larger set of similar objects. The target objects used in these earlier studies were 24 facial expressions chosen from the Frois-Wittmann series (Hulin and Katz, 1935). The input information was a pair of verbal descriptions, each of which was composed by subjects in an earlier study (Manis and Armstrong, 1971). Here is an example of a typical description from the Manis and Platt study:

> According to the picture, this person seems to be happy. This kind of feeling one could obtain after an unexpected success or winning a battle or winning a sport game. He seems to be proud of what he has done.

Subjects were shown pairs of descriptions which varied in redundancy. After reading a pair of passages, subjects chose the target facial expression either

immediately following the description presentation, or following an interpolated retention interval, during which time the subjects worked on irrelevant arithmetic problems.

The redundancy within a message-pair was assessed by the extent to which the component descriptions elicited similar choice profiles across the 24 alternative facial expressions when the passages were presented separately for decoding (Cronbach and Gleser, 1953). Messages that implied a similar referent (or referents) were defined as redundant; whereas, messages that suggested different sets of referents were defined as nonredundant. This measure of referential redundancy implies that when choice distributions do not overlap to a large degree, the resulting intersection corresponds to fewer categories (or choice alternatives) than is the case when there is a large overlap between the two choice distributions. In other words, nonredundant information facilitates convergence toward the correct response, whereas redundant information does not. It was predicted that in the immediate response condition, nonredundant pairs should yield higher hit rates (correct responses) than redundant pairs due to convergence.

Following an interpolated delay interval, the above analysis suggests that, given a sufficient amount of forgetting, the nonredundant message-pairs may no longer facilitate convergence toward the correct target referent,

thus causing a decline in hit rate performance. Nonredundant descriptions are assumed to imply different sets of possible alternative choices. Thus, if part of one message was forgotten, the lost information most likely would not be represented by the information which is recalled. In this case, nonredundant pairs might not be able to produce a convergence toward the correct choice, thus resulting in a relatively rapid decline in performance. By contrast, redundant pairs may yield relatively stable performance patterns. That is, if the descriptions in a redundant message-pair actually provide the same (or similar) information with respect to the appropriate choice alternatives, then it would seem likely that although part of one message may be forgotten, performance would be relatively unaffected, since the information would be available from the other description in the pair. Hence, one might expect that the hit rates in the two redundancy conditions might not be significantly different when subjects have to work at an interpolated task before decoding the message-pair. Manis and Platt (1976) refer to the above set of predictions and assumptions as the structural model.

The results from the second study reported by Manis and Platt (1976) are shown in Figure 1.[1] Hit rate performance is displayed as a function of the redundancy between the input messages and the delay between reading

[1]Since the results from the two studies produced very similar performance patterns, only the results from the second study will be presented and discussed.

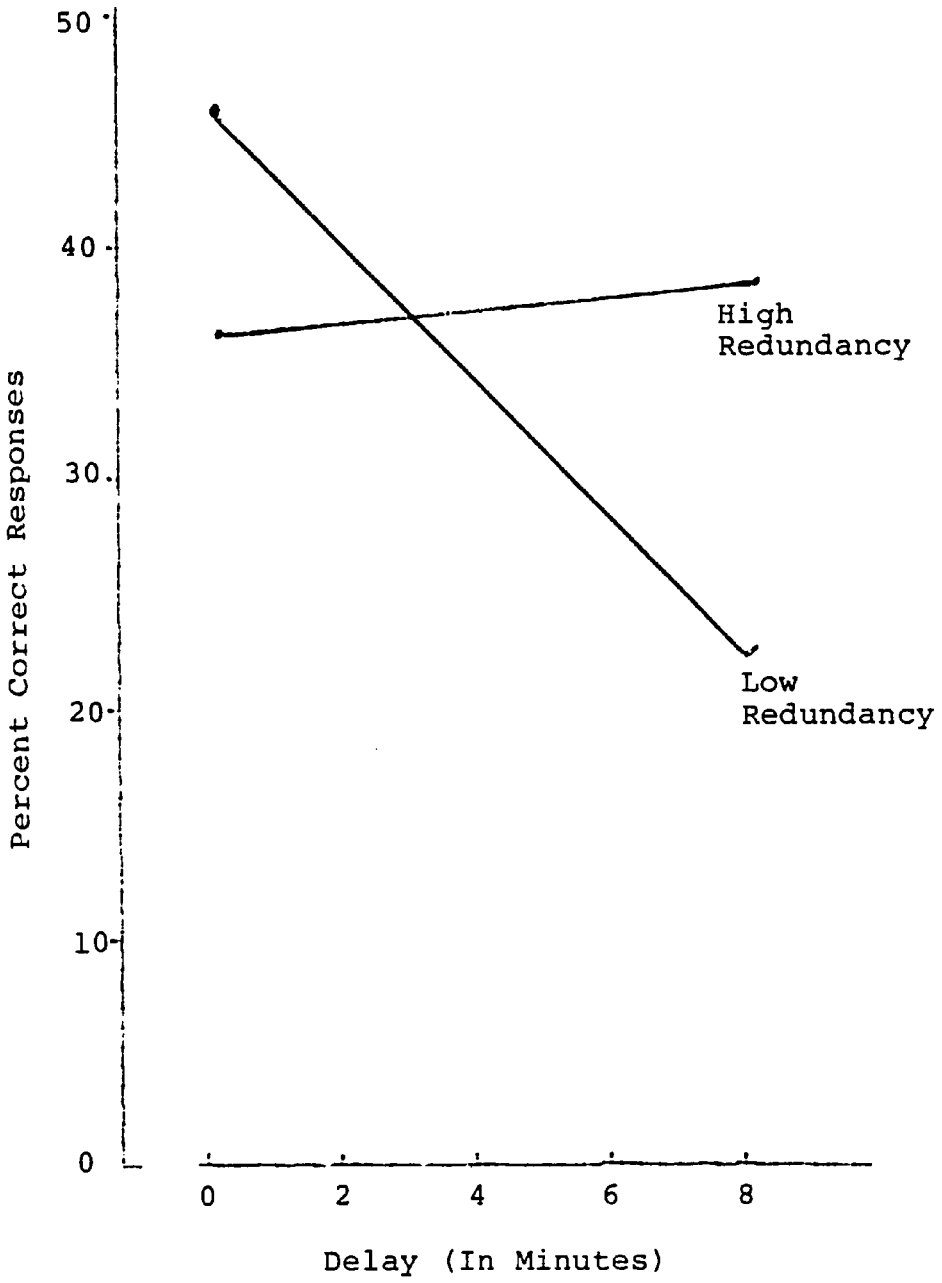


Fig. 1. Mean percent correct response as a function of redundancy and delay (from Manis and Platt, 1976).

the initial message-pair and selecting the correct target facial expression. The graph shows that when subjects responded immediately following the verbal presentation, nonredundant passages were more accurately decoded than redundant message-pairs, as predicted by the structural model outlined above. By contrast, after the extended retention period (eight minutes), subjects were more accurate in response to redundant pairs than nonredundant pairs. The result from the delayed response condition is contrary to the prediction made by the structural model, which assumes constant forgetting in both redundancy conditions and implies an ultimate convergence to a common performance level. Manis and Platt interpreted these delayed response results as a possible indication that more information was lost (forgotten) from the nonredundant message-pairs.

While differential forgetting (dependent upon the redundancy of the input message pair) is clearly one possible explanation for the Manis and Platt results, these data cannot be unequivocally interpreted in this fashion, for the picture selection task may not directly reflect the retention levels in the various experimental conditions. That is, performance variables <u>other</u> than memory factors may have affected the subjects' selection responses.

The primary purpose of this dissertation is to directly examine the effect of referential redundancy on retention, not only to further elucidate the mechanisms underlying the Manis and Platt (1976) results, but also to extend the generality of previous findings concerning the effect of redundancy on memory (see below).

In an earlier attempt to explore the relationship between retention and referential redundancy, Platt and Manis (1976) asked their subjects to read pairs of descriptions that varied in redundancy. Instead of decoding these description-pairs by attempting to select the intended target referent (facial expression) associated with each one, the subjects were simply asked to summarize the component passages, one at a time. Subjects summarized the descriptions either immediately after they were presented, or after an eight-minute delay period, during which time subjects worked on an irrelevant arithmetic task.

The respondents' summaries were content analyzed to determine the amount of information that they recalled. Each component description was separated into several independent pieces of information. These categories were used to "score" the summaries that were produced; the score given to each summary was then entered into an analysis of variance.

The results yielded a marginally significant ($p < .10$) interaction between redundancy and delay.

That is, while the high redundancy pairs generally elicited better recall of the information, the difference between the two redundancy conditions was larger in the delayed response condition than in the immediate response condition. To further explicate this effect, the delayed response data were analyzed separately. Here the main effect due to redundancy was highly significant ($p < .025$); that is, following the eight-minute retention interval, subjects recalled significantly more information in the high redundancy condition than in the low (non-) redundancy condition.

While these results provided some evidence that memory performance was partly dependent on the redundancy of the input message-pair, the results showed an anomalous pattern that varied unexpectedly from one item to the next despite the promising overall pattern.

A second weakness in this earlier memory study was the fact that the subjects were instructed to summarize the written material such that another person, upon reading the summary could accurately choose the target referent. That is, subjects were cognitively "tuned" as transmitters (Zajonc, 1960). Previous research has shown that subjects who are set to transmit information to another person tend to relay information which is internally consistent, unified, organized. By contrast, subjects who are set to receive information tend to

summarize what they have previously received in a less unified, consistent manner (Zajonc, 1960; Cohen, 1961). This implies that the subjects in the Platt and Manis experiment may have focused on the subsequent task of their "listeners," thus selecting only consistent, unified, and organized information to include in their summaries. Hence, the instructions may have biased the summaries in such a way that "private" recall of the information may not have been properly assessed, and may inadvertently have favored the recall of redundant (consistent) message-pairs.

While recall probably best approximates the type of memory used by subjects in the decoding task, recall was rejected as the retention measure for the present study reported below in favor of recognition. Most importantly, since the stimulus material used in the present experiment was the same as that used by Manis and Platt (1976), a recognition task bypasses the complicated problem of content analyzing the obtained summaries of colloquial prose, a major methodological problem in and of itself. Secondly, a recognition task allows little opportunity for the subject to reconstruct the original message from prior knowledge either of the English language or typical situations that were described in the input messages. Finally, recognition should provide a more sensitive measure of retention, since it does not depend on the presence of effective retrieval cues.

While the Platt and Manis study (1976) weakly suggests that referential redundancy may differentially affect the rate at which information is forgotten, there is other work in more traditional areas of experimental psychology that is generally consistent with this point of view. Past research concerned with the effects of redundancy on memory can be categorized into two groups, according to the operational definition of redundancy. Most verbal learning experiments have defined redundancy as the repetition of a stimulus unit within a series or list of stimuli. Other experimental studies have defined redundancy more broadly as the type of internal structure present in a stimulus set. These latter studies have used geometric forms, nonsense syllables, words, and more extended prose passages in testing various hypotheses concerned with the effects of redundancy on memory and other cognitive processes.

Redundancy as Repetition

The literature which defines redundancy as repetition is relevant to this discussion, since the referential redundancy measure used by Manis and Platt (1976) assumes that two descriptions that imply similar sets of referents probably convey the same (or similar) information. At a semantic level, then, referentially redundant message-pairs repeat the underlying information (deep structure)

contained in the two passages, whereas referentially non-redundant pairs present messages that are more separable, or different from one another.

It is well known that subjects retain the semantic component of input information longer than the surface structure of the messages (Sachs, 1967). That is, subjects tend to retain the underlying meaning, the gist of the input material, far longer than the individual lexical components, the particular words used to compose the various input sentences. Hence, it is psychologically meaningful to talk about how the repetition of deep structure might affect retention of input information.

Most memory theorists would agree that repetition should, in principle, facilitate memory for the repeated items. This effect may be due to a number of mechanisms, such as increased memory trace strength for repeated items, or the existence of multiple representational codes in memory. There is a large body of experimental literature that confirms these expectations (Waugh, 1962, 1963, 1967; Peterson and Peterson, 1959, 1962; Peterson, Wampler, Kirkpatrick, and Saltzman, 1963).

In a typical study, Waugh (1962) examined the effect of intra-list repetition on free recall memory. She found that the probability of recalling a stimulus word depended upon the number of times the word had been repeated in the input list. As the number of repetitions

increased, subjects were more successful in recalling the word.

More recently, Wickelgren (1972) demonstrated that repetition affected the rate at which subjects lost input information after several long-term retention periods. Subjects were presented with a series of words for study. Within the word lists, a particular word was presented either once, twice, three, or four times. Wickelgren also varied the spacing between successive repetitions. Following the presentation of the list for study, the critical words were tested for recognition at delays of 1, 2, 5, 10, 20, 30, or 60 minutes; however, not all delay intervals were tested for all repetition conditions. Subjects responded by making a yes-no recognition judgment, along with a confidence rating from (1) least to (4) most confident. Using statistical decision theory, Wickelgren obtained memory strength discriminability measures (d' values) for each subject in the various conditions.

The results showed that the rate at which subjects lost information (words) depended upon the number of times the word was presented within the study list. Words that were presented once were lost (forgotten) at a faster rate than words repeated several times during the input list. Moreover, the decay rate decreased as the number of presentations increased; that is, there was an inverse

relationship between repetition and the rate at which the information was forgotten.

The data also suggested that the spacing between the successive repetitions of a stimulus word had very little impact on the decay rate. Traditionally, it has been found that longer intervals (lags) between successive presentations facilitate retention, while very short lags produce relatively little effect upon memory (Melton, 1967; Glanzer, 1969; Madigan, 1969; Bjork and Allen, 1970; D'Agostino and DeRemer, 1973; Glenberg, 1976). However, as Glenberg (1976) notes, little research has dealt with the effects of both lag intervals and retention intervals on subsequent retention of the input information. Rather, most research on lag effects has used very short retention intervals.

In summary, then, Wickelgren's study demonstrates differential forgetting, dependent upon the number of times a stimulus word was presented in the study list.

Redundancy as Internal Structure

While most studies of verbal learning and verbal memory have typically defined redundancy as repetition, there is a body of literature in the fields of perception and concept formation that define redundancy in a more complex fashion. As mentioned above, redundancy has also been conceptually defined as the type of internal structure

present in a set of stimuli. Essentially, the internal structure of a stimulus set refers to the type of correlation which exists between the relevant stimulus dimensions.

The concept of internal structure has been derived from information theory which first formally defined redundancy (Shannon and Weaver, 1949; Attneave, 1959). Garner (1962, 1974) noted that the information theory concept of redundancy could quantify the amount of redundancy (constraint) operating within a system or stimulus set, but could not determine the form or nature of the constraint. Garner's notion of form of redundancy (type of internal structure) refers to the nature of the contingencies or correlations between the dimensional variables that combine to form the stimuli of interest.

The correlational structure of a stimulus set may take several forms. First, a correlation may exist between two dimensions such that the various levels of these two dimensions are perfectly correlated. For example, consider a set of visual stimuli, geometric forms, that are produced by orthogonally combining four different dimensions, each of which has two values or levels. Furthermore, suppose that in a subset of these geometric forms two of the dimensions, say form and color, are perfectly correlated such that the squares are always blue and the circles are always red. The form of the redundancy in this particular subset of stimuli is simple in nature;

that is, most of the redundancy present in the subset is due to the perfect (or simple) correlation between the dimensions of shape and color. Similarly, the redundancy of a subset may be the form of a perfect correlation between more than two dimensions. As in the example above, it may be that a simple correlation exists among three dimensions: shape, color and size.

Finally, a correlation may exist in a more complicated form, such as an interaction between several dimensions and their different levels. This case is analogous to a partial correlation, as differentiated from a simple or perfect correlation. A perfect correlation between two or more dimensions will be referred to as a "simple" form of redundancy, while the more complicated partial correlation will be called a "complex" form of redundancy.

The concept of the form of redundancy is closely related to more intuitive definitions of redundancy. The factor which determines the form of the redundancy in a stimulus set is the conceptual rule used to select the individual stimuli to be included in the subset presented for study. If the selection rule produces perfect (or linear) correlations between two relevant stimulus dimensions, then the form of redundancy will be simple; however, if the rule produces partial correlations between the dimensions, the form of redundancy will be complex in nature. The form of the redundancy or internal structure of a set of stimuli, then, indicates the nature of

the relatedness between the dimensional variables, and depends upon the rule used to select the items for membership in the stimulus set presented in the experiment.

Several studies have shown that simple forms of redundancy, which are present in a sequence of letters or words, facilitate learning, using both recognition and recall measures of retention (Miller and Selfridge, 1950; Miller and Friedman, 1957; Miller, 1958; Sharp, 1958; Carson, 1961). Most of these studies, however, have measured retention shortly after the presentation of the study lists. As a result, these studies cannot highlight the effect of redundancy (as internal structure) on long-term retention (i.e., the rate at which subjects forget input information) but rather, they can elucidate the various mechanisms which may underlie the basic effect of redundancy on short-term retention.

Miller (1958) generated strings of letters which varied in the form of redundancy by either chosing the letters randomly or by using a set of rules (a finite state model) which introduced a constraint into the selection process. The particular type of constraint present generated by the finite state model was neither exceedingly simple nor complex; however, it was far more systematic than the random generation of the letter sequences. Thus, in comparison to the random strings, the constrained strings contained a relatively simple form of redundancy.

Miller found that the redundant strings were learned more quickly and more accurately than the random strings. Furthermore, examination of the items which were recalled showed evidence of chunking (Miller, 1956) in the redundant string condition, but not for the random strings.

That recall was better for redundant strings than for nonredundant strings suggests that subjects were able to perceive and learn the selection rule in the redundant strings. The subjects, then, used this information to their advantage, producing faster and more accurate performance. Similar effects of simple forms of redundancy have been observed in studies of concept attainment using free recall measures (Garner and Whitman, 1965; Whitman and Garner, 1962, 1963; Whitman, 1966; Koeppel, 1968; Musgrave and Gerritz, 1968; Nelson, Garland, and Crank, 1970).

Deese (1961) has suggested that superior recall of redundant material may be due, in part, to the subjects' ability to reconstruct the input message (e.g., a sentence) from a small core of information that is recalled at the time of test. That is, because subjects are highly familiar with the grammatical rules which govern the construction of sentences in our language, subjects may use these rules to regenerate the missing portion of a partially recalled sentence.

In other words, the easily perceived and learned selection rule that determines the redundancy within an

input list or sentence assists the subject at the time of recall by directing the reconstruction of the entire stimulus list or sentence from the small core of information retained. This notion, then, implies that the locus of the effect of redundancy on recall is at the retrieval stage.

Alternatively, it may be that subjects, when learning redundant material, recode the information into large chunks of information. Recoding is made possible by the fact that there is an easily perceptible relationship between the words or ideas presented in the message. Chunking, as Miller (1956) has pointed out, effectively reduces the memory load by decreasing the number of units to be stored. From this standpoint, then, one could argue that the presence of a simple form of redundancy may affect the encoding process, by allowing redundant information to be stored more efficiently (i.e., fewer chunks). Several authors (Miller, 1956, 1958: Carson, 1961; Lachman and Tuttle, 1965; Krueger, 1970) have discussed recoding hypotheses which vary in detail, but all agree that recoding results in fewer functional units to process and store than if no recoding scheme was used, given the same amount of input information.

For example, suppose that the finite state model used to construct the redundant strings of letters in Miller's (1958) study contained the rule that a G always follows an X. Upon realizing this relationship, a subject would

only need to store an X, rather than the XG pair. This scheme would reduce the memory load by reducing the number of individual letters to be stored. By contrast, the random strings contain no easily perceptible or specifiable selection rule. Subject responding to random strings are forced to store all of the individual letters, since they cannot be recoded. This example suggests, then, that subjects who are exposed to redundant strings have less to remember (due to the recoding process) than subjects responding to nonredundant or random strings. Encoding efficiency, then, should directly affect performance on tests of retention.

One way to differentiate these two contrasting explanations would be to compare performance on a recall task to the performance that obtains on a recognition task. Recall is typically assumed to involve two stages; search and recognition. By contrast, recognition excludes the search stage and depends only on whether or not the subject recognizes the information as being familiar or relevant. That is, in a recognition task, the experimenter provides the proper retrieval cue, thus obviating any uncertainty as to the proper location of the correct information. Hence, the subject only decides whether or not he has seen the information before. The construction notion suggested by Deese implies that there should be minimal differences in recognition performance

between redundant and nonredundant material, since recognition is less dependent upon retrieval processes. The recoding hypothesis, in contrast, predicts that performance should be superior in the redundant condition regardless of the measure used in access retention, since both response measures (recall and recognition) are sensitive to differences in encoding.

There has been mixed support for these contrasting accounts. Studies by Lachman and Tuttle (1965) and Rosenberg (1968, 1969) provide evidence that supports the recoding hypothesis, thus suggesting that redundant information is better retained than nonredundant information due to encoding differences. However, Kintsch (1968) found that while the structure of an input list had no effect on recognition, the list structure did affect recall. Kintsch interprets these results as further evidence of a two-stage process of recall, with recognition being a subprocess of recall.

Kintsch (1968) suggests that one reason his results differ from those of Lachman and Tuttle (1965) is that his recognition results indicate differences in item recognition, while Lachman and Tuttle's procedure examined class recognition. Item recognition refers to those tasks in which the subject must differentiate items within a homogeneous set, deciding which items were presented, and which items were not. Class recognition refers to tasks

that employ distractors from different categories than those used in the study part of the session. Kintsch notes that if recognition is based on class recognition, one would expect better recognition of organized lists as compared to random or unorganized lists, presumably because subjects would base their decisions on whether or not the test word was a member of the list categories, a decision which is different from whether or not a particular item was presented in the input list.

The relevance of this explanation to Rosenberg's (1968) results is less clear, however. Rosenberg's subjects were asked to read a rather long passage (several paragraphs) within which either associatively related or unrelated nouns were embedded. The two passages, high- and low-association, contained fourteen key nouns that were followed shortly by three other nouns that were either high- or low-associates of the key nouns. The low-association passages were comprehensible, but presented the subjects with a more difficult integration task than the high-association passages. After reading one of the passages, subjects were either asked to recall as much as possible from the initial passage, or were asked to indicate whether or not each of a list of nouns appeared in the passage.

Rosenberg reports results for two scoring methods: one that includes responses to all nouns that were presented in the two passages, and one for just the fourteen

key words that were presented in both passages. Both measures show a significant effect due to association within the passages, with high-association passages better retained than low-association passages. In general, the recognition scores were significantly higher than the recall scores, but there was no interaction between the type of retention measure and association within the passage. These results, then, could not be accounted for by means of a class versus item recognition argument suggested by Kintsch (1968), since both recognition and recall measures were sensitive to passage association structure even when attention was focused just on the key nouns that were presented in both of the passages.

The evidence reviewed thus far suggests that there may be two important factors contributing to the facilitative effect of redundant messages on retention. First, subjects may make use of the structural constraint operative within a redundant message during the retrieval stage of recall. In doing so, subjects can "fill in the gaps" of their memory on the basis of a predictable (redundant) input message. Secondly, the redundant structure in an input message may facilitate efficient encoding and storage of the information by allowing subjects to chunk or integrate the information into smaller units (chunks) each of which contain more information

than any of the individual units (words) that comprise the input message. By contrast, nonredundant messages are less likely to be recoded into smaller units, since the information contained in the messages is less readily reduced to a few, easily perceived bits of information. That is, redundant information may free the subject either to process the available information at a higher (more abstract) level (Craik and Lockhart, 1972), or to process further incoming information. During recall, however, it is most likely that both factors operate together to facilitate recall of redundant messages or word lists. Lachman and Tuttle (1965) discuss a similar notion.

In summary, most of the literature from the experimental psychology area suggests that redundancy does facilitate memory. That is, after either brief or extended retention intervals, most studies show that subjects can remember more information from redundant message or input lists than from less redundant (nonredundant) messages. Moreover, there is some indirect evidence which supports a differential forgetting notion, dependent upon the redundancy in the input list (Wickelgren, 1972; Platt and Manis, 1976).

As mentioned previously, the major purpose of this dissertation is to examine the effect of referential redundancy on (recognition) memory. This brief review of the relevant literature suggests that subjects should

remember more information from redundant message-pairs than from nonredundant message-pairs. It is expected that when minimal demands are made upon the subjects' memory, the difference in performance between two redundancy conditions should be relatively small. By contrast, after an extended retention period, the difference between the two redundancy conditions should be quite substantial. Essentially, then, a differential rate of forgetting is predicted, such that over time subjects show a more modest rate of forgetting for the information in redundant message-pairs, as compared with nonredundant message-pairs. This hypothesis is later referred to as the differential forgetting hypothesis.

The Representation of Information in Memory

Another issue that is addressed in this dissertation is the mode in which subjects process and ultimately represent (store) information in memory. Recently, researchers have been particularly interested in the role of imagery or visual-spatial representations in the memory system (Paivio, 1969, 1971; Pylyshyn, 1973; Kosslyn, 1975). Paivio (1969, 1971) suggests that there may be a functional distinction between the way we process visual or imaginal information as opposed to verbal information. Moreover, he claims that spatially-oriented stimuli may be encoded by means of two memory traces, one visual-spatial and one

verbal; by contrast, he contends verbal information is probably encoded only by means of verbal units.

Pylyshyn (1973), on the other hand, argues against several implicit notions that underlie most models of visual processing. Thus, he denies (a) that stimuli are represented pictorially in the memory system, and (b) that processing an already encoded visual image involves perceptual interpretation before the memory code is comprehensible. In contrast, Pylyshyn supports models of memory and thinking that posit some highly abstract, perhaps unobservable (to the "mind's eye") mediator between the perceptual interpretation and storage of an event and the retrieval and transformation of the abstract memory code into language that is understandable to others.

It is beyond the scope of this paper to argue in favor or against these opposing viewpoints; however, it is important to recognize that different types of stimuli may lead to different modes of encoding and storage of input information, and that the same stimuli may be encoded in different ways.

Because the stimuli used in the following study were descriptions of facial expressions, it is altogether possible that the verbal descriptions may be encoded visually; that is, subjects may try to image the facial expression described in the messages, and encode the visual interpretation of these descriptions. In contrast, another

strategy may be to simply encode one or two key words that would help to remember the remaining information. A third possible strategy may be a combination of the above, such that subjects encode both a verbal and a visual representation of the input information.

The preceding discussion of the effects of redundancy on retention implicitly assumed that subjects normally encode and store input information in verbal terms. Of particular interest is the impact of the type of encoding strategy used by the average subject on the differential forgetting hypothesis. It may be that the type of representation code stored in memory will affect the impact of redundancy on retention. It is conceivable, for example, that when respondents use a visual code, they can retain the information in nonredundant message-pairs more effectively than the information in redundant pairs. Thus, let us assume that each description in a pair refers to or describes a feature or characteristic of the target facial expression. Since redundant messages convey roughly the same information, presumably the same feature or characteristic is described in both messages. By contrast, nonredundant message-pairs convey separate pieces of information; that is, two or more features of the target face. As a result, subjects should be able to develop a more detailed image of the target expression from nonredundant messages than redundant messages. It

may be that the more features represented in the image, the more memorable the image.

Loftus and Bell (1975) found that subjects recognized highly detailed photographs more often than line drawings of the same information. Presumably, the photographs contained more detail; thus there was a higher probability of finding informative, recognizable detail. By contrast, however, Nelson, Meltzer, and Reed (1974) did not find a difference in recognition between photographs and line drawings. Rather, Nelson, et al. found that the long-term rate of forgetting from a picture did not depend upon the number of informative details contained in the stimuli. The available evidence, then, cannot unequivocally determine the effect of visual encoding on the retention of simple versus complex images.

There are several possible techniques that would allow reasonable inferences concerning the ways in which incoming information is represented in the subject's memory system. The most common techniques are either to give prior instructions about encoding and storage strategies (Paivio, 1969; Paivio and Yuille, 1967; Yuille and Paivio, 1967), or to require subjects to work on different distractor tasks which presumably interfere with different modes of processing (Pelligrino, Siegel and Dhawan, 1975, 1976). The latter technique was chosen for this study, since it allows assessment of what subjects

will do naturally. That is, there is no real assurance that subjects actually image or attend to the words when told to do so; however, if subjects are asked to work on different interference tasks, it is readily apparent whether or not they actually comply with the requirements of the task.

Two different distraction tasks, verbal and visual, were included in the present experiment, primarily for exploratory purposes; that is, no specific model was invoked to predict which distractor task should interfere more with the subjects' memory. Since the input information is presented in verbal form, it might be reasonable to expect that subjects might attend to the descriptions as purely verbal units, and hence a verbal distractor task should produce greater interference than a visual distractor task. However, subjects were also asked to integrate the information such that they might accurately determine the correct target referent (facial expression) from which the descriptions in each message-pair were derived, as in the task employed in Manis and Platt (1976). This requirement suggests that the average subject might attempt to "image" the facial expression such that a more accurate match might be obtained in the choice task. Because of these conflicting lines of analysis, it is difficult to reach a definite prediction as to which of the distractor tasks will produce greater interference.

In summary, the following study explores the impact of referential redundancy on recognition memory, as a function of the type of distraction during the delay interval. Previous research supports the hypothesis that information is typically forgotten more quickly from input lists that are composed mainly of unrelated words or items than from lists containing conceptually related items. In place of simple word lists that have previously been used in studies of this type, the present experiment was conducted with more complex, everyday stimuli (i.e., extended descriptions of various facial expressions written in colloquial English). Evidence supporting the relationship between redundancy and retention would thus extend the generality of earlier research in this area.

CHAPTER II

METHODS

Overview

The main hypothesis discussed in the previous chapter can be stated very briefly: the ability of subjects to retain the information contained in a message-pair should be directly related to the degree of redundancy between the two input descriptions. The present study also explores the effects of two interference tasks--verbal and visual--on the long-term retention of the information contained in the message-pair. While the available evidence does not permit any clearcut prediction, it nonetheless seemed possible that the verbal task might interfere more than the visual task since the information to be remembered was presented verbally.

Subjects participated in a recognition task in which they were shown a series of message-pairs. After each pair was displayed, a third (probe) description was presented for recognition. The respondent's task was to determine whether or not the information contained in the probe description matched at least one of the previous descriptions contained in the initial message-pair. Subjects were also asked to rate how confident they were of

their recognition response, on a five-point scale.

Subjects responded to the probe descriptions either immediately following the presentation of the message-pair, or after a four-minute delay interval, during which time they worked on one or two interference tasks. Half of the subjects worked on the verbal task, while the other half of the subjects worked on the visual task. After responding to the probe descriptions, all subjects were asked to choose the facial expression that was described by the initial pair of messages.

Subjects

One-hundred-twenty students from The University of Michigan were paid to participate in this study. Subjects were recruited from the paid subject pool organized by the Human Performance Center for human experimentation. An attempt was made to recruit equal numbers of male and female subjects; however, the final sexual composition of each group was determined by the actual attendance. Subjects were run in groups of five or fewer. Data from four subjects were discarded because they did not follow the instructions properly. Subjects participated in just one session, and then were debriefed and paid.

Materials and Apparatus

Stimulus Descriptions

Subjects were shown a series of description pairs in a recognition task. The individual descriptions were generated by a group of college students in a previous study (Manis and Armstrong, 1971). In that study, subjects were shown several facial expressions from the Frois-Whittman series (Hulin and Katz, 1935) and were asked to verbally describe a number of them. For example, the subjects were asked to describe the "mood, feelings, or thoughts of the person pictured," or to "describe the situation he is in and his reaction to it." They were also asked to "make the description clear enough so that someone else would know which picture you've written about (Manis and Armstrong, 1971, p. 382-83).

Eight facial expressions that were neutral with respect to the pleasant-unpleasant dimension (Schlosberg, 1952) were designated as target referents. For each of the eight faces, more than fifty descriptions were collected in the Manis and Armstrong study. Here is a typical example: "The man is deeply involved in watching a James Bond movie. The hero is in trouble again, and the man doesn't dare take his eyes off Bond for fear he'll miss something."

Referential Redundancy

Referential redundancy refers to the extent to which two messages imply similar sets of referents. The target referents in this experimental task are the various faces described by the verbal descriptions. Thus, in order to assess referential redundancy, one must be able to determine the implied set of referents for each description, such that comparisons between messages can be made.

Manis and van Rooijen (1973) asked a separate group of college students to decode the various descriptions obtained from the Manis and Armstrong study. These subjects were asked to read each description and to indicate the intended referent (facial expression) from an array of 24 different faces that spanned the pleasantness continuum. The array of 24 faces used in the Manis and van Rooijen (1973) study and in the present experiment are shown in Figure 2. From the subjects' responses, then, the investigators were able to construct a frequency distribution (response profile) for each description, indicating the number of individual choices for each of the 24 alternative facial expressions.

The referential redundancy between the individual descriptions in a message pair was assessed by the similarity of the choice profiles that were elicited by the component descriptions when they were decoded separately (Cronbach and Gleser, 1953). The profile similarity was

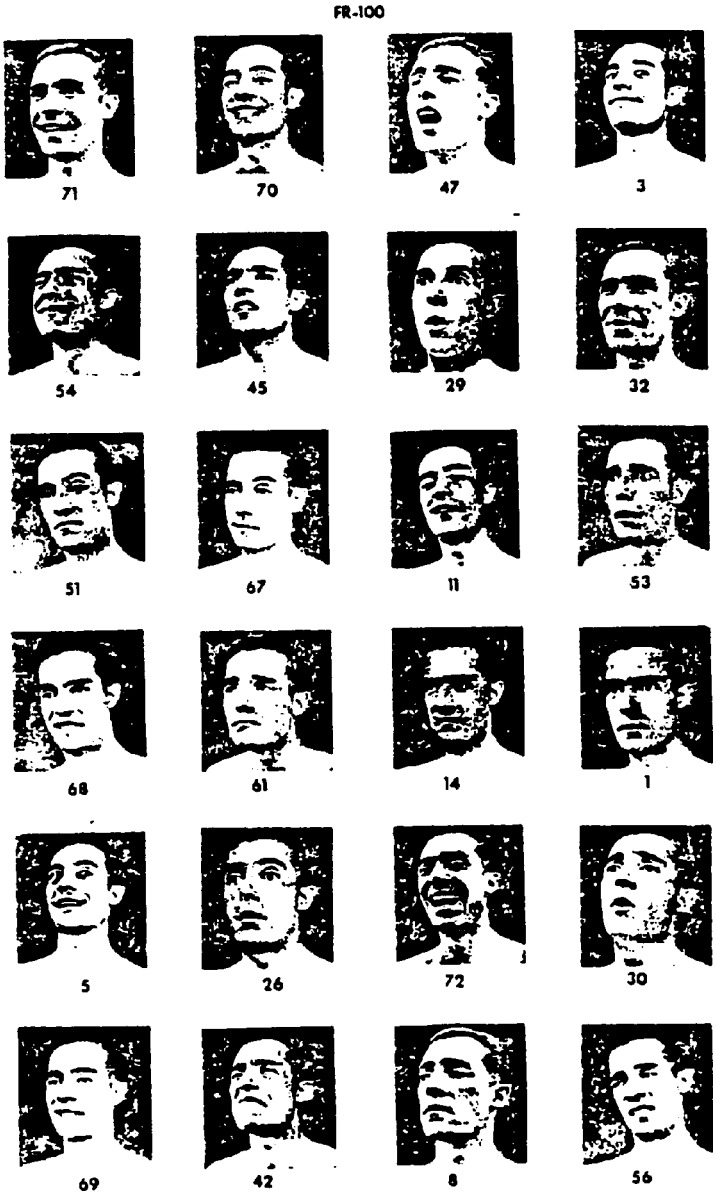


Fig. 2. Frois-Wittmann photographs (Hulin and Katz, 1935) from which the verbal descriptions were obtained and from which the experimental respondents made their reference choices.

measured by means of the Euclidean distance measure,

$$D = \sum_{i=1}^{n} (f_{i1}-f_{i2})^2$$

where:

f_{i1} = the frequency with which alternative i was chosen in response to the first description of the pair,

f_{i2} = the frequency with which alternative i was chosen in response to the second description of the pair, and

n = the total number of alternatives possible; in this case, n = 24. (Osgood and Suci, 1952.)

The D-score is inversely related to the degree of redundancy in the message set. That is, when a description pair has a low D-score, there is a high degree of redundancy; when a pair has a high D-score, there is a low degree of redundancy.

This measure of redundancy is sensitive to the degree of overlap in the response profiles of the two descriptions that are paired together. When there is a considerable degree of overlap between the two distributions, the two descriptions are defined as redundant; when there is a smaller degree of overlap, the two descriptions are defined as less redundant. Examples of message-pairs producing quite similar and different response profiles are shown in Figure 3. A similar approach to the measurement

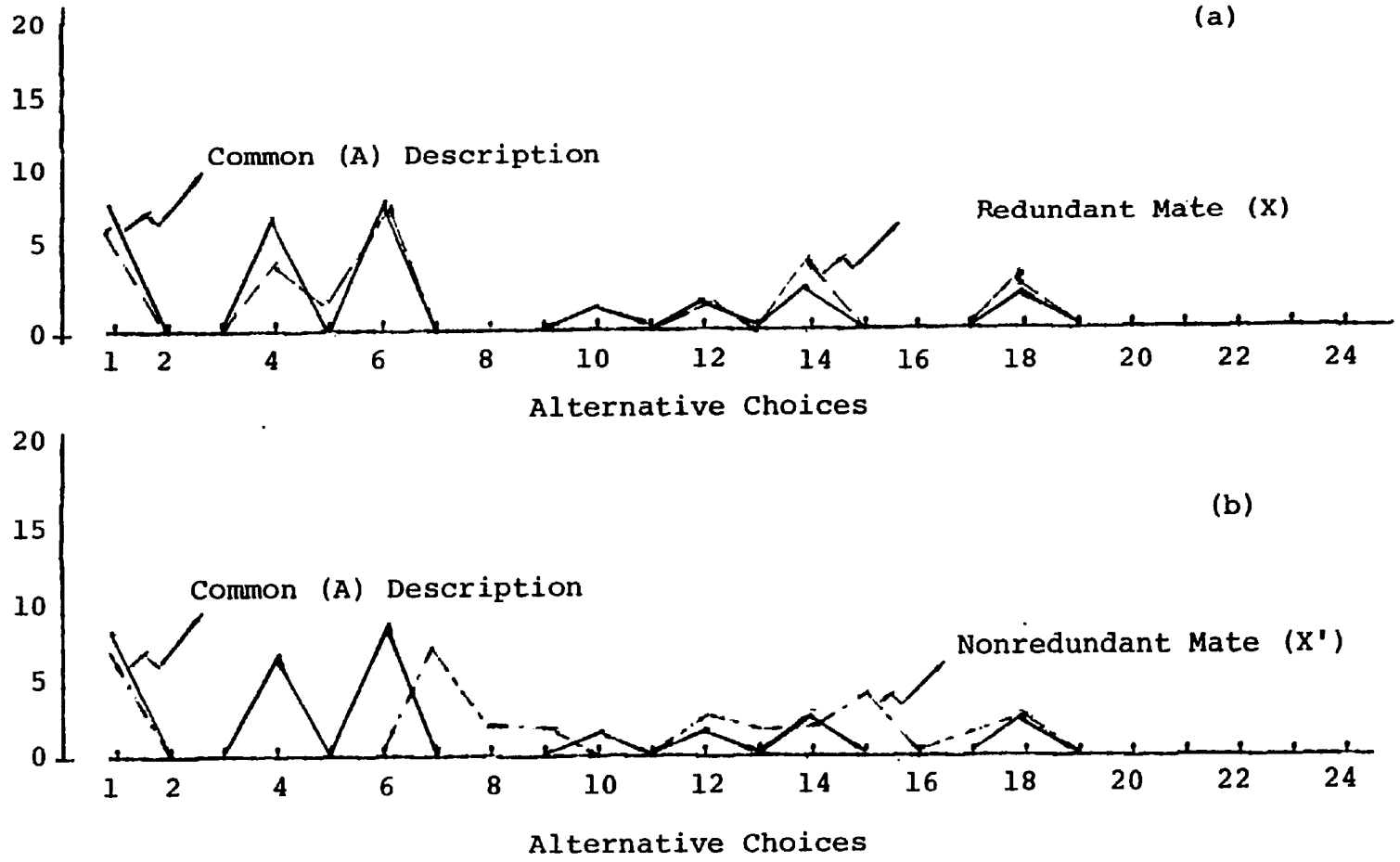


Fig. 3. Examples of high redundant (a) and low redundant (b) response profiles for which alternative #1 is the correct target referent.

of redundancy in a message set has been proposed separately by Deese (1962) and Wyer (1973). See Appendix A for the various pairs of high-redundant and low-redundant pairs of descriptions used in the present study.

Selection of Message-Pairs

The following procedure was adopted to generate pairs of high-redundant and low-redundant messages, while controlling for possible retention differences of the component descriptions. First, from each pool of fifty passages that described one of the eight neutral target faces, pairs of descriptions (X and X') were chosen such that they were equal in validity (quality). Validity refers to the extent to which the description enabled the subjects in the Manis and van Rooijen study (1973) to correctly identify the proper target photograph. Five categories of validity were selected from which pairs of descriptions were chosen. The five categories of validity ranged from low validity descriptions, eliciting between 18% and 27% hit rate (percentage of subjects selecting the correct choice) to high validity descriptions, eliciting hit rates from 58% to 67%. The middle range categories included those descriptions that produced 28-37%, 38-47%, and 48-57% correct response rate from the original norm group. Only those descriptions that produced response distributions having the correct choice as the modal

response were considered for possible selection. This constraint was included so that both descriptions within any given pair that were eventually shown in the recognition task contained information that referred to the correct target referent.

As a result of the first phase, then, a number of pairs, whose component descriptions were approximately equal in validity, were obtained. The second phase of the selection procedure involved selecting a third description, A, which when paired with the X description, produced a message-pair that was high in redundancy; but when paired with the X' description, formed a message-pair that was low in redundancy. This common description was selected from either the very same validity category, or from a neighboring category as the X and X' passages. Again, only those descriptions that elicited the correct response as the modal response were considered for possible selection. The measure of referential redundancy is a relative measure of the degree of overlap between two response distributions. In order to determine the relative degree of redundancy in any given message pair, the D-scores for the two message pairs containing the same common description (A) were compared. For each of the eight neutral faces, the three description triples, A, X, X', that produced the largest difference in D-scores were chosen for presentation in the recognition task.

The description triples are listed in Appendix A with their respective D-scores. Profile comparisons yielded a mean D-score for high redundant message-pairs of .164, with a range from .080 to .259; the low redundant message-pairs had a mean D-score of .438, with a range from .320 to .558. The mean difference in D-scores between corresponding low redundant and high redundant message pairs was .272, with a range from .218 to .356.

In order to generate three description triples for each of the eight neutral faces, it was necessary to include triples that varied in average validity and in the relative difference in redundancy (i.e., D-scores). The design of the experiment is such, however, that relevant comparisons are made across the twenty-four message-pairs, so that any individual differences between triples should affect all relevant conditions equally.

Probe Descriptions

Recognition tasks require that the experimenter present probes or cues which the subjects match to their representation of the input information which has been stored in memory. The nature of the probes used in a recognition task are important, since they indirectly affect the subjective strategies used when encoding and storing the initial input information. For example, if the subjects knew that the probe cue either contained

the exact same words as the original description or completely different words, subjects might spend more time attending to the individual words in the description, rather than trying to understand the underlying meaning of the passage. Thus, the type of probes chosen for the test determine, in part, the scope of inferences allowed by the subsequent data. Because we were most interested in the degree to which subjects could retain the gist or the semantic component of the initial message-pair, probe descriptions were constructed such that subjects were forced to make their recognition decisions on the basis of the semantic or informational content of a given probe, rather than on the basis of the surface structure, the particular words used in the probe description.

To control subjective response sets during the experimental task, at least two types of probe descriptions were necessary, those whose correct answer was "yes," or those whose correct answer was "no." In fact, three general categories of probe descriptions were constructed, so that response generalization curves could be determined. The three categories were: (a) probes that contained the same semantic meaning as one of the input messages, (b) probes that contained a similar semantic meaning, and (c) probes that contained a different semantic meaning from both of the original passages. Examples of these three types of probes together with the original description are shown in Table 1.

TABLE 1

AN EXAMPLE OF A COMMON (A) DESCRIPTION WITH AN IDENTICAL, SIMILAR, AND DIFFERENT PROBES

Common Description (A):
The man in this picture is the classic picture of surprise. He may not be altogether pleased by the surprise.
Identical Probe:
The man in this picture is not completely pleased by the surprise, but he is a classic picture of surprise.
Similar Probe:
The man in this picture is somewhat concerned by what he sees. He doesn't seem to be pleased by what he sees.
Different Probe:
The man in this picture is the classic picture of boredom. He is pleased by what he sees, however.

Only the common descriptions of the various triples were probed in the recognition task, i.e., passage A, which was included in both the AX (redundant) and AX' (nonredundant) pairs. By probing only the common ("A") descriptions, this study can be conceptualized as one concerned with the effect of the contextual redundancy on the subjects' ability to retain the information contained in the common description.

The procedure for constructing the probe descriptions involved two phases. First, the experimenter modified the common descriptions for any given description triple in several ways. To generate probes that contained the same semantic meaning, synonyms were substituted for several nouns within the description. This technique was used, since it seemed to involve the least amount of semantic change, while incorporating lexical or surface change within the probe description. Probes that contained either similar or different semantic meaning were obtained by either substituting antonyms when possible, or in some cases, by describing a different situation. An attempt was made, however, to retain the overall sentential structure, such that subjects would not be able to base their recognition decisions solely on a change in the surface structure of the sentences.

This overall procedure was used to generate six modified versions of each "A" description, two versions for each type of semantic change (identical, similar, or different). Rather than depend upon the experimenter's idiosyncracies to determine what constitutes a semantic change and what does not, the 148 items (24 common descriptions x 6 modifications) were presented to a group of 15 subjects. The subjects were asked (a) if there had been a semantic change from the original description to the modified version, and (b) to rate the degree of semantic

change present between the two descriptions on a seven-point scale ranging from (1) "identical, no semantic change" to (7) "different, a large degree of semantic change."

The raters compared the various descriptions and their corresponding modifications under three conditions. One-third of the raters read pairs of descriptions, the original and the modified version. After reading the pair, these raters answered the two questions concerning the existence and degree of semantic change, if any. The other raters read the original description paired with either the redundant or the nonredundant mate that was chosen for presentation in the recognition task. After reading the message-pair, the modified version was presented in conjunction with the same redundant or nonredundant mate; that is, raters in these conditions read four descriptions per trial, one pair containing the original description, the other pair containing the modified version. These raters, too, judged the existence and degree of semantic change between just the original and modified description; that is, they were not asked to rate the semantic similarity of the two pairs of descriptions. Thus, ratings were obtained for the various original descriptions and the modified versions when studied alone, or when presented within a redundant or nonredundant context.

Probe descriptions were selected for the recognition task using two criteria. First, at least 13 of the 15 raters had to agree as to whether or not the modified version contained the same information as the original description. This figure was chosen, since 13 of a possible 15 total responses corresponds to a significant departure ($p < .01$) from a 50-50% split, as assessed by the sign test (see Dixon and Massey, 1969, p. 509).

Semantically identical probes were those descriptions that were judged as containing the same semantic meaning as the original descriptions to which they were compared. By contrast, semantically similar and semantically different probes were judged as descriptions containing different information from that contained in the corresponding original descriptions. This criterion was included so that only the semantically identical probes would have a correct response of "yes, the probe description contains the same information as at least one of the previous descriptions," in the recognition task.

A second selection criteria required that the mean subjective ratings of the degree of semantic change on the seven-point scale had to fall within certain, specified boundaries that were determined a priori. The boundaries were: (a) not greater than 2.0 for probes denoting the same semantic meaning, (b) between 3.0 and 5.0 for probes having similar semantic meaning, and (c) not less than 5.0 for probes having different semantic meaning.

Using this procedure, then, three probes that varied in the degree of semantic change were chosen for the 24 common ("A") descriptions. The raters' responses were analyzed by means of matched t-tests across the different items. The results yielded no significant differences between any combination of the three "contextual" conditions. That is, the raters' average response concerning the degree to which a semantic change had occurred was not affected by the contextual redundancy within which the original and modified version were read. Moreover, there was no significant difference between either redundancy condition and the condition in which raters simply compared the modified version to the original description. These results are presented in Table 2. For each comparison, a correlation coefficient was also calculated in order to determine if the overall distribution of responses across the three types of probes were affected by the three conditions in which raters made their responses. As shown in the right-hand column in Table 2, all correlation coefficients are significantly different from zero, indicating that the distribution of raters' responses were quite similar, regardless of the condition within which the pair of descriptions were judged.

TABLE 2

SUMMARY STATISTICS FOR PAIRWISE COMPARISONS BETWEEN THE RATER'S TWO REDUNDANCY CONTEXTS AND CONTROL CONDITIONS

Condition	Mean	Standard Deviation	Correlation Coefficient
High Redundancy	4.17	2.04	
Low Redundancy	4.08	2.08	.86, $p<.0005$
Difference Between the Means, $t(142) = .26$, n.s.			
High Redundancy	4.17	2.04	
Alone	3.88	1.94	.90, $p<.0005$
Difference Between the Means, $t(142) = .73$, n.s.			
Low Redundancy	4.08	2.08	
Alone	3.88	1.94	.90, $p<.0005$
Difference Between the Means, $t(142) = .62$, n.s.			

These data suggest that the semantic ratings of the original descriptions and the modified versions were not affected by the context within which the raters read the original description and subsequently judged the semantic relationship between the original and modified version. Any differences between the redundancy conditions in the recognition task, then, cannot be due to perceived differences in semantic meaning, as affected by the contextual redundancy of the original pair of messages.

A complete list of the original and the three probe descriptions used in the recognition study are found in Appendix A.

Presentation

The forty-eight description pairs (twenty-four common descriptions by two redundancy contexts) were made into individual slides. Message-pairs were presented by means of an automatically controlled slide projector. Subjects were given 30 seconds in which to read the two passages in the message-pair that began each trial. Following the presentation of the message-pair, subjects were shown a probe description for 30 seconds, during which time they were asked first, to indicate whether or not the probe contained the same information as at least one of the original descriptions from the previous message-pair, and secondly, to indicate how confident they were of the first response, on a five-point scale. The confidence scale was included to provide a more sensitive measure of recognition. Currently, reaction time measures are quite popular as a means of determining recognition responses. Several authors, however, have shown that reaction time and confidence ratings are highly correlated (Johnson, 1939; Emmerich, Gray, Watson, and Tanis, 1972). A reaction time measure would be quite complicated in this situation, since each probe description would involve

differential reading times. Thus, the confidence technique was chosen as a more practical means of measuring recognition.

After responding to the probe description, subjects were shown the array of facial expressions shown in Figure 2 and were asked to select the target face that was described by the original pair of messages that began the trial. This manipulation was included in order to control the subjects' cognitive set, such that they would be encouraged to integrate the two descriptions, rather than retaining them separately in memory. Subjects were given 25 seconds in which to make this choice. In total, there were 24 test trials, preceded by two warm-up trials to acquaint the subjects with the procedure. Subjects were given a five-minute rest period half way through the session.

Delay Tasks

On half of the trials, after reading the initial message-pair, the respondents were asked to work on an interpolated delay task before reading and responding to the probe description and selecting the target face. Half of the subjects worked on a SAT-like verbal task (verbal condition), whereas the other half were asked to work on several visual hidden picture puzzles (visual condition). Subjects were signalled to begin work on the interpolated

task by a blank screen after reading the initial message-pair and by verbal instructions from the tape recorder that simultaneously controlled the slide projector. Subjects worked on their respective tasks (verbal or visual) for four minutes. The delay period ended when the probe description for that trial was presented on the screen.

The delay trials were presented without prior warning, so that subjects could not prepare for them in any special way, as compared to the immediate response trials. Indeed, within a subject's response booklet, the response pages for all trials were preceded by three pages of either verbal materials or hidden picture puzzles. Thus, the response booklets did not enable the subjects to determine whether the next trial would be an immediate or a delay trial.

The two interpolated tasks were chosen such that the subjects would attend and work on them for the full four minutes of any delay period. The verbal tasks were selections taken from a practice book for the Scholastic Aptitude Test given to entering college freshmen. The items were combinations of vocabulary, reading selections, analogies, and grammar exercises--the typical mix of verbal comprehension items found in standardized tests. Subjects were given three pages of verbal items to complete in four minutes, a task virtually impossible to achieve.

The visual tasks were taken from children's magazines, such as Highlights and Children's Digest. The subject's task was complicated by the fact that the actual hidden objects embedded in the larger picture were not made available, as is the typical practice in the children's magazines. Moreover, the number of hidden objects within the larger picture was indicated by a number placed in the upper right-hand corner of the picture. In most cases, this number was larger than the number of objects actually hidden within the picture. This "deception" was undertaken as an attempt to encourage subjects to continue working on the set of three puzzles for the full four-minute delay period, rather than giving up after their first run through the puzzles. In both tasks, then, subjects were given more than they could complete in the time that was available, as a way to insure that subjects continued to work on the tasks for the full delay interval. A sample of the two interpolated tasks are contained in Appendices F and G.

Experimental Design

The experiment was designed as a six-way analysis of variance, with four within-subject variables and two between-subject factors. The within-subject variables reflect (a) the degree of redundancy between the two passages in the message-pair that began each trial, either high in

redundancy or low in redundancy, (b) whether the trial in question involved responding to the probed description immediately following the presentation of the initial message-pair (immediate response condition), or after a four-minute delay period (delayed response condition), (c) the type of probe description presented for recognition in any given trial, whether the probe description was semantically identical, similar or different from the original description, and (d) two complete replications of the entire twelve-cell design produced by orthogonally combining the above three factors (referred to as trial blocks). The two between-subject variables were (a) the type of interpolated task that the subject worked on during the delayed response conditions, either a verbal or a visual task, and (b) a group factor that determined the particular description pair presented in any given condition and the ordering of the experimental conditions within the session. Twelve different groups were run for each of the delay task conditions (verbal vs. visual).

One variable that has repeatedly been shown to affect retention of information is the serial position of the item within a list. The present task involves reading pairs of descriptions, then responding to a probe description. The probe description only tested recognition of the common description when embedded in a high-redundant or a low-redundant message-pair. Hence, it would be ideal

if the position of the common description could be varied systematically to control for within-pair order effects. In order to accomplish such a design, however, the number of groups would have to be doubled, resulting in 48 groups, 24 for each delay task condition. Rather than expand the number of groups to such a large number, the position of the common description was held constant for each description triple. Half of the triples, then, had the common description in the first position, while the other half had the common description in the second (last) position. Again, since the relevant comparisons are aggregated across the various groups, the serial position of the critical description should affect all conditions to the same degree.

Twenty-four triples were developed so that all subjects could respond to a different message-pair in each of the twenty-four test trials. The twenty-four triples were then randomly paired, thus producing twelve pairs of description triples. Each member of the twelve pairs of description triples was labelled either as a one or a two. All "one" triples appeared in the first half of the session, while all "two" triples appeared in the second half of the session. This designation was fixed, thus any particular triple appeared only in the first half or only in the second half of the session for all of the experimental groups.

These twelve pairs, then, were randomly numbered. The twelve numbers were entered into a randomized 12 by 12 latin square design to determine the order in which the twelve experimental conditions would be presented, as well as which particular description triple would be presented in the various experimental conditions. This method was used such that overall performance measures would be unaffected by (a) differences in the various description triples with regard to retention, and (b) serial position effects. The latin square design, then, produced twelve different experimental groups that differed in the particular description pair presented in a given condition, and the order of presentation of the twelve main experimental conditions.

Table 3 illustrates the 12 by 12 latin square design used to organize the experimental sessions for the verbal task. The exact same table was used for the visual task condition. Across the top of the table are the twelve experimental conditions produced by orthogonally combining two levels of redundancy, two levels of delay, and three types of probe descriptions. The rows represent the twelve different groups that were created for proper counterbalancing of the independent factors of interest. Five subjects were run in each separate group. The cell entries refer to the twelve different pairs of description triples included in the study. The first message-

TABLE 3

REPRESENTATION OF TWELVE ORDERS OF PRESENTATION ADMINISTERED TO SUBGROUPS OF RESPONDENTS

	High Redundancy						Low Redundancy					
	Immediate			Delay			Immediate			Delay		
Group	I[a]	S[b]	D[c]	I	S	D	I	S	D	I	S	D
I	2	4	7	8	12	1	10	5	11	3	9	6
II	11	1	4	5	9	10	7	2	8	12	6	3
III	6	8	11	12	4	5	2	9	3	7	1	10
IV	10	12	3	4	8	9	6	1	7	11	5	2
V	4	6	9	10	2	3	12	7	1	5	11	8
VI	8	10	1	2	6	7	4	11	5	9	3	12
VII	5	7	10	11	3	4	1	8	2	6	12	9
VIII	7	9	12	1	5	6	3	10	4	8	2	11
IX	3	5	8	9	1	2	11	6	12	4	10	7
X	1	3	6	7	11	12	9	4	10	2	8	5
XI	12	2	5	6	10	11	8	3	9	1	7	4
XII	9	11	2	3	7	8	5	12	6	10	4	1

[a]Identical probe. [b]Similar probe. [c]Different probe.

pair of the experimental session was always pair 1, followed by the other pairs in numerical order. In this way, each group went through the design by a different pathway. Thus, each combination of redundancy, delay and probe appeared in a different ordinal position for each of the twelve experimental groups.

Dependent Variables

The dependent variables of primary concern were: (a) the subject's recognition choice, (b) the accuracy of the subject's response, and (c) the confidence assigned to a given response, rated on a five-point scale. Since the probe descriptions were chosen such that only the semantically identical probe would have a correct response of "yes, the information is the same as that contained in at least one of the previous descriptions," variables (a) and (b) are essentially the same. Hence, only two dependent variables will be discussed below, the subject's recognition responses and the confidence assigned to a response.

The subject's confidence associated with a given response was weighted by the direction of the response, such that whenever the subjects responded "yes," the confidence scores were greater than five (6-10); whenever the confidence was associated with a "no" response, the confidence scores were five or less (1-5). This procedure

was adapted from Bransford and Franks (1971) and serves mainly to stretch the confidence scale from 1 (very confident that the probe is different) to 10 (very confident that the probe is the same). This measure was included to provide a more sensitive measure of recognition than the simple yes-no recognition choice, especially when very few recognition errors occur.

CHAPTER III

RESULTS AND DISCUSSION

Statistical Techniques and Considerations

Data Analysis

The recognition choice data and the confidence data were analyzed by two procedures. The first asked whether the different probe condition generated similar response patterns as a function of redundancy, delay, and task. The second utilized the data obtained from the identical and different probe condition in a signal detection-like analysis, which presumably controlled for possible biases. Because the results from the first analysis produced data patterns that were difficult to interpret parsimoniously, the results from the first procedure will be reported only briefly, after which the results from the signal detection-like analysis will be discussed in greater detail.

Corresponding analyses of the confidence data (confidence rating weighted by recognition choice) and the recognition choice data produced very similar results; therefore, to facilitate exposition, only the results from the confidence measure will be reported, since this measure was based on all of the data that was available.

Random Variables

Originally, the experimental design was planned such that subjects would be the only random variable, with all other factors treated as fixed effects. However, Clark (1973) and Forester and Dickinson (1976) have cautioned researchers using linguistic or verbal stimuli that both subjects and verbal stimuli should be treated as random variables, since most researchers hope to generalize across both subjects and verbal material. In brief, Clark (1973) argues that researchers using linguistic stimuli have overstepped their bounds when asserting that "their findings are true for language in general" (Clark, 1973, p. 335). He discusses a statistical technique whereby experimenters can evaluate the generalizability of their effects to new groups of subjects and to other verbal stimuli, as well. More recently, Wike and Church (1976) and others (Clark, Cohen, Smith, and Keppel, 1976) have questioned the validity of Clark's suggestions. Wike and Church (1976) point out two major conceptual problems with Clark's argument. First, they take issue with Clark's definition of a random effect. They suggest that an effect should be treated as a random effect if: (a) the number of levels used in the study does not exhaust all of the possible levels of the effect in the larger population, and (b) the experimenter randomly selected the various levels of an effect as opposed to using a

constrained selection rule for determining which levels to include in the design. They argue that Clark attends only to the first criteria, that "the mode of selecting the p levels (number of possible levels of an experimental factor) for Clark is apparently either unimportant or "secondary" (Wike and Church, 1976, p. 250). Secondly, they argue that Clark's quasi-F technique is unduly conservative, thus avoiding Type I errors (rejecting a true null hypothesis), at the expense of committing Type II errors (failing to detect a true difference).

In general, critics of Clark's position are mostly concerned with the proper definition of random versus fixed effects. The ultimate goal of the research endeavor cannot dictate which effects should be treated as random or as fixed effects. Rather, the criteria cited above should determine which effects are indeed random effects and which are fixed. With regard to this study, it is clear that the stimuli were not randomly selected, but were chosen on the basis of several criteria. Thus, only subjects can be properly treated as a random effect, since only subjects were randomly chosen and assigned to conditions. And, strictly speaking, we cannot confidently generalize to other stimuli, not included in the present experiment.

Analysis of the Separate Probe Conditions

There was more variability between experimental groups than anticipated. Recall that the particular description pairs which were presented as exemplars for a given condition differed between the twelve experimental groups. The groups also differed with regard to the ordinal position of the various conditions within the experimental session. In general, the "groups" variable interacted with most effects of theoretical interest. This situation indicates that overall, the obtained effects were not as "regular" as they could be, since some groups may have actually produced data patterns that were the reverse of the average tendency across all twelve groups. Since the various group by effect interactions are theoretically uninteresting, it seems worthwhile to estimate the strength of the various effects relative to the variability between the groups. This comparison can be achieved by calculating an F-statistic which relates the variability due to the overall effect to the variability due to the effect by group interactions. It should be emphasized that this comparison cannot indicate the extent to which a particular effect generalizes across both subjects and stimuli, but rather, it demonstrates the extent to which the effect generalizes across both subjects and the twelve groups that were included in the present experiment. In the results reported below, the conventional F-statistic which

compares the effect to random variation across subjects will be denoted by F_S, while the comparison between the effect and the effect by group interaction will be designated by F_{ExG}.

Overall Analysis

The confidence data were subjected to a six-way analysis of variance. The six factors included: two levels of Redundancy, two levels of Delay, two levels of Task, three levels of Probe, twelve levels of Group, and two levels of Trial Block. Figure 4 displays the overall confidence scores as a function of the type of description used to probe the subjects' memory. Note that very high or very low confidence scores reflect the subject's substantial confidence that the probe contained identical or different information than the original input. By contrast, low confidence is indicated by a score in the 5-6 range. As suggested by the decreasing function, a highly significant main effect due to type of probe was obtained, $F_2(2, 192) = 1074.23$, $p < .001$; $F_{PxG}(2,22) = 244.33$, $p < .001$. Thus, subjects were able to discriminate between the three kinds of probes, as reflected by the steadily decreasing confidence scores across the three levels of probe descriptions that conveyed increasingly different information from the original descriptions. Overall, this result demonstrates the accuracy

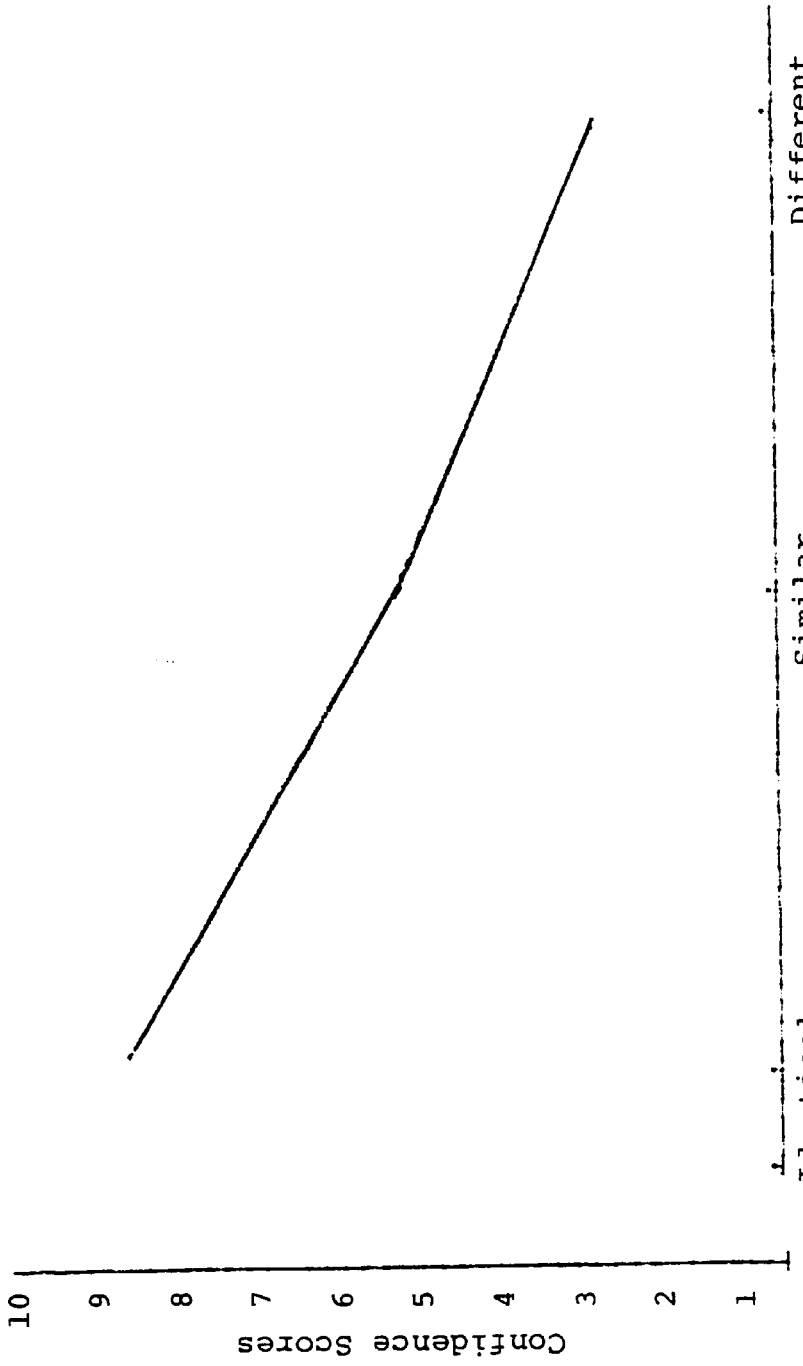


Fig. 4. Mean weighted confidence scores as a function of probe type.

of the experimental subjects' recognition choices (weighted by their confidence). That is, the experimental subjects' confidence ratings directly reflect the raters' judgments concerning the semantic relationship between the various probe descriptions and the corresponding common description.

The overall Delay x Redundancy interaction that was predicted by the differential forgetting hypothesis was far from significant, $p < .20$. However, a four-way interaction between Delay, Redundancy, Task, and Probe was obtained, $F_s(2, 192) = 4.56$, $p < .025$; $F_{DxRxTxPxG(2,22)} = 3.55$,[1] $p < .05$. This result suggests that the delay by redundancy interaction was affected by the interpolated task that subjects worked on during the delay trials and by the type of description used to probe the subject's memory. To further explicate this complex result, separate analyses were run on the three different probe conditions.

Identical Probes

Figure 5 shows the confidence scores obtained from the identical probe condition as a function of (a) the redundancy between the messages in a pair, and (b) the delay between reading the initial pair of passages and

[1]Note that the $F_{DxRxTxPxG}$ statistic is the comparison between the effect (in this case, the DxRxTxP interaction) and the effect by group interaction. This term was referred to above as the F_{ExG} statistic.

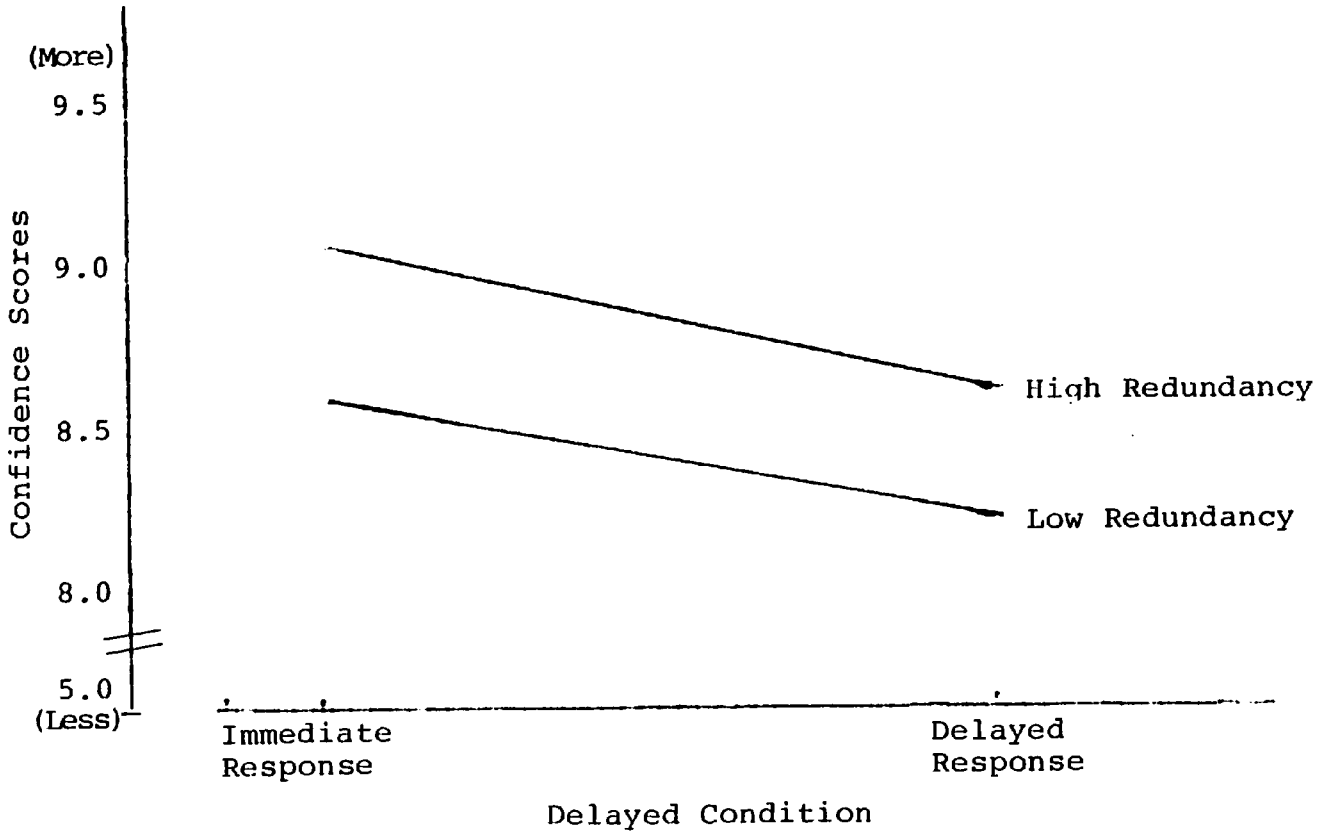


Fig. 5. Mean weighted confidence scores for the identical probe condition as a function of redundancy and delay.

responding to the probe description. The graph essentially contains two parallel lines, demonstrating a main effect for Redundancy, $F_S(1, 96) = 10.33$, $p < .005$; $F_{RxG}(1, 11) = 2.93$, $p = .11$, and a main effect for Delay, $F_S(1, 96) = 8.17$, $p < .01$; $F_{DxG}(1, 11) = 3.57$, $p < .10$. The redundancy main effect indicates that subjects were more accurate and confident of their recognition decisions in the high redundancy condition than in the low redundancy condition. Similarly, the delay effect reflects more confidence when responding immediately following the presentation of the message-pair than after the delay interval.

This graph does not show the predicted interaction between redundancy and delay; that is, the performance for the low redundancy condition does not deteriorate faster than that for the high redundancy condition. The two parallel lines suggest, by contrast, that subjects forget the information at the same rate across time for the two redundancy conditions.

The identical probes yielded another finding of theoretical interest: the type of interpolated task had a marginal impact on the subjects' performance at the two delay periods, $F_S(1, 96) = 3.58$, $p < .10$; $F_{TxDxG}(1, 11) = 5.99$, $p < .05$. That is, the subjects' confidence declined more rapidly when they worked on the verbal task during the retention interval than when they

worked on the visual task. This implies that the verbal task may have produced more interference than the visual task, and consequently caused the subjects to lose more of the critical information needed to accurately verify the semantically identical probes.

Similar Probes

In the similar probe condition, the confidence data yielded a complex Task x Delay x Redundancy interaction, $F_s(1, 96) = 7.21$, $p < .01$; $F_{TxDxRxG}(1, 11) = 7.96$, $p < .025$. This interaction reflected the fact that the form of the Delay x Redundancy interactions depended upon the interpolated tasks. For the verbal task condition, subjects became more confident of their responses to low redundant message-pairs over time, and less confident of their responses to high redundant pairs. By contrast, in the visual condition, the reverse pattern was found. It is unclear why the overall pattern of results should be completely reversed from one task to the other; quite possibly, this result may be unreliable, reflecting a Type I error.

The mean confidence score for the similar probe condition was 5.19. This score implies that overall, subjects were not confident of their recognition decisions, since the mean score is in the mid-range of the confidence scale. A mean confidence score between five and

six could be obtained in two ways. First, subjects could correctly respond, that the probe contained different information from the original, and then rate their confidence at the lower end of the five-point confidence scale. Alternatively, the subjects' recognition accuracy and confidence could both have been highly variable, producing a mean score between five and six. In order to determine which of these contrasting patterns seemed most valid, the error terms that were obtained in the analysis of the similar probe condition were compared to the corresponding error terms from the other probes (pooling the error terms from the identical and different probe conditions). In every case, the error term from the similar probe analysis was significantly larger ($p < .05$, at least) than the pooled error term from the other analyses. Moreover, the average error rate (incorrect recognition response) for the similar condition was 41%, compared to 11% and 13% for the identical and different probe conditions, respectively. While the raters in the norm study agreed that the similar probes involved a semantic change from the original descriptions, the results from the experimental subjects did not reflect the general consensus of these norm judgments. These results suggest that the experimental subjects had a very difficult time deciding whether the similar probe did or did not contain the same information as the original description. The large error

rate together with the relatively large random error, suggests that the data from the similar probes may be less diagnostic (less informative) than the results obtained from the identical and different probe conditions. Further analyses will therefore exclude the similar probe data, and will focus instead on the results elicited by the identical and different probes, both of which yielded very similar (low) error rates.

Different Probes

Figure 6 shows the results from the different probe data as a function of the redundancy between the two descriptions of the initial pair, and the delay interval. In the immediate response condition, subjects were more confident of their recognition responses after reading low redundant message-pairs than high redundant pairs. However, after the delay period, this pattern was reversed, such that subjects were more confident in their responses to high redundant message-pairs than to low redundant pairs. Thus, the subjects' recognition performance was differentially affected by both the redundancy of the initial message-pair and the delay period, as reflected by a significant Redundancy x Delay interaction, $F_s(1, 96) = 4.10$, $p < .05$; $F_{RxDxG}(1,11) = 3.55$, $p < .10$.

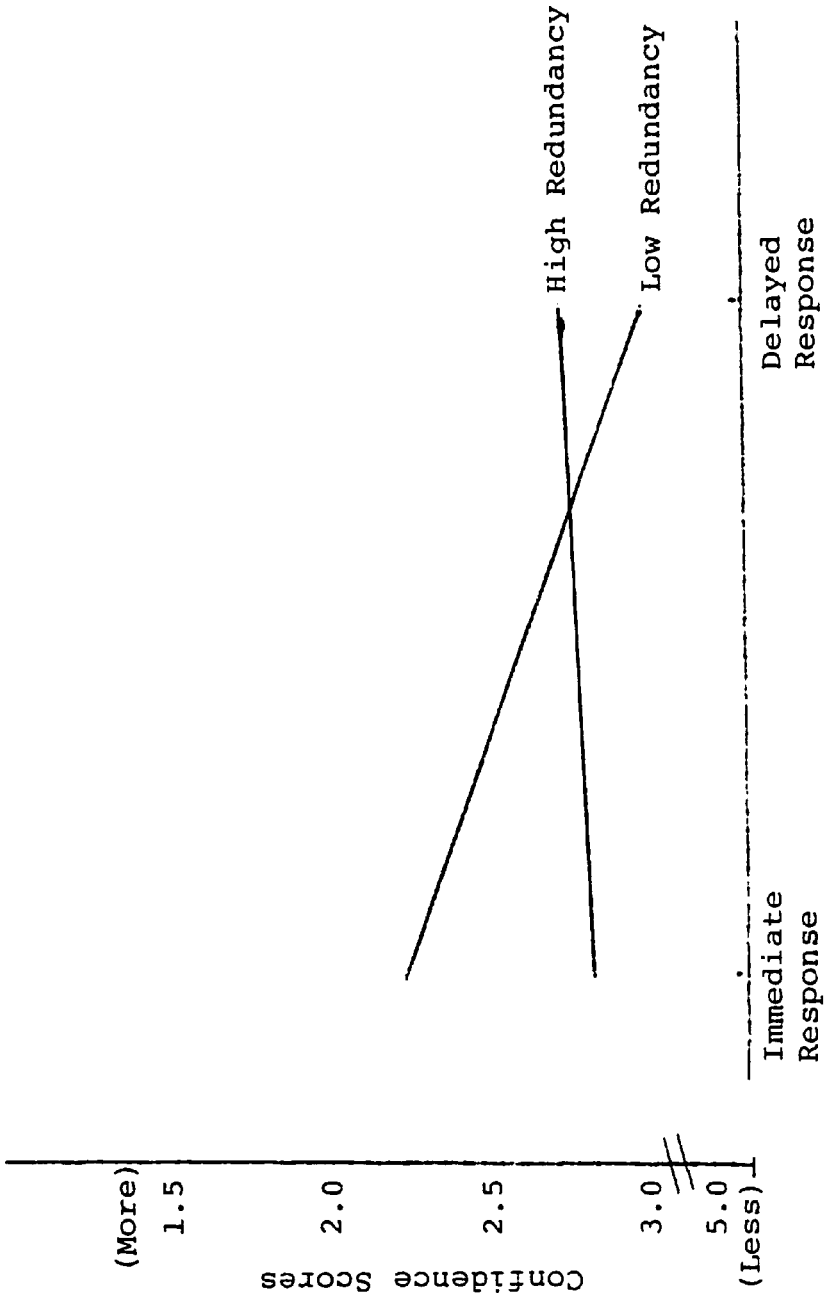


Fig. 6. Mean weighted confidence scores in the different probe condition as a function of redundancy and delay.

The Redundancy x Delay interaction was somewhat affected by the interpolated task that subjects worked on during the delay interval. While the Task x Redundancy x Delay interaction did not reach an acceptable level of significance, the overall data pattern suggested a trend similar to that found in the identical probe condition. That is, subjects had a more difficult time retaining information from the message pairs when required to work on the verbal task as compared to the visual task.

Overall, however, the two probe items, identical and different, seem to yield different results. The identical probes produced no evidence of differential forgetting in the low versus high redundancy conditions. In contrast, the different probes produced a significant Redundancy x Delay interaction which was in the predicted direction (more rapid performance decrement in response to items that were presented in a low redundant context).

It is conceivable that the two types of probe items may have yielded different results because they elicited rather different evaluation processes (in contrast to our initial assumption). The instruction to the subjects implied a <u>disjunctive</u> decision strategy for the identical

probe condition, but a conjunctive strategy for the different probe condition. That is, subjects were told that if the information contained in the probe description matched at least one of the previous descriptions, answer "yes," but if the probe matched neither, answer "no." This instruction may have inadvertently suggested different decision strategies dependent upon the type of probe presented. For identical probes, subjects only need to obtain one "yes" match in order to evoke a positive response. By contrast, for probes containing different information, two "no" responses are required in order to justify a negative response.

These two different response strategies may have directly affected the subject's confidence ratings. For example, subjects evaluating their confidence associated with a positive response may have focused primarily on the strength of the one "yes" match that they obtained, thus precluding the other comparison from their final decision. In contrast, when the description that was used to probe the subject's memory contained different (changed) information, the subject's final confidence rating may well have been based on two comparisons. In this case, the subjects may have used a variety of different weighting systems to determine their final confidence rating, such as averaging, summing, or perhaps weighting the two confidence ratings by the strength of the individual comparison.

Apart from the different strategies that might have been suggested to subjects in the two probe conditions, the identical probes may produce better retrieval cues for the subjects than different probes, by addressing the proper content area more efficiently. This being the case, subjects should have more time in which to compare the probe to the coded representation of the previous information. This implies that the identical probe condition may more accurately reflect possible differences between the two redundancy conditions than the different probe condition.

Conversely, correct responses to different probes may be of little diagnostic value in determining the respondent's retention of a particular piece of information. For example, suppose: (a) a low redundant pair was presented, and (b) when the probe was presented, the subject has forgotten the common (A) description, but has retained the information contained in the other (X') description. When the subject is asked to evaluate a different probe, he responded, "no," thus indicating that the probe description does not match the stored information (X'). His response is recorded as correct, although our hypothetical subject has not actually remembered the information that was being probed. Suppose, however, the subject had been probed by a description that contained the <u>same</u> information as the description which he has

forgotten. In this case, the subject should again answer "no," since the information that has been retained is different from that contained in the probe item; note, however, that in this case, the "no" response is scored as incorrect. Thus, in the different probe condition, the subject's response would be scored as accurate, even though he had forgotten the material for which the experimenter was probing; by contrast, in the identical probe condition, the subject's response would be scored as incorrect, thus providing a more accurate assessment of retention.

Correction for Response Biases

While responses to identical probes may be more informative as to the respondent's retention processes than the data obtained from the different probe condition, responses to both probes are subject to response biases which may affect the overall pattern of results. It is well accepted that recognition decisions contain two components that may affect a subject's ultimate response: (a) decisions concerning the familiarity of a given probe or piece of information, and (b) subjective response bias, based on a particular subject's predisposition to respond in a certain direction (e.g., same or different; yes or no) (Coombs, Dawes, and Tversky, 1970). One method developed by psychophysics and profitably applied to

memory problems is that of signal detection analysis. Signal detection is a technique used to measure discrimination or recognition performance that is unaffected by subjective responses biases.

Signal detection essentially compares a subject's hit rate to his or her false alarm rate. The hit rate is the extent to which a subject responds "old" when probed by a familiar stimulus, that is, one which the subject has seen before. The false alarm rate is the extent to which a subject answers "old" in response to a new stimulus, one which he has never seen before in the experimental session. In order to use signal detection analysis, however, each subject must respond to a given stimulus and probe cue several times, such that a reliable estimate of both the hit rate and false alarm rate may be obtained for the individual respondent.

The design used in this experiment thus precludes signal detection analysis for two reasons: (a) subjects responded only twice to each experimental condition, and (b) subjects responded to different message-pairs, rather than to the same pair, in the repeated versions of each condition. The data collected in this study can, nonetheless, be analyzed by a technique which is logically analogous to signal detection, but does not invoke the rigorous assumptions that are implicit in a signal detection analysis.

The technique used in the present study was really quite simple. For each experimental condition, the average hit rate obtained from the identical probe condition was compared to the average false alarm rate obtained from the different probe condition. Thus, the analysis simultaneously used all of the data collected in the two probe conditions rather than analyzing them separately. Comparing hit rates to false alarm rates is comparable to subtracting the false alarm rate from the hit rate.

This method is essentially the same as the standard correction for guessing, which has previously been used to correct recognition performance for possible response bias. Rosenberg (1968) corrected his recognition data for subjective tendencies to give false positives, using the formula:

$$X = C - \frac{k(E)}{D}$$

where:

X = the corrected recognition score,

C = the number of correct hits, the number of "yes" responses to old stimuli,

E = the number of false positives, the number of "yes" responses to new stimuli,

D = the number of distractors in the list (new stimuli), and

k = a constant, referring to the number of old stimuli in the test list.

With this formula, a subject's score should reduce to zero if he responded positively (or negatively) to every item on the recognition list. A negative score reflects a high degree of inaccuracy, such that the subject continually says "new" to an old stimulus, and "old" to a new stimulus.

This standard correction procedure produces individual scores that mirror the individual scores given to subjects when their performance in the different probe condition is subtracted from their performance in the identical probe condition. Table 4 shows the two scoring methods for all possible combinations of hits and false alarms. The similarity between these two methods for generating unbiased measures of recognition performance lends further credence to the procedure used in the following analysis.

The discussion thus far has implicitly focused on a procedure for analyzing the binary (yes-no) recognition choices, where there are just two possible categories for a subject's response. This technique can also be applied to a measure of recognition that involves more categories of possible responses, such as the confidence measure obtained by weighting the confidence rating by the initial recognition choice. Thus, the two measures of recognition, the yes-no choices and the confidence ratings, were subjected to a six-way analysis of variance, such that the

average hit rates and false alarm rates could be compared. The analyses included the same factors as the overall analysis reported at the beginning of the chapter; however, only two levels of the probe variable were included, the identical and different probe conditions.

TABLE 4

COMPARISON BETWEEN THE SIGNAL-DETECTION-LIKE SCORES AND THOSE OBTAINED FROM THE CORRECTION FOR GUESSING FORMULA

Response to Identical Probe (1)	Response to Different Probe (2)	(1) - (2)	Correction for Guessing[a]
0[b]	0	0	0
0	1	-1	1
1	0	1	-1
1	1	0	0

[a]These scores were obtained by applying the formula found on page 78 of the text. In this case, D = 1, k = 1, and the maximum values possible for both C and E are one; thus, the formula reduces to: X = C - E.

[b]The entries in the first two columns refer to the subject's recognition choice. A "yes" response is coded as a zero, a "no" response is coded as a one.

The results from the corresponding analyses yielded essentially the same results. Since the recognition choice data are easier to describe, as there are only two levels of possible response as opposed to ten for

the confidence measure, these data will be discussed below. The results and data patterns described for the recognition choice data can also be attributed to the confidence measure.

The mean hit rate and false alarm rate for the various redundancy by delay conditions are presented in Table 5, and are shown graphically in Figure 7. The third row in Table 5 contains the difference between the mean hit rate and the mean false alarm rate for the different conditions. Similarly, the dependent measure which is scaled on the ordinate axis in Figure 7 is the mean difference, obtained by subtracting the mean false alarm rate from the mean hit rate. This difference score is the relative measure of discrimination between old and new information that is unaffected by response bias.

Focusing attention on the high redundant condition in Table 5, the difference scores show that while there was a decline in the overall hit rate from the immediate response condition to the delayed response condition, there was also a corresponding drop in the false alarm rate from the immediate response condition to the delayed response condition. Since both the hit rate and the false alarm rate descended across time, the difference between the two means (immediate and delayed response) remained relatively stable, as shown by the approximately horizontal line for the high redundancy condition

TABLE 5

MEAN HIT RATE, FALSE ALARM RATE AND DIFFERENCE SCORES FOR THE REDUNDANCY BY DELAY INTERACTION

	High Redundancy		Low Redundancy	
	Immediate Response	Delayed Response	Immediate Response	Delayed Response
Hit Rate	.94	.89	.875	.84
False Alarm Rate	.155	.11	.105	.15
Difference	.785	.78	.77	.69

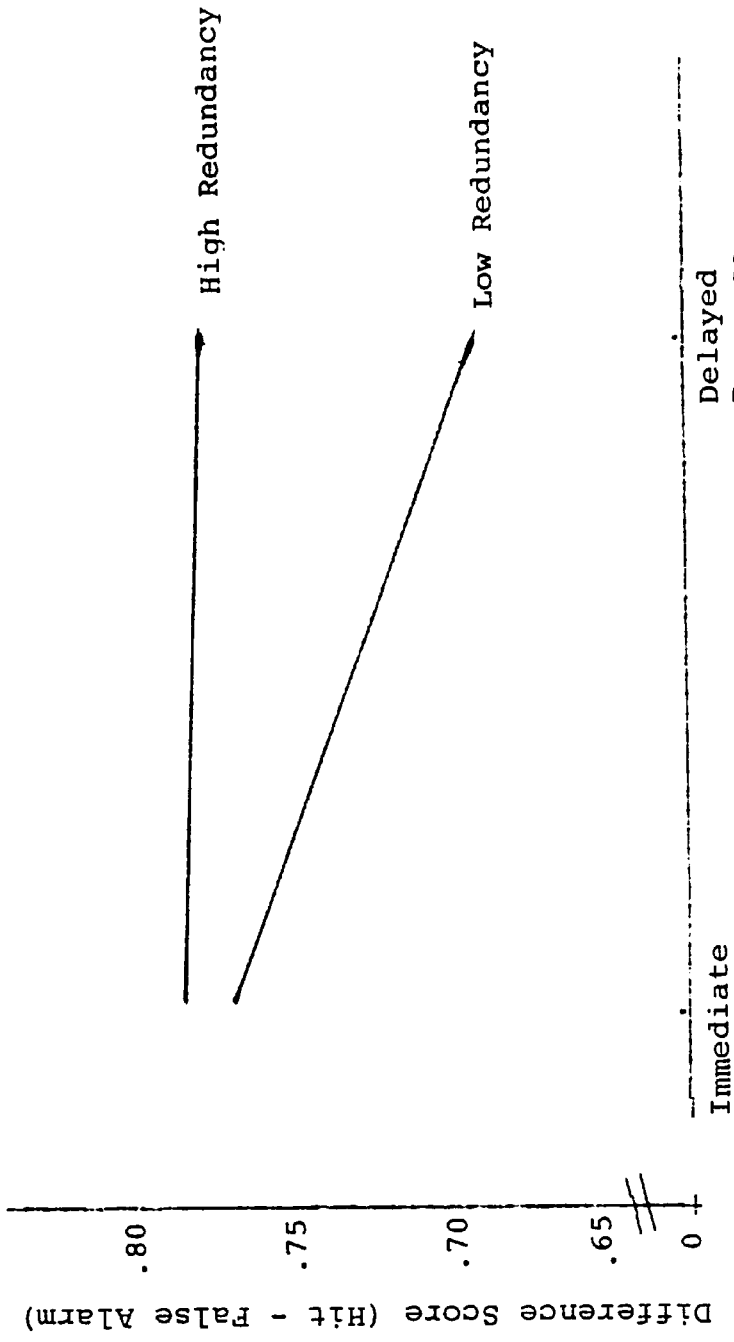


Fig. 7. The difference between the mean hit rate and the mean false alarm rate as a function of redundancy and delay.

(see Figure 7). These data suggest that in the high redundant condition, subjects have lost relatively little information, but may have changed their response criterion, producing fewer affirmative responses to both types of probes after a delay period. According to this analysis, within the high redundancy condition, the subjects' ability to discriminate between new and old information is about the same in the immediate response and the delayed response conditions. However, since subjects may feel less confident about their decisions in the delayed response condition, they elect to use a more conservative response criterion (they are more reluctant to say "yes") than in the immediate response condition.

In contrast, the response rate for the low redundancy condition is quite different from that in the high redundant condition. Again, for the low redundant condition the hit rate declines with the passage of time; however, the false alarm rate increases (see Table 5). This situation, then, produces difference scores that decrease from the immediate response condition to the delayed response condition. This data pattern suggests that in the low redundant condition, the subjects <u>have</u> lost critical information as a result of the delay interval, thus producing fewer hits and more false alarms. Comparison of the difference scores in the two delay periods suggests that subject lose more critical information in the

low redundant condition than in the high redundant condition (where performance is surprisingly stable over time).

Taken together, the means displayed in Table 5 suggest that the analysis of variance should show a three-way interaction: Redundancy x Delay x Probe. This triple interaction was, however, far from significant, $p < .25$. The overall analysis did, nonetheless, reveal a marginal four-way interaction (Task x Redundancy x Delay x Probe, $p = .15$)[2] that seemed potentially important. This four-way interaction may mean that the triple interaction that we anticipated may in fact be significant for at least one of our two delay tasks (visual vs. verbal). Table 6 shows the mean hit rates and false alarm rates for the four redundancy by delay condition, with the data broken down by the respondents' assigned task. Careful inspection of Table 6 reveals that the overall data pattern (shown in Table 5 and in Figure 7) is due primarily to the verbal task condition. These data are displayed graphically in Figure 8.

In the verbal condition (Figure 8, left-hand panel), the difference between the hit rates and false alarm rates for the high redundancy message-pairs remained relatively stable across the two delay periods; however,

[2]This and subsequent p-values are based on two-tailed tests, although a one-tailed test would sometimes be acceptable, due to the directional nature of the differential forgetting hypothesis. A one-tailed test would effectively reduce the two-tailed p-value by half.

TABLE 6

MEAN HIT RATE, FALSE ALARM RATE AND DIFFERENCE SCORES FOR THE REDUNDANCY BY DELAY INTERACTION DISPLAYED SEPARATELY FOR THE TWO DELAY TASKS (VERBAL AND VISUAL)

	High Redundancy		Low Redundancy	
	Immediate Response	Delayed Response	Immediate Response	Delayed Response
VERBAL TASK				
Hit Rate	.95	.88	.91	.84
False Alarm Rate	.18	.11	.09	.18
Difference	.77	.77	.82	.66
VISUAL TASK				
Hit Rate	.93	.90	.84	.84
False Alarm Rate	.13	.12	.12	.11
Difference	.80	.78	.72	.73

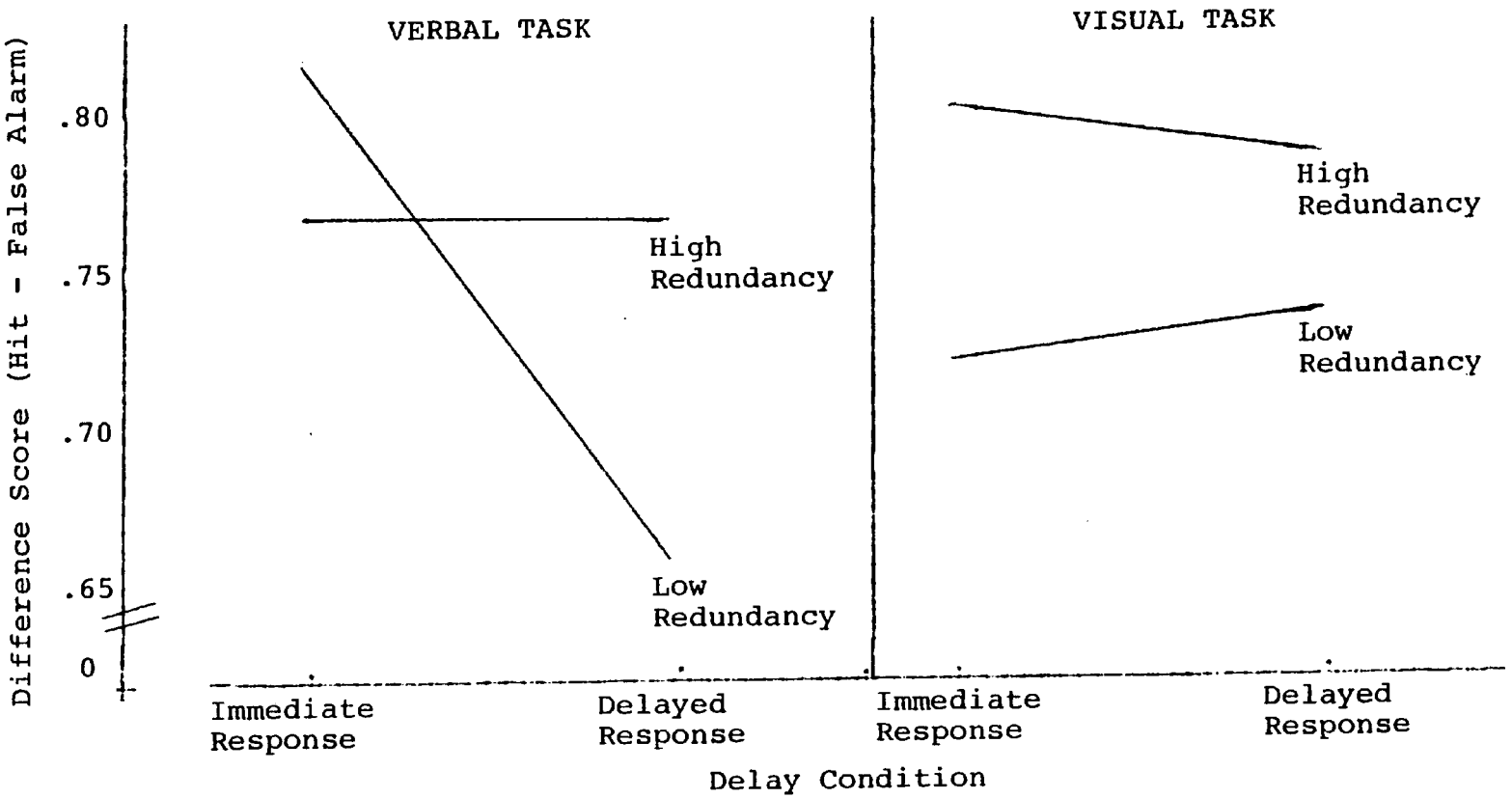


Fig. 8. The difference between the mean hit rate and the mean false alarm rate as a function of redundancy, delay, and task.

for the two redundant pairs, the mean difference score fell off rather sharply as the delay increased. By contrast, there seems to be no appreciable interaction between redundancy and delay among the subjects who were assigned to the visual task condition (Figure 8, right-hand panel). Although the four-way interaction between redundancy, delay, probe types, and task was marginal, the verbal and visual tasks were nonetheless analyzed separately, to elucidate the apparent "task" differences shown in Table 6 and Figure 8.

Verbal Task

Among the subjects assigned to the verbal task, there was a marginal Redundancy x Delay x Probe interaction, $F_s(1, 48) = 2.72$, $p = .105$; $F_{RxDxPxG}(1, 11) = 2.89$, $p = .11$. This means that the retention of the information in the original message-pair depended upon the redundancy between the two initial passages. Subjects were able to retain the information in high redundant message-pairs relatively well; by contrast, subjects tended to lose information from low redundant pairs rather rapidly, as shown by the decline in recognition performance from the immediate response condition to the delayed response condition.

The data pattern shown for the verbal task condition actually appear more promising than is reflected by the

marginal interaction obtained from the analysis of variance. Thus, when the two redundancy conditions were analyzed separately, the results from the low redundancy condition yielded a significant departure (decline) from a horizontal line ($p < .05$), whereas the null hypothesis could not be rejected for the high redundant condition. These separate results, then, suggest a highly significant interaction; however, as reported above, the Redundancy x Delay x Probe interaction was marginally significant at the .10 level. It is, of course, conceivable that one or more important variables may have been omitted from our analysis, thereby inflating the estimate of the random error.

Further analysis suggested that the triple interaction (R x D x P) was affected by the difference between the high-redundant and the corresponding low-redundant message-pairs. The 16 triples that yielded message-pairs with large and moderate differences in redundancy produced results similar to the overall pattern shown in the left-hand panel of Figure 8 (verbal task condition). However, those message-triples that included description-pairs which were only slightly different with respect to redundancy showed no evidence of the triple interaction; for these message-pairs, the "high" redundancy and "low" redundancy message-pairs yielded similar results.

It appears, therefore, that the description-pairs that were most similar in redundancy may not have been sufficiently different to produce the predicted performance pattern. Unfortunately, however, due to the repeated measures design of this experiment, those triples that contain minimal differences with respect to redundancy cannot readily be subjected to statistical evaluation. One can only speculate that an analysis of those items that showed substantial D-score difference between the high and low redundant pairs (i.e., large redundancy differences) might show more significant results than were obtained from the entire pool of items.

Overall then, for the verbal task, the results shown in Figure 8 seem to follow the pattern predicted by the differential forgetting hypothesis; subjects retained less information from low redundant pairs than from high redundant pairs. The significant decline in performance in the low redundant condition suggests that subjects do tend to store some, if not all, of the coded information in verbal form.

Visual Task

The pattern of results generated by subjects who worked on the visual task did not follow the pattern predicted by the differential forgetting hypothesis. Rather, the subjects' performance in both redundancy conditions

seemed to be relatively stable over time (see Figure 8, right-hand panel). Hence, the Redundancy x Delay x Probe interaction was far from significant, $F < 1$. A Redundancy main effect was found, however, $F_S(1, 48) = 5.25$, $p < .05$; $F_{RxG}(1, 11) = 4.29$, $p = .06$. This redundancy effect was due primarily to poor recognition performance in the low redundant condition; this pattern was manifested in both the immediate and the delayed response conditions. The surprising result here was that the subjects performed so poorly in the immediate response condition after reading a low redundant message-pair.

Taking the obtained task differences at face value, it is conceivable that the verbal task produced more interference than the visual task due to the relationship between the type of processing required by the task, and the manner in which subjects actually processed, coded, and stored the input information. Assuming that a subject processed the information verbally, a plausible coding strategy might be to store one or two key words that summarize the two input messages.[3] In contrast, if the subject processed the information visually, he most likely imaged the facial expression described in the two messages, and stored that image.

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[3]Several subjects voluntarily reported using this strategy in their attempts to retain the initial information.

In order for the intervening task to interfere with a subject's memory, the task should utilize processing mechanisms similar to those used to comprehend and store the input information. It is possible that the visual task may not have produced as much interference as the verbal task due to a lack of correspondence between the processes involved in completing the delay task, and those necessary to successfully process the input information. That is, discovering hidden figures may have required processes that did not interfere with encoding and storing the input information, whether that information was coded verbally or visually. In contrast, the verbal task not only required attention to a variety of words, but also involved those processes that are necessary for comprehending verbal material (e.g., the initial message-pair).

This being the case, a more effective visual task might have been one that required subjects to attend to other faces, similar to those described by the initial message-pairs. For example, one such task might involve looking at an array of eight or twelve faces, after which the subjects would be asked to rank order the faces according to their "likeability" or "pleasantness." It then would be easy to construct a verbal task which involves the very same task (rank ordering stimuli), but would present adjectives rather than faces. These intervening

tasks, then, would be comparable with respect to the actual task performed, but would contrast the different processing modes (verbal versus visual).

In summary, the final analysis which was presented above provides a clearer picture of the effect of referential redundancy on long-term retention than the analysis which examined each probe condition separately. The signal detection-like analysis yielded marginal trends, primarily in the verbal task condition, consistent with a differential forgetting notion; that is, low redundant material was lost (forgotten) more rapidly than high redundant information. Also, there was some evidence that the verbal delay task produced more interference than the visual task; however, the reliability of this effect is questionable. That is, most of the apparent difference between the two tasks was found in the immediate response condition, when subjects were not required to work on an interpolated task. By contrast, no significant difference was found between the two tasks after the extended delay period (when subjects actually did engage in one of the two tasks).

CHAPTER IV

CONCLUSIONS

In general, the signal detection-like analysis revealed trends that were marginally supportive of a differential forgetting hypothesis, for retention was partly dependent upon the redundancy between the two passages that constituted the to-be-remembered message-pair. Subjects seemed to show better retention when the focal information was presented within a high redundant context. That is, recognition performance declined over time in the low redundancy condition, but remained relatively stable in the high redundancy condition. This overall pattern was relatively clear when subjects worked on the verbal delay task, but was not manifested when they worked on the visual task.

The basic pattern of these results replicates a previous finding by Platt and Manis (1976). Platt and Manis gave subjects similar pairs of descriptions that were either high or low in redundancy. Rather than present a third description as a probe for recognition, subjects were asked to write a verbal summary of each description in the initial pair. Subjects summarized the material either immediately following the presentation of the input

information, or after an extended delay period, during which time they worked on irrelevant arithmetic problems. Thus, the basic design of Platt and Manis' study was quite similar to that used in the present experiment.

Platt and Manis found that subjects recalled more information from the high redundant pairs than from the low redundant pairs; moreover, the difference in recall increased from the immediate response condition to the delayed response condition, thus indicating differential forgetting, dependent upon the redundancy of the initial message-pair.

In both of these studies, however, the basic Redundancy x Delay interaction was either marginal, or nonsignificant; nonetheless, the obtained trends were in the same direction, with retention of the low redundant information inferior to that of the high redundant information, especially after the delay period. While the recall study had several methodological weaknesses, stemming from the content analysis considerations (see the relevant discussion in Chapter I), the present study cannot be subjected to this criticism. One methodological shortcoming of the present experiment, however, focuses on systematic differences among the various description triples that were included in the design. Basically, it was found that some description triples produced description pairs that were not substantially different with respect to

redundancy; moreover, the results from these pairs did not support the differential forgetting hypothesis.

Apart from this methodological problem, the overall Redundancy x Delay interaction may not have produced a more striking effect due to the relatively short retention period (four minutes in this study). Past research (Sachs, 1967) has shown that subjects tend to loose the surface structure of the input sentences very quickly, but retain the semantic component for quite a while. A four-minute delay period was used so that subjects could complete the experimental session within a reasonable amount of time (two hours). The promising pattern of results that were nonetheless obtained, suggests that if a longer delay interval had been included in the design, the recognition performance might have yielded more clearly significant differences between the high and low redundant message-pairs.

A similar situation regarding delay intervals was discussed by Manis and Platt (1976). They asked subjects to decode high and low redundant message-pairs by selecting the target facial expression described by both passages. Subjects, again, chose a face either immediately following the input presentation, or after a delay interval. In their first experiment, the delay intervals were either two or four minutes. In the second study, the delay period was extended to eight minutes. The results of the

two studies were comparable, however, the overall data pattern was not significant in the first study (where the maximum delay was four minutes), but was highly significant in the second study (eight minute delay). It seems that when descriptive passages are used as input stimuli, longer delays may be necessary in order to demonstrate effects that derive from a loss in semantic information.

Two underlying mechanisms provide plausible explanations for the general trends reported above. First, as suggested by the work on repetition, redundant information may be retained longer than low redundant material because the repetition of the (semantic) information strengthens the memory trace associated with that information. Thus, after a delay period, subjects should perform better when responding to a high redundant message-pair than to a low redundant pair. This prediction derives from the assumption that the strength of the resulting memory trace is directly related to the number of times a subject is exposed to the information. Furthermore, it is assumed that the probability of recognizing the input information is directly related to the strength of the coded memory trace. Since high redundant message-pairs present roughly the same information twice (since they imply the same set of alternative referents), these pairs should result in a relatively strong memory trace, thereby facilitating recognition performance. By contrast, low

redundant pairs present two different pieces of information, which are presumably encoded separately by means of two memory traces of about average strength. Thus, performance in the low redundant condition should be inferior to that in the high redundant condition, especially after the retention interval.

An alternative interpretation suggests that the redundancy of a message-pair may affect the subject's ability to organize and integrate (chunk) the input information, such that efficient memory codes can be established. As Miller (1956) and others have pointed out, recoding input information into fewer chunks effectively reduces the memory load, which in turn facilitates retention. It is reasonable to assume that high redundant information may be easier to chunk than low redundant information because the second message in a high redundant pair conveys very similar information to that transmitted by the first message. The easily perceived consistency between the messages may facilitate recoding or chunking, thereby decreasing the number of units to be stored. Decreasing the memory load in this manner may free the subject to process the retained (stored) information to a deeper level (Craik and Lockhart, 1972) or to process further incoming information. In any event, recoding the input information results in fewer chunks of information to retain.

Low redundant pairs, by contrast, convey two different messages which may not always fit together in a consistent manner. When confronted with low redundant information, subjects can either store the two messages separately, constructing two different chunks of information, or they may attempt to combine the two messages into one integrated unit, perhaps losing some potentially important information in the process.

For example, given a low redundant message-pair, suppose that a subject decides to store the information contained in each description in two separate chunks of information. It has been demonstrated that retention is inversely related to the number of chunks stored in memory; that is, the fewer the chunks, the better the retention. Thus, high redundant pairs should elicit superior recognition performance than the low redundant pairs, since according to this account, only one chunk of information would be stored in the high redundancy condition as compared to two chunks in the low redundant condition.

Similarly, consider what would happen if the subject elects to store low redundant information as an integrated chunk; i.e., combining information from <u>both</u> descriptions in a low redundant pair. Since different information is conveyed in the two passages, recoding the entire message set into one chunk of information necessarily involves editing and consolidating the information into a comprehensible whole. In doing so, it is quite likely that the

subject will have to "throw out" critical information. Thus, such a subject may opt for a more efficient encoding strategy which presumably will facilitate retention, at the expense of deleting information which may be of value during the recognition test. Assuming, then, that the recoded version of the low redundant pair does not contain as much critical information (information from the common description) as a comparable chunk from a high redundant message-pair, it is reasonable to predict that subjects responding to high redundant pairs should perform better than those responding to low redundant message-pairs. Hence, regardless of the coding strategy utilized by subjects in the low redundant condition, the present analysis predicts better retention of high redundant as compared to low redundant information.

The data collected in this study cannot adequately discriminate between these alternative explanations. Actually, the two mechanisms differ primarily on one point; that is, whether the repetition of information strengthens the coded representation of the information, or whether repetition generates a more efficient memory code, which may be equally as strong as the memory codes established for low redundant information. It is beyond the scope of this dissertation, however, to argue for or against either position. Further work is needed to determine which of these two possible mechanisms operate to produce

differential forgetting, dependent upon the redundancy of the input information.

The above discussion outlined two plausible coding strategies available to subjects, encoding the two descriptions separately, or combining the information from both descriptions to form one integrated unit. The referent associated with the input information may be one factor which affected the respondent's preferred type of encoding strategy. Recall that in the present study, subjects were told that both descriptions in the initial message-pair were attempts by different people to describe the very same facial expression (target referent). Moreover, after each recognition trial, subjects were asked to select the probable target face described by the pair of descriptions that were presented at the very beginning of the trial. Thus, subjects were continually reminded that the two passages described the same target face. This factor may have affected the storage strategy used by the subjects (e.g., forcing subjects to combine the information from both descriptions into one coded unit), thereby affecting the overall performance obtained in the various experimental conditions. In other words, attributing the two input passages to the same referent may produce one result (like those of the present study) that may, in fact, be quite stable and replicable. In contrast, attributing the two descriptions to different referents

may produce a different set of results. This is indeed an empirical question which can be readily explored.

The present results, together with those of the Manis and Platt (1976) study suggest that the structural characteristics of the initial message-pair, and the ease with which the input information can be retained, are both related to the accuracy of the subject's decoding performance (ability to select the correct target referent). When subjects decode message-pairs immediately after reading the descriptions, the amount of information retained from the initial messages alone cannot adequately predict the ability of subjects to select the correct target referent. When memory demands are minimal, the structural property of the message-pair (redundant versus nonredundant) is an effective predictor of decoding accuracy. However, given an interpolated retention interval, memory plays an increasingly important role in predicting whether or not subjects will be able to choose the correct target face. In this case (after a delay period), there seems to be a direct relationship between the amount of information retained and the probability that subjects will be able to accurately select the correct referent. While referential redundancy aids long-term memory, it does not necessarily facilitate (short-term) categorical decisions based on the input information.

Finally, a remark should be made about the statistical method that was devised to obtain performance measures that were relatively unaffected by subjective response biases. Logically, the technique is quite similar to signal detection analysis, in that it compares the average hit rate to the average false alarm rate. This method seems to provide a viable alternative for obtaining a recognition measure which controls for possible response biases when the standard signal detection analysis is precluded, due to the nature of the experimental design. This technique may be particularly useful to experimenters using stimuli that are more complex than the traditional stimuli used in memory experiments (unrelated words, nonsense syllables), since more complex stimuli may necessitate single observations on a given exemplar, rather than repeated observations, as required by signal detection analysis.

APPENDICES

APPENDIX A

A COMPLETE LIST OF THE DESCRIPTIVE PASSAGES AND CORRESPONDING PROBE DESCRIPTIONS PRESENTED TO THE EXPERIMENTAL SUBJECTS, WITH SUMMARY D-STATISTICS

Set No. 1

(A) Common Description:

Fear or anxiety for someone you have feeling for, but who is in a position to hurt himself.

Perhaps the look you would give a child of yours if you were about to warn him to get out of a street because a car is coming, etc.

(X) High Redundant Mate:

Here he shows surprise, but he shows much concern, like his favorite actress is being taken away by the villain or his favorite football player dropped an easy pass in the last second that would have won his team the world championship.

(X') Low Redundant Mate:

This is a questioning "Why?" look. The next words spoken by this person will be a gentle, fatherly "Now I really don't think you mean that."

D - Low Redundancy Pair	.460
D - High Redundancy Pair	.180
Difference	.280

Set No. 1 Probe Descriptions

(I) Identical:

Fright or worry about someone who you care for very much, but who is about to get hurt.

Maybe the look one would give a child as you warn her to get out of the path of a moving car, etc.

(S) Similar:

Frantic amazement of something a young child did, a child for whom you have strong feelings.

Perhaps it is the look you would give if the child suddenly drove the car out into the street, etc.

(D) Different:

Alarming fear of someone you have some feeling for, but who is in a position to hurt you.

Perhaps the look you might give a child if he was about to kick you in the leg after getting out of the car, etc.

Set No. 2

(A) Common Description:

Pure disdain. Whatever it is he's faced with, the actor doesn't think it is any challenge, and he wants all around to know. He might give his brothers at θx this look when asked about his date the previous night.

(X) High Redundant Mate:

The man in this picture seems slightly belligerent. His experssion shows that he wants to indicate to someone that he is not to be duped and is highly skeptical of the veracity of whoever is speaking to him. Not only does he want to indicate his own cleverness, but he also seems somewhat insulted that anyone would try to put anything over on him.

(X') Low Redundant Mate:

Actually, the picture conveys more self-assurance than joy, which might be the normal response. Whatever joy or happiness exists is resultant from the confidence of the person--as if he just put something over on someone and is now saying, "I told you so--Ho! Ha!"

D - Low Redundancy Pair	.440
D - High Redundancy Pair	.191
Difference	.249

Set No. 2 Probe Descriptions

(I) Identical:

Pure scorn. The actor doesn't think that the situation with which he is faced presents a challenge, and he lets everyone around him know how he feels. He might give his fraternity brothers at θx these looks when they ask him about his date last night.

(S) Similar:

Pure scorn. Whatever it is he's faced with, the actor thinks it an important challenge, and wants all around to know how he feels. He might look this way when asked to describe his date last night by his fraternity brothers at θx.

(D) Different:

Pure chagrin. The actor is up against a very important challenge and he doesn't know whether or not he can pull it off. He might give his brothers at θx this look when asked to account for the money missing from the treasuring coffer.

Set No. 3

(A) Common Description:

The man in this picture is the classic picture of surprise. He may not be altogether pleased by the surprise.

(X) High Redundant Mate:

"Wowie!" Surprise, wonder.

"Holy Smokes!"

Maybe someone just told him that an exam is tomorrow, or could be something good as well as something bad.

(X') Low Redundant Mate:

"Oh--Goodie!" He has just heard something of surprise about something he likes. He is showing his surprise and happiness at the same time.

D - Low Redundancy Pair	.506
D - High redundancy pair	.150
Difference	.356

Set No. 3 Probe Descriptions

(I) Identical:

The man in this picture is not completely pleased by the surprise, but he is a classic picture of surprise.

(S) Similar:

The man in this picture is somewhat concerned by what he sees. He doesn't seem to be pleased by what he sees.

(D) Different:

The man in this picture is the classic picture of boredom. He is pleased by what he sees, however.

Set No. 4

(A) Common Description:

This is a sick-to-my-stomach, the-whole-world-has-tumbled-upon-me look. He is thinking, "Where will I go" What will I do?" This is the look of someone who has flunked a final: vacant-eyed, pathetic, hopeless. He is saying, "Oh well, I didn't expect to pass anyway."

(X) High Redundant Mate:

He looks as if he were going to have to make a decision and either way he decides, the outcome will still be unfavorable to him. He looks depressed in an apathetic way, as if both consequences of his decision would be equally unfavorable.

(X') Low Redundant Mate:

This man is watching TV. The commercial is laying it on thick about a new car wax. The man is very interested and is considering the qualities being described. He might be saying to himself, "That stuff doesn't look bad, guess I'd better go out and get some. The car should be polished this weekend."

D - Low Redundancy Pair	.487
D - High Redundancy Pair	.242
Difference	.245

Set No. 4 Probe Descriptions

(I) Identical:

This is the-whole-world-has-tumbled-upon-me, sick-to-my-stomach look. He seems to be thinking, "What will I do? Where will I go?" This is the look of someone who has just flunked a final exam: blurry-eyed, helpless, pitiful. He might be saying, "Oh well, I didn't think I was going to pass anyway."

(S) Similar:

This is a sick-to-my-stomach, the-whole-world-has-tumbled-upon-me look. He is thinking, "Where will I go? What will I do?" This is the look of someone who has flunked a final: vacant-eyed, pathetic, hopeless. He is saying, "Oh no! Now I can't get into medical school."

(D) Different:

This is glad-to-be-alive, the-whole-world-has-smiled-upon-me look. He is thinking, "Where will I go? What will I do?" This is the look of someone who has passed a final: bright-eyed, ecstatic, breathless. He is saying, "Oh boy, now I can get into law school."

Set No. 5

(A) Common Description:

A rather meaningless expression. The drawn-back chin indicates a small amount of repulsion, yet the lips and eyes indicate a certain sardonic amusement, either at a situation or at his reaction to a situation. He has perhaps seen something both amusing and repellent/pitiful, like an old woman falling into a mud puddle.

(X) High Redundant Mate:

The person in this picture is trying to make a serious face but he can't. He is just about to smile. He is in a happy, gay mood. He has just heard that his classmate "only got" a B+ on his physics final. He thinks this is quite good. He is trying to make believe he is sorry for his classmate, but he is really not. So we get a strange facial expression in this picture.

(X') Low Redundant Mate:

The man is communicating cold hostility. A speaker is saying something with which he disagrees. Perhaps the subject is being fired. He is not free to speak.

D - Low Redundancy Pair	.442
D - High Redundancy Pair	.195
Difference	.247

Set No. 5 Probe Descriptions

(I) Identical:

The expression is rather meaningless. The drawn-back chin shows a small amount of aversion, yet the lips and eyes indicate a certain derisive amusement, either at a situation or at his reaction to the situation. He has perhaps seen something both humorous and repulsive/disgusting, like an old woman falling into a mud puddle.

(S) Similar:

A rather mean expression. The drawn-back chin shows a small degree of disgust, yet the lips and eyes indicate a certain disdainful derision, either at a situation or at his reaction to a situation. He has perhaps seen something both repulsive and repellent/pitiful, like an old woman falling into a mud puddle.

(D) Different:

The expression is rather complex. The drawn-up chin shows some degree of thoughtfulness, yet the lips and eyes show a pleasing amusement, either at a situation or at his reaction to a situation. He has perhaps seen something both amazing and delightful/beautiful, like a young woman modeling a new creation.

Set No. 6

(A) Common Description:

The man looks like he is mad. He looks like he is about to start a fight, or is involved in one. He may just be plain mad though.

Possibly his wife wrecked the car. She did something stupid or caused an accident doing a lot of damage to the car.

I would be thinking about burning my wife's driver's license at a time like this if I were married.

(X) High Redundancy Mate:

The actor manifests qualities of sternness and anger. A father warning his son would have a similar expression. So also would a man accusing (pointed finger not shown) another or even man observing implementation of punishment or necessary task. Compared with all the rest, this facial expression is most nearly normal. Scorn is shown.

(X') Low Redundancy Mate:

Grimly determined, J.P.S. Successful is posing for a photograph to go into the report his firm is sending to the stockholders. He certainly wants them to think he is dedicated to the task.

D - Low Redundancy Pair	.402
D - High Redundancy Pair	.154
Difference	.248

Set No. 6 Probe Descriptions

(I) Identical:

The actor looks very upset. He looks like he is about to start fighting, or is already involved in a fight. He may be just palin angry though.

Maybe his wife totaled the car. She may have done something dumb like cause an accident which completely wrecked the car.

I would be considering tearing up my wife's driver's license at this time if I was a married man.

(S) Similar:

The man looks like he is angry. He seems as though he is about to start crying, or is already crying. He may just be plain upset though.

Possibly his wife told him that she wrecked the car, but it wasn't her fault.

I would be thinking about tearing up my wife's driver's license if I were married.

(D) Different:

The actor seems like he is very pleased. He looks like he is about to start singing and dancing. He may be just plain happy though.

Possibly his wife won a metal in the stock car races, but was in an accident doing a lot of damage to the car.

I would be thinking about taking my wife out to dinner at a time like this if I were married.

Set No. 7

(A) Common Description:

Pained. Someone might have stepped on his toe; he looks up and says oh! ooo! and he is just about to say get off. Probably the pain was unexpected.

(X) High Redundancy Mate:

He is urging. Possibly, he is urging that last pin down, at the bowling alley. Or he might be urging his son to make the winning basket at the basketball game. Or he might be urging the Mother's Club to vote against a bill legalizing liquor in his country.

(X') Low Redundancy Mate:

He appears surprised, but disappointed or defeated at the same time. He could be surprised about someone else's failure or his own, but he does not appear to be directly involved in it. Nevertheless, there appears to be pity in his expression, but it could be somewhat feigned for the benefit of whoever else is involved in the situation.

D - Low Redundancy Pair	.320
D - High Redundancy Pair	.80
Difference	.240

Set No. 7 Probe Descriptions

(I) Identical:

Hurt. Someone probably just stepped on his toe; he is just about to tell him to get off and says oh! ooo! The pain was probably not expected.

(S) Similar:

Upset. Someone probably just stepped on his foot; he looks up and is about to say oh! ooo! when the other guy apologizes. The apology was probably unexpected.

(D) Different:

Pleased. Someone might have jsut polished his shoes; he looks up and says oh! ooo! and is just about to thank him. Probably the added service was not expected.

Set No. 8

(A) Common Description:

Here he looks astonished by something and he also looks as though he can't believe or comprehend the situation. The situation could be startling that it is beyond his comprehension or else he is subconsciously refusing to accept the situation.

(X) High Redundancy Mate:

This is a dumbfounded look--incredulous, but not particularly titillated or even admiring. The man looks dazed, almost as if struck or ready to pass out.

(X') Low Redundancy Mate:

He looks straight ahead--surprised almost, but not quite sad. Sort of dumbstruck, he doesn't seem to know what to do except look out straight ahead.

D - Low Redundancy Pair	. 344
D - High Redundancy Pair	. 126
Difference	. 218

Set No. 8 Probe Descriptions

(I) Identical:

He looks amazed by something here. He also seems as if he neither comprehends nor believes the situation. The situation might be so frightening that it is beyond his comprehension or else he is covertly declining to accept the situation.

(S) Similar:

Here he looks surprised and he also seems as if he can't quite understand what is happening. The event might be so novel that it is beyond his imagination or else he is not consciously trying to comprehend the situation.

(D) Different:

Here he looks fearful of some object; he also seems as though he as been through this experience before. The situation might be so upsetting that he loses control and cannot comprehend what is going on or else he is unconscious and hence refuses to accept the situation.

Set No. 9

(A) Common Description:

Here is depicted a feeling of supreme, swaggering self-confidence. The man's competence is at stake in a field in which he believes he excels and he is sure he will soon have a chance to prove his skills. He could be saying, "So you don't think I can handle a woman your size, hah? Well, sweetheart, roll back the covers and let's see."

(X) High Redundancy Mate:

Supreme self confidence. A devil-may-care look with a smirk to match.

Expresses personal belief in ability, power or achievement of bearer.

(X') Low Redundancy Mate:

A wink in reverse. Astonished only half way. The other half it's hard to say; almost a blank look.

D - Low Redundancy Pair	.472
D - High Redundancy Pair	.149
Difference	.323

Set No. 9 Probe Descriptions

(I) Identical:

This man is extremely confident of his self image. His skill is at stake in a field in which he thinks he is tops and he is almost certain he will be able to test his competence soon. He might be saying, "So you don't think I can manage a woman your size, hah? Well, lover, push back the covers and let's see."

(S) Similar:

Here is depicted a feeling of supreme, swaggering self-condemnation. The man's ability is at stake in a field in which he is superior and he is certain he will have a chance to show his skills soon. He might be saying, "So you think I can't manage a woman like you, hah? Well, sweetheart, roll back the sheets and let's find out."

(D) Different:

Here is depicted a feeling of extreme, swaggering self-consciousness. The man's competence is at stake in an area in which he does not excell and he is certain he will have to prove his skills soon. He could be saying, "So you think I can't get along with a woman like you, hah? Well, sweetheart, come out from your cover and let's see."

Set No. 10

(A) Common Description:

He now looks as if someone told him off for doing something, and he's being cocky about it and smirking. There is a look of disrespect, and also an obvious attempt to hold back the giggles he feels inside.

(X) High Redundancy Mate:

A joking, mocking sadness seen especially in eyes and mouth--a "now isn't that too bad" mocking expression.

(X') Low Redundancy Mate:

Face betrays anger and perhaps hurt and disgust.

The frown seems too exaggerated to mean merely disgust, so I would suspect the person has been hurt by whatever situation he is reacting to.

D - Low Redundancy Pair	.501
D - High Redundancy Pair	.196
Difference	.305

Set No. 10 Probe Descriptions

(I) Identical:

Now he looks as if someone berated him for doing something, and he's smiling and being cocky about it. There is a look of irreverance, and also a clear attempt to hold back the laughter he feels inside.

(S) Similar:

He now looks as though someone chided him for doing something, and he's laughing and making jokes about it. There seems to be a deep look of respect, and also a futile attempt to hold back the giggles he feels inside.

(D) Different:

He now looks as if someone asked him to help do something, and he's being pert about it and is laughing. There is a look of deep respect, and also a clear attempt to hold back the laughter he feels inside.

Set No. 11

(A) Common Description:

The man looks as if someone has just given him an opposite opinion to his own. That would be okay, but he thinks they are right or he looks like he regrets having done something. He seems to be thinking, "I should have known it couldn't work," or "that I was wrong."

(X) High Redundancy Mate:

Blank unhappiness and disbelief. Typical expression when a person does not know the answer to a test question.

(X') Low Redundancy Mate:

He looks as though he's saying:* "Well, I'll have to think about it, but $4 for these shoes, I don't know!" I would say the picture expresses thought or decision making with a certain negative attitude or skepticism. However, there is even a bit of starry-eyed detachment, as if to say, "such a way to make a living!" (as an anecdote to our shoes salesman).

*Must be read with a good New York 'Jevish' accent.

D - Low Redundancy Pair	.442
D - High Redundancy Pair	.163
Difference	.279

Set No. 11 Probe Descriptions

(I) Identical:

The man seems as if someone has just disagreed with his own opinion. That wouldn't bother him, but he thinks that his own opinion is wrong or he seems as though he has second thoughts about doing something. He seems to be thinking, "I should have known it wouldn't work out" or "I was wrong."

(S) Similar:

The man looks as if someone has just given him an opposite opinion to his own. That would be okay, but he thinks they are wrong or he looks like he regrets having done something. He seems to be thinking, "I should have known it couldn't work," or "that I was wrong."

(D) Different:

The man looks as if someone has just given him a new lease on life. He thinks they are right and is willing to go along with almost anything they say. He seems to be thinking, "I can't believe this is happening to me," or "am I lucky they came along."

Set No. 12

(A) Common Description:

The man is mildly astounded by something happening in front of him, perhaps rather far off.

(X) High Redundancy Mate:

The man is deeply involved in watching a James Bond movie. The hero is in trouble again and the man doesn't dare take his eyes off Bond for fear he'll miss something.

(X') Low Redundancy Mate:

His face expresses surprise. He is so surprised you could knock him over with a feather. He is saying, "who, me?"

D - Low Redundancy Pair	.436
D - High Redundancy Pair	.170
Difference	.266

Set No. 12 Probe Descriptions

(I) Identical:

The man is slightly amazed by an event which happened in front of him, somewhat in the distance, however.

(S) Similar:

The man is extremely terrified by something which happened right in front of him, maybe off in the distance.

(D) Different:

The man is intensely concerned by something that happened in front of him, right before his very eyes.

Set No. 13

(A) Common Description:

Here he shows surprise, that something unexpected happened, like he heard the Mets won a game, or the Indians defeated the Cowboys, or Perry Mason lost a case.

(X) High Redundancy Mate:

Surprise of someone that witnesses an impossible event and is asked to do it next. Eyes and brows convey surprise, mouth conveys amazement.

(X') Low Redundancy Mate:

Watching this year's U. of M. football team. Surprise and disbelief are shown by the eyebrows and eyes. Also the mouth is neither smiling nor grimacing, it's just more or less hanging open.

D - Low Redundancy Pair	.403
D - High Redundancy Pair	.80
Difference	.323

Set No. 13 Probe Descriptions

(I) Identical:

Something unexpected happened which causes him to look astonished, like he heard that Perry Mason lost a case, or the Mets won a game, or the Indians defeated the Cowboys.

(S) Similar:

Here he shows suspense, that something unexpected might happen, like the Mets might win a game, or the Indians might defeat the Cowboys, or Perry Mason might lose a case.

(D) Different:

Here he expresses the typical boredom that accompanies a common or predictable event, like the Mets lost a game, or the Indians lost to the Cowboys, or Perry Mason won a case.

Set No. 14

(A) Common Description:

Looks real angry. Someone has just really done him dirty or has done something so stupid as to have really messed him up. I think he is also trying to think (in the back of his mind) of some way to remedy the situation.

(X) High Redundancy Mate:

Subdued anger coming fast to the surface. "Don't mess with this cat or he gonna break a bottle cross your face." Vengeful.

(X') Low Redundancy Mate:

He looks completely speechless and shaken. It was probably based on something he heard rather than on something he saw because his eyes are blank.

D - Low Redundancy Pair	.470
D - High Redundancy Pair	.133
Difference	.337

Set No. 14 Probe Descriptions

(I) Identical:

Seems really mad. Someone has done something so stupid as to have really messed him up or has just really done him dirty. I think he is also trying to think (in the back of his mind) of some way to remedy the situation.

(S) Similar:

Looks really perturbed. Someone has just said something dirty or obscene so as to upset him and the others with him. I think he is also trying to think (in the back of his mind) of some way to embarrass the guy.

(D) Different:

Looks very happy. Someone has just told him a dirty joke or has complimented him on his fine performance during the contest. I think he is trying to think (in the back of his mind) of some way to capitalize on the situation.

Set No. 15

(A) Common Description:

Conceit and challenge--as directed to a girl, perhaps. Pleasure (wallowed in!) of image of self, challenge to another to question the "quality" causing such conceit, or to prove a worthwhile object of interest to the "great being."

(X) High Redundancy Mate:

He has a self-assured smirk on his face. He looks a conceited person who is trying to impress someone with either his good looks or intelligence. Conceit seems obvious in his expression.

(X') Low Redundancy Mate:

He looks like he thinks he's a young toughy. Like stay away, man, don't mess with me, I am into too much for you. He's looking down on someone.

D - Low Redundancy Pair	.363
D - High Redundancy Pair	.126
Difference	.237

Set No. 15 Probe Descriptions

(I) Identical:

Challenge and conceit--as directed toward a girl, perhaps. Happiness (wallowed in!) with one's image, summons to another to challenge the "property" causing such conceit, or to deem a worthy object which should interest the "great one."

(S) Similar:

Challenge and chagrin--as directed to a girl, perhaps. Delight (wallowed in!) of self-image, but challenges another to question the "quality" of the girl's conceit, or to prove a worthwhile object of concern to the "great beauty."

(D) Different:

Confusion and callousness--as directed to a girl, perhaps. Disgust (wallowed in!) of his self image, he challenges another to prove the "quality" causing the other's interest, or to discuss the worthiness of such action to the "great master."

Set No. 16

(A) Common Description:

Here he looks like he's just been the object of conversation, and is a bit abashed by the story told about him. He's subdued and perhaps embarrassed, and wears a frown with his mouth. His eyes keep their alertness. He's not defensive, but takes the comments or criticism as just.

(X) High Redundancy Mate:

He seems to be ashamed of something in this picture. But not quite. His mouth is in a position that might indicate shame, but his eyes betray a lack of sincere concern for what he's supposed to be ashamed of.

(X') Low Redundancy Mate:

A little self satisfied smile shows that the man is happy with something he has seen or done but rather than smile or grin he only looks happy with his eyes and a slight down pull on his lips. While it may look as if he were sad--the eyes push this feeling away for they are happy. It is a lopsided smile--meant to convey a humorous thought or feeling.

D - Low Redundancy Pair	.439
D - High Redundancy Pair	.221
Difference	.218

Set No. 16 Probe Descriptions

(I) Identical:

Here he seems like he's just been the center of a conversation, and is a bit abashed by the story which was told about him. He's embarrassed and perhaps speechless, and is frowning with his mouth. His eyes are attentive. He accepts the comments as just criticism in a non-defensive manner.

(S) Similar:

Here he looks like he's just been the center of the discussion and is a bit amazed by the story told about him. He's seriously impressed by the conversation, but wears a frown with his mouth. His eyes tend to wander. He's not defensive, but accepts the criticisms as just.

(D) Different:

He has just been the topic of conversation, and seems a bit confused by the story told about him. He's noticeably upset and perhaps embarrassed. He's frowning with his mouth, but his eyes seem alert and attentive. He's on the defensive, and takes the comments or criticism as unjust.

Set No. 17

(A) Common Description:

With an eyebrow raised, he has a slight smirk, as if to say, "God, I'll bet she really thought she'd fool me."

Either contempt or a bit surprised, but not showing it much.

(X) High Redundancy Mate:

Definitely reacting skeptically, Mr. X looks as if he's thinking, "Oh yeah, tell me another fairy tale, ya dope," or perhaps at another level he might be questioning the authority or accuracy of one of his professors as the expression is not too terribly obvious.

(X') Low Redundancy Mate:

In this picture he is watching something that only slightly amuses him, possibly a slow-moving movie. He seems to be waiting for something exciting to happen. His raised eyebrow seems to indicate that something is anticipated.

D - Low Redundancy Pair	.349
D - High Redundancy Pair	.113
Difference	.236

Set No. 17 Probe Descriptions

(I) Identical:

With his eyebrow arched, he has a smirkish grin, as if to say, "Boy, I guess she really thought she had me fooled."

He is either somewhat scornful or a bit astonished.

(S) Similar:

He has a slight grin and his eyebrow is raised, as though he is thinking, "God, I'll really fool her this time."

He is showing either contentment or a bit of suspense, but not showing it much.

(D) Different:

With an eyebrow arched, he has a stern look as if to say, "God, she really thought I was a fool."

Either conniving or a bit suspicious, but not showing it much.

Set No. 18

(A) Common Description:

This man is saying, "ha ha ha, think you got something on me there, wait till you see what I've got up my sleeve." But it is not a serious situation, it involves the fake kind of competition involved in a card game--created competition about something which really isn't that important and an exaggerated kind of name calling and insult which isn't really meant--a ritual of sporting events, etc.

(X) High Redundancy Mate:

He has a come hither look that he is using in half jest.

(X') Low Redundancy Mate:

"Come off it!" Cynical.

D - Low Redundancy Pair	.497
D - High Redundancy Pair	.227
Difference	.270

Set No. 18 Probe Descriptions

(I) Identical:

The man is saying, "ha ha ha, think you'll fool me, wait till you see what I've got in store for you." But it isn't a serious situation, it involves a created kind of competition involved in sporting or card games--a fake competition about something which really isn't that important and a name calling and insult which isn't really meant--a ritual of sporting games, etc.

(S) Similar:

The actor is saying, "ha ha ha, if you think you've got something on me, wait till you see what I've planned for you." This is a very serious situation in which the competition is quite serious, as that which is involved in many card games involving money--created competition about something which is very important, making the players resort to exaggerated name calling and insults--a ritual of sporting events, etc.

(D) Different:

The man is saying, "ha ha ha, you're all wet, buster. Why don't you leave me alone." It is a very serious sitaution, one which you often find in high-power card games--a bold type of competition which is very important and leads to insults and name calling--a ritual of sporting events, etc.

Set No. 19

(A) Common Description:

"Will he make the touchdown or won't he?" Mr. X's head and expression are strained, his neck craned to express his concentration. His mouth forms a circle as if he has just sucked in his breath in anxiety. His eyes mirror his concern and suspence, but he's ready to break into a smile of satisfaction if the situation turns out favorably.

(X) High Redundancy Mate:

"Joe" is watching something he feels much concern about. The lady on the flying trapeze is about to do a double flip. O-O-O-O- says the crowd as their eyebrows meet and their mouths open. Their faces look like they would like to send out a warning (don't do it!) but cannot, and can only watch and express concerned fear.

(X') Low Redundancy Mate:

The expression here is one of pleading, ingratiation. He is very openly begging for something.

D - Low Redundancy Pair	.453
D - High Redundancy Pair	.130
Difference	.323

Set No. 19 Probe Descriptions

(I) Identical:

"Will he score a touchdown or won't he?" Mr. X has an outstretched neck so as to concentrate on the ongoing game. His expression seems strained and his mouth is open as if his breath was lost due to the anxiety of the game. His eyes reflect his suspense and concern, but he'll break out into a big smile if the game turns out satisfactorily.

(S) Similar:

"Will he score the touchdown or won't he?" Mr. X seems to strain or crane his neck so as to see the ongoing game. His mouth is open as if to shout some obscenity to the umpire. His eyes show a devilish defiance, but he's ready to cheer if the foul is called on the other team.

(D) Different:

"Will he make the touchdown or won't he?" Mr. X is concentrating on the ongoing game. He adjusts his neck tie so as to relieve the strain. His mouth is open as if to call out a play to the players. His eyes reflect the futile hopelessness of the game. He's ready to throw in the towel if the situation turns out unfavorably.

Set No. 20

(A) Common Description:

This man is giving a cold, piercing stare. He seems ready to say "All right, you asked for it" if he were an assassin, or "All right, leave if you want," if he has just been jilted.

(X) High Redundancy Mate:

It seems to me that he expresses anger--intense anger, as though someone has deliberately contradicted something he just said and he is the sergeant!

(X') Low Redundancy Mate:

This is the only really tragic picture. The intensity, yet blankness of the man's eyes show him to have just experienced a shocking event in his life. He is stunned, staring off into himself, groping to find answers to a meaningless tragedy in his life, meaningless not because he cannot feel it, but because there was no reason, no cause, why it had to happen to those he loved. He won't cry, but the experience has hardened him to life and a new understanding of the universe and what fate means.

D - Low Redundancy Pair	.376
D - High Redundancy Pair	.153
Difference	.223

Set No. 20 Probe Descriptions

(I) Identical:

The actor is giving a piercing, cold glare. He seems to be saying, "All right, you asked for it" if he was a murderer, or "Okay go if you want," if he has just been given the shaft.

(S) Similar:

The man is giving a deep, penetrating glare. He could be saying, "Oh man, are you an idiot" if he was a tough guy or "All right, do what you want" if he was a manager.

(D) Different:

The man is giving a warm, loving look. He seems to be saying, "All right, buy the orange one" or "Okay, whatever you want" if he was out shopping with his wife.

Set No. 21

(A) Common Description:

Surprise without fear. "Holy cow! Really?" he thinks. "I sure hope that doesn't happen again."

(X) High Redundancy Mate:

He looks like he may have been surprised in the dark, such as might happen after entering the door for his surprise birthday party. This would probably be just as the light is snapped on and everyone yells "Happy Birthday."

(X') Low Redundancy Mate:

This seems like a look of surprise and delight. You might expect this type of look, more often, on a small child whi has just received a new, brightly colored toy.

D - Low Redundancy Pair	.442
D - High Redundancy Pair	.115
Difference	.327

Set No. 21 Probe Descriptions

(I) Identical:

Surprise without fright. "Wow! Really?" he thinks to himself. "I certainly hope that it doesn't happen again."

(S) Similar:

Fear without hope. "Really? Are you kidding?" he thinks. "I sure hope that it happens again."

(D) Different:

Fear without surprise. "Holy cow! Really?" he thinks. "I sure hope that it doesn't happen again."

Set No. 22

(A) Common Description:

He looks as though he has just been told something he doesn't quite believe and is about to say, "Oh, really." He could just be trying to look jaunty and debonnaire--slightly like Maurice Chevalier.

(X) High Redundancy Mate:

He looks "cocky." He seems to be listening to somebody, and skeptical about what he is hearing. He's waiting for the person to finish, so that he can add some "smart" remark. He is questioning, doubting, and preparing an answer while listening. However, he has a smirk on his face, showing that he is in a relatively pleasant mood. His next remark will be witty, but will not hurt the other individual.

(X') Low Redundancy Mate:

"You think so, eh?" is what this fellow seems to be saying. It's not antagonistic--he doesn't look like he's going to try to argue the guy out of his position--mostly he's just skeptical and thinks the other guy is a little bit nuts for having that opinion. "But if he wants to think that, that's his business."

D - Low Redundancy Pair	.360
D - High Redundancy Pair	.133
Difference	.227

Set No. 22 Probe Descriptions

(I) Identical:

He's just been told something he doesn't really believe and is about to say, "Oh, come now." He might be trying to look stylish and graceful--much like Maurice Chevalier.

(S) Similar:

He seems as though he has been told something that doesn't sit well with him and is about to say, "Oh, don't be rediculous." He might, on the other hand, just be trying to appear wordly and disagreeable--much like Maurice Chevalier.

(D) Different:

He looks like he believes what he has just been told and is about to say, "I agree." He might just be trying to seem congenial and submissive--slightly like Maurice Chevalier.

Set No. 23

(A) Common Description:

"Oh--how beautiful"--this man utters in a hush because it is so lovely it takes his breath away. He can hardly speak, is afraid to move because he will break its spell. Then he does move and hugs and kisses the other person and runs around and touches it and thanks the other person again. It may be something he's always wanted, something so terribly beautiful and it has been given to him.

(X) High Redundancy Mate:

"Suddenly the dawn".... This man has had a problem explained to him over and over but could not understnad how to answer the question. After 7 trials by the teacher the man finally got the reasoning behind the whole thing as if someone had turned on a switch. He seems to say "Oh, yeah, now I see--how stupid of me."

(X') Low Redundancy Mate:

Overacted awe and delight.

His 86-year-old grandmother or 3-year-old nephew just gave him a birthday gift: a sequence-covered salt-shaker. How wonderfun! He can barely suppress hysterics--and grandma can tell.

D - Low Redundancy Pair	.495
D - High Redundancy Pair	.233
Difference	.262

Set No. 23 Probe Descriptions

(I) Identical:

"Oh--how beautiful"--this man says in a hush because it is so marvelous that it takes his breath away. He is afraid to move, so as not to break its spell. Then he moves all at once--to touch it and to hug and kiss the other person who has been so kind as to give him this most precious object, something that he has always wanted.

(S) Similar:

"Oh--how beautiful"--the man says in a whisper because it is so awesome it takes his breath away. He is afraid to move because he will break its spell. Then he does move and hugs and kisses it and runs around and touches it. He thanks the other person again and again. After this outburst, the men come and take the may away, back to his cell.

(D) Different:

"Oh--how terrible"--the man utters in a whisper because it is so atrocious it takes his breath away. He can hardly speak, is afraid to move because he might break it. Then he does move and tries to get the other people away from the horrid sight. He thanks the other person again for helping him to get out. It may be something he's always hated, something so awful, and he has been rescued from it.

Set No. 24

(A) Common Description:

He is trying to look impressed but apparently his true feelings flood out the reaction he should show. He looks slightly bored of watching and wishes it were all over. He is thinking that if he had the chance, he could do a much better job--he is superior to the fellow he is watching.

(X) High Redundancy Mate:

Actor could be listening to an argument or set of excuses, to which he must respond, and which response he realizes is already anticipated by arguer, i.e., actor could be a teacher listening to late-paper excuses, knowing what student wants to say, yet not pleased with, and unsure of validity of, excuses or argument. Hesitancy to believe presented material, and a tinge of "why don't you stop trying to convince me before you thoroughly alienate me" attitude shows through.

(X') Low Redundancy Mate:

He looks disturbed. He looks like he is mentally rejecting something.

Possibly he smells some unpleasant odor, or maybe has heard a very dry joke, or yet, maybe he sees something he does not particularly care for.

If I were in that sort of position I would do my best to change whatever was causing the distress. He is not happy, but not sad either; he looks bewildered.

D - Low Redundancy Pair	.442
D - High Redundancy Pair	.160
Differences	.282

Set No. 24 Probe Descriptions

(I) Identical:

His true feelings flood out the reaction he should show, although he is trying to look impressed. He looks somewhat bored and hopes it will end soon. He is thinking that he could do a much better job, if he had the chance--he is <u>better</u> than the fellow he is watching.

(S) Similar:

He is trying to look impressed but apparently his true feelings flood out the reaction he should show. He looks slightly bored of watching and wishes it were all over. He is thinking that if he had the chance, he could not do a better job--he is <u>inferior</u> to the fellow he is watching.

(D) Different:

He is trying to look unimpressed but apparently his true feelings flood out the reaction he should show. He looks slightly amused by what the speaker is saying and wishes he could have a chance to speak with him privately. He is not sure that anyone could do a better job--the fellow is clearly <u>superior</u> to other fellows that he has watched.

APPENDIX B

INSTRUCTIONS FOR RATERS IN HIGH REDUNDANT AND LOW REDUNDANT CONDITIONS

Name:_____

Male/Female

Date:_____

This is a study of semantic meaning. You will be presented with several pairs of descriptions of a person, situation or event. Immediately following the first pair of descriptions, a second pair will be presented. The second pair consists of one description which is exactly the same as one of the descriptions in the original pair, and a second description which has been modified from its corresponding description. Your task will be to read both pairs of descriptions and to judge to what extent the modified description differs in meaning from its original mate. Notice that your judgments should reflect only the semantic change that has occurred between the original standard and its mate. A semantic change is reflected by a change in the underlying meaning of a sentence, not by a change in the specific words or phrasing used to convey the meaning of the sentence. For example, suppose the original sentence is, "The nurse helped the doctor." The sentence, "The doctor was helped by the nurse" does not convey a different message, although the specific wording of the two sentences are somewhat different. On the other hand, the sentence, "The doctor helped the nurse" does convey a different message and hence corresponds with a change in meaning, or a semantic change. That is, in all cases, the modified description in the second

message set differs from the original description in the first message set in the specific wording or phrasing used in the particular description. This should not concern you; rather, please attend to the change in meaning (if any) that exists between the two descriptions and rate how much change has occurred.

The original description pair will always be presented first, followed by the second pair which contains the modified description. After you have read the two pairs or passages, please answer the questions which are presented directly below the final message set. The two questions will always be the same. The first question asks if there has been any detectable semantic change between the original description and the modified mate. The second asks how much change has occurred.

Here is an example:

Despite the fact that the corners of the actor's mouth are curved down, it appears that he is reacting to a somewhat amusing situation. He is chuckling or laughing quietly to himself.

He finds someone in the group he is with very amusing and is quietly laughing to himself, but trying not to attract attention to himself and thereby spoiling the atmosphere of humor.

Despite the fact that the corners of the actor's mouth are curved down, it appears that he is reacting to a

somewhat amusing situation. He is chuckling or laughing quietly to himself.

He thinks someone in the group is very boring and is silently yawning, but is trying not to attract attention to himself and thereby preserves the atmosphere of interest.

1. Is the (semantic) information contained in the modified description the same as the information contained in its original "mate"?

   Yes _____ No _____

   (same semantic meaning (different semantic meaning)

2. Please indicate the amount of semantic change that has occurred in the modified description:

   Identical:_____:_____:_____:_____:_____:Very Different

   (no semantic change) (a large degree of semantic change)

For this example, if you think there has been a change in meaning between the original description and the modified description, check "No" for the first question. Now go on to the second question which asks you to estimate the amount of semantic change in the modified counterpart. You can rate the amount of change of semantic change by placing an "x" somewhere along the line to indicate how much semantic change has taken place between the original description and the modified description.

You will notice that some descriptions are repeated several times throughout the booklet. This shouldn't concern

you; simply treat each description set as a separate, independent item. There are approximately 150 description sets in the following booklet. Thus, in order to respond to all sets in a reasonable amount of time, don't spend too much time on any one set. I should also alert you to the fact that there is printing on both sides of each page, so be careful not to miss any set.

If you have any questions, please call--Margie Platt, 769-7100 ext. 487 (Ofc.); 769-0793 (Home).

Return this booklet to Margie Platt or Catherine Hoch, 3rd floor, IRS.

APPENDIX C

INSTRUCTIONS FOR RATERS IN "ALONE" CONDITION

Name:_____

Male/Female

Date:_____

This is a study of semantic meaning. Several original descriptions of situations or events have been modified in varying degrees. Your task will be to read the original description and to rate how much semantic change has occurred in the second description. Notice that your judgments should reflect only the semantic change (i.e., change in meaning) that is apparent between the original standard and its mate. A semantic change is reflected by a change in the underlying meaning of a sentence, not by a change in the specific words or phrasing used to convey the meaning of the sentence. For example, suppose the original sentence is, "The nurse helped the doctor." The sentence, "The doctor was helped by the nurce" does not convey a different message, although the specific wording of the two sentences are somewhat different. On the other hand, the sentence, "The doctor helped the nurse" does convey a different message and hence corresponds with a change in meaning, or a semantic change. That is, in all cases, different wordings or phrases will be present in the two descriptions which compose any given pair. This should not concern you; rather, please attend to the change in meaning (if any) that exists between the two descriptions and rate how much change has occurred.

The original description will always be presented first, followed by the modified description. After you have read the two descriptions, please answer the questions which are presented directly below the description pair. The two questions will always be the same. The first question asks if there has been any detectable semantic change between the two descriptions. The second asks how much change (if any) is present.

Here is an example:

He finds someone in the group he is with very amusing and is quietly laughing to himself, but trying not to attract attention to himself and thereby spoiling the atmosphere of humor.

He thinks someone in the group is very boring and silently yawning, but is trying not to attract attention to himself and thereby preserves the atmosphere of interest.

1. Is the (semantic) information contained in the modified description the same as the information contained in its original "mate"?

   Yes _____ No _____

   (same semantic meaning) (different semantic meaning)

2. Please indicate the amount of semantic change that has occurred in the modified description:

   Identical:_____:_____:_____:_____:_____:Very Different

   (no semantic change) (a large degree of semantic change)

For this example, if you think there has been a change in meaning between the original description and the modified description, check "No" for the first question. Now, go on to the second question which asks you to estimate the amount of semantic change in the second or modified description. You can rate the amount of change by placing an "x" somewhere along the line to indicate how much semantic change has taken place between the original description and the modified description.

You will notice that some descriptions are repeated several times throughout the booklet. This shouldn't concern you; simply treat each description pair as a separate, independent item. There are approximately 150 description pairs in the following booklet. Thus, in order to respond to all pairs in a reasonable amount of time, don't spend too much time on any one pair. I should also alert you to the fact that there is printing on both sides of each page, so be careful not to miss any pairs.

If you have any questions--call Margie Platt
769-7100 ext. 487 Ofc.
769-0793 (Home)

Return this booklet to Margie Platt or Catherine Hoch--3rd floor, ISR.

APPENDIX D

INSTRUCTIONS FOR EXPERIMENTAL SUBJECTS IN VERBAL TASK CONDITION

Instructions for Subjects in Verbal Task Condition

Name:_____

Male/Female

I.D. #:_____

This is a study of cognition and memory. In this session there will be two types of verbal problems. In both types of problems, memory is an important factor, so try to concentrate as we proceed through the session.

In the first type of verbal problem, you will be shown several pairs of descriptions on the screen. Both of the describtions in each pair will be based on one of the facial expressions in this array. These descriptions were written by Michigan students similar to yourselves. Each pair of descriptions will be presented for 30 seconds.

You will have two tasks to complete after reading the pair of descriptions. First, you will be shown a third description on the screen which has been derived from one of the passages in the original message pair. After reading this description, answer the questions at the top of your response sheet. The questions are concerned with the difference (if any) in the underlying meaning between the third description and the corresponding description in the original message pair. The first question asks whether the information contained in the third description has the same underlying meaning as at least one of the descriptions in

the previous pair. The second question asks you to rate how confident you feel about your first answer. You can do this by placing an "x" somewhere along the scale which goes from "very low confidence" to "very high confidence."

For example, read the pair of descriptions on the screen. The next description has the same underlying meaning as one of the descriptions in the previous pair. Notice that the third description differs in wording from both descriptions in the original pair. This will always be the case; however, sometimes the meaning will not have changed, and sometimes the meaning will have changed. Your job will always be the same. First, you will read a pair of descriptions. Next, a third description will be presented. This description will differ from both passages in the original pair in the particular wording or phrasing used in the sentences. Decide whether the third description means the same as at least one of the original descriptions; if so, check the Yes category for question one. If, however, the third description means something different from both of the original descriptions, check No. Finally, place an "x" somewhere along the confidence scale to indicate how confident you are of your first response.

After you have responded to the first set of questions, the array of faces which you just saw will be presented on the screen. When you see the faces, quickly glance through the array and choose a facial expression

which, in your opinion, was the one described by the original pair of descriptions which you read at the very beginning of the trial. You can place your picture choice in the space provided at the bottom of the response sheet. That is, for each pair of descriptions that you are shown, we would like you to first, read a third description and answer questions about it and second, select the particular photograph that the authors were writing about.

Now let's try one of these verbal problems for practice. After you have read the two descriptions, a third description will appear on the screen. After reading the third description, answer the questions which appear at the top of the response page. You will be given 40 seconds to both read and answer the questions. Immediately after, the array of faces will appear on the screen. Please choose the facial expression which was described by the initial message pair and place the number of your choice in the appropriate response blank at the bottom of the page. You will have 15 seconds in which to make your choice.

Trial _____

1. Does the description presented on the screen right now have the same underlying meaning as at least one of the descriptions in the previous message pair?

   Yes _____ No _____

2. How confident are you of your choice made above?

   Very low confidence:_____:_____:_____:_____:_____:Very high confidence

* *

3. The pair of passages shown at the very beginning of this trial were most probably based on photograph _____.

Now let's talk about the other verbal task, which is straightforward, but demanding. There is a sample problem on the next page. Simply read the instructions at the beginning of the various sections and answer the questions as directed by circling the letter which corresponds to the correct response. These problems are very similar to the verbal problems of any standardized test that you have taken so many times. Be certain to read the instructions carefully and proceed as directed. There are no trick problems; you will have to work quickly, however, in order to do well. That is, we are only going to give you 5 minutes in which to complete the three pages of verbal problems, and I can assure you that this is not nearly enough time. As a result, we don't expect you to complete all of the problem sets that are presented. We will be interested, however, to see how many problems you can accurately complete in the time you have available. To get a good score you'll have to work quickly and accurately.

The two types of verbal problems will be presented intermittently. The most difficult thing about the arrangements for this group is the fact that you will often be required to work on the verbal comprehension problems while you are in the midst of the verbal choice problem. Thus, in some cases, after you have read the two descriptions in the pair, but have not yet been shown the third description or asked to choose a face, you will be required to work on

several verbal comprehension problems. This will undoubtedly complicate matters, since you will have to wlrk on the comprehension problems, while trying to remember the information contained in the description pair (since you will eventually have to read a third description, answer questions, and choose a face). Just do the best you can.

Now let's discuss the mechanics of the session. In your response booklet there are four successive pages that correspond to each trial, preceded by a page which contains the appropriate trial number. The first three pages contain verbal comprehension problems. The fourth page provides space for your responses to both the questions pertaining to the third description and for your picture choice.

If, following a pair of descriptions, a blank appears on the screen before the third description is presented, work on the three pages of verbal comprehension problems, circling the correct responses. When the third description does appear on the screen, turn to the response page for that trial (the fourth page) and proceed to read the description and answer the questions at the top of the page. Again, you will be given 40 seconds to both read the third description and answer the questions. This should be more than enough time to answer both questions. When the 40 seconds has elapsed, the array of facial expressions will be presented on the screen. At this time, select the facial expression which was described by the message pair which was presented at the very beginning of the trial. Enter your

choice in the appropriate response blank at the bottom of the page, and proceed to the next page in the booklet to be ready for the next trial.

If the third description appears immediately following the pair of descriptions, ignore the three verbal comprehension problems for that trial and proceed directly to the response and choice page for that trial.

I realize that these tasks are difficult; all I ask is that you try to do as well as you can, and answer the various problems in the order that they are presented.

All right--we're ready to begin. Are there any questions?

In each of the forty sentences below, there are four underlined words or phrases. If you think there is an error in usage, grammar, diction, or punctuation in the underlined part, mark the letter indicated on your answer paper. If there is no error in any of the underlined parts, mark (E) on your answer paper.

1. Your (A) argument is no different (B) from (C) the last speaker (D) who opposed the legislation. No error (E)

2. Please help me decide which (A) of the two activities to choose--going to the theater with John or (B) to attend (C) tonight's (D) dinner-dance at the hotel. No error (E)

3. Shirley is very (A) fidgety (B), which (C) is an annoying trait (D). No error (E)

4. Every woman in the ward (A) hoped (B) that their (C) child would be a normal and healthy (D) baby. No error (E)

5. When I have to (A) decide which (B) of two applicants for a job to hire, I find myself (C) giving the position to the

the one who uses the best English. No error
(D) (E)

6. That is the kind of a house in which I should like to
(A) (B) (C) (D)

live. No error
(E)

7. When you go shopping, will you please bring this note
(A) (B)

to the manager of the grocery department? No error
(C) (D) (E)

8. Charles asked would I go to the ball game with him.
(A) (B) (C) (D)

No error
(E)

9. We were particularly frightened of John driving the
(A) (B) (C)

car in the race. No error
(D) (E)

10. Because I was seated on the dais just in back of the
(A) (B) (C)

speaker, I could see the audience's reaction to his
(D)

vituperative remarks. No error
(E)

11. During the recent gasoline shortage, the amount of
(A) (B)

accidents on our highways decreased markedly. No error
(C) (D) (E)

APPENDIX E

INSTRUCTIONS FOR EXPERIMENTAL SUBJECTS IN VISUAL TASK CONDITION

Instructions for Subjects in Visual Condition

Name:_____

Male/Female

I.D. #:_____

This is a study of cognition and memory. In this session there will be two types of problems, one involving verbal skills, and the other focusing on your ability to solve simple visual problems. In both types of problems memory is an important factor, so try to concentrate as we proceed through the session.

Let's discuss the verbal task first. You will be shown several pairs of descriptions on the screen. Both of the descriptions in each pair will be based on one of the facial expressions in this array. These descriptions were written by Michigan students similar to yourselves. Each pair of descriptions will be presented for 30 seconds.

You will have two tasks to complete after reading the pair of descriptions. First, you will be shown a third description on the screen which has been derived from one of the passages in the original message pair. After reading this description, answer the questions at the top of your response sheet. The questions are concerned with the difference (if any) in the underlying meaning between the third description and the corresponding description in the

original message pair. The first question asks whether the information contained in the third description has the same underlying meaning as at least one of the descriptions in the previous pair. The second question asks you to rate how confident you feel about your first answer. You can do this by placing an "x" somewhere along the scale which goes from "very low confidence" to "very high confidence."

For example, read the pair of descriptions on the screen. The next description has the same underlying meaning as one of the descriptions in the previous pair. Notice that the third description differs in wording from both descriptions in the original pair. This will always be the case; however, sometimes the meaning will not have changed, and sometimes the meaning will have changed. Your job will always be the same. First, you will read a pair of descriptions. Next, a third description will be presented. This description will differ from both passages in the original pair in the particular wording or phrasing used in the sentences. Decide whether the third description means the same as at least one of the original descriptions; if so, check the Yes category for question one. If, however, the third description means something different from both of the original descriptions, check No. Finally, place an "x" somewhere along the confidence scale to indicate how confident you are of your first response.

After you have responded to the first set of questions, the array of faces which you just saw will be presented on the screen. When you see the faces, quickly glance through the array and choose a facial expression which, in your opinion, was the one described by the original pair of descriptions which you read at the very beginning of the trial. You can place your picture choice in the space provided at the bottom of the response sheet. That is, for each pair of descriptions that you are shown, we would like you to first, read a third description and answer questions about it and second, select the particular photograph that the authors were writing about.

Now let's try one of the verbal problems for practice. After you have read the two descriptions, a third description will appear on the screen. After reading the third description, answer the questions which appear at the top of the response page. You will be given 40 seconds to both read and answer the questions. Immediately after, the array of faces will appear on the screen. Please choose the facial expression which was described by the initial message pair and place the number of your choice in the appropriate response blank at the bottom of the page. You will have 15 seconds in which to make your choice.

Trial _____

1. Does the description presented on the screen right now have the same underlying meaning as at least one of the descriptions in the previous message pair?

   Yes _____ No _____

2. How confident are you of your choice made above?

   Very low confidence:_____:_____:_____:_____:_____:Very high confidence

* *

3. The pair of passages shown at the very beginning of this trial were most probably based on photograph _____.

Now let's talk about the visual problems, which are straightforward, but demanding. There is a sample problem on the next page. Your job is simply to circle the hidden figures which are imbedded in the larger picture. On each page there is a number, usually on the top right hand corner, which is underlined; this number indicates the number of hidden figures to be discovered in the picture. When you have found one of the hidden figures, simply circle the figure with your pencil. There are no trick problems; you will have to work quickly, however, in order to do well. That is, we are only going to give you 5 minutes in which to complete three visual problems, and I can assure you that this is not nearly enough time. As a result, we don't expect you to complete all of the problems that are presented. We will be interested, however, to see how many hidden figures you can find in each problem in the time you have available. To get a good score you'll have to work quickly and accurately.

The two types of problems--verbal and visual--will be presented intermittently. The most difficult thing about the arrangements for this group is the fact that you will often be required to work on the visual problems when you are in the midst of a verbal problem. Thus, in some cases, after you have read the two descriptions in the pair, but have not yet been shown the third description or asked to choose a face, you will be required to work on several hidden figures

problems. This will undoubtedly complicate matters, since you will have to work on the hidden figures task, while trying to remember the information contained in the description pair (since you will eventually have to read a third description, answer questions, and choose a face). Just do the best you can.

Now let's discuss the mechanics of the session. In your response booklet there are four successive pages that correspond to each trial, preceded by a page which contains the appropriate trial number. The first three pages contain hidden picture problems. The fourth page provides space for your responses to both the questions pertaining to the third description and for your picture choice.

If, following a pair of descriptions, a blank appears on the screen before the third description is presented, work on the three hidden figures problems, circling the images that you find. When the third description does appear on the screen, turn to the response page for that trial and proceed to read the description and answer the questions at the top of the page. Again, you will be given 40 seconds to both read the third description and answer the questions. This should be more than enough time to answer both questions. When the 40 seconds has elapsed, the array of facial expressions will be presented on the screen. At this time, select the facial expression which was described by the message pair which was presented at the very beginning of the

trial. Enter your choice in the appropriate response blank at the bottom of the page, and proceed to the next page in the booklet to be ready for the next trial.

If the third description appears immediately following the pair of description, ignore the three visual problems for that trial and proceed directly to the response and choice page for that trial.

I realize that these tasks are difficult; all I ask is that you try to do as well as you can, and answer the various problems in the order that they are presented.

All right--we're ready to begin. Are there any questions?



Appendix E Sample

APPENDIX F

A SAMPLE OF THE VERBAL DELAY TASK

Each of the questions below consists of two words which have a certain relationship to each other, followed by five pairs of related words. Select the pair of words which are related to each other in the same way as the original pair of words are related to each other.

1. connoisseur : painting :: (A) egotist : self (B) gourmet : viands (C) miser : gold (D) jury : criminal (E) artist : critic

2. virtue : virtuoso :: (A) goodness : angel (B) viscous : viscosity (C) anger : irascible (D) braggart : braggadocio (E) vice : dauber

3. cartographer : gazetteer :: (A) conductor : newspaper (B) novice : expert (C) author : composer (D) lexicographer : dictionary (E) lexicographer : thesaurus

4. simile : metaphor :: (A) prose : poetry (B) poetry : prose (C) real : suggested (D) same : different (E) different : implied

5. mongrel : collie :: (A) man : god (B) man : angel (C) alloy : iron (D) anger : piety (E) variegated : motley

6. literal : figurative :: (A) connotative : denotative (B) allegory : fable (C) photograph : painting (D) novel : play (E) symbol : allusion

7. notorious : malefactor :: (A) conspicuous : leader (B) egregious : philanthropist (C) reprehensible : altruist (D) renowned : benefactor (E) criminal : alias

8. amulet : evil :: (A) fort : attack (B) fire : hose (C) eggs : rotten (D) police : law (E) talisman : good

9. master : servant :: (A) judge : jury (B) monarch : vassal (C) serf : noble (D) capital : labor (E) landlord : tenant

10. mouse : mice :: (A) data : datas (B) datum : dates (C) die : dice (D) monkey : monkies (E) administrator : administratrix

Each of the questions below consists of a word printed in italics, followed by five words lettered A to E. Choose the word which is most nearly opposite in meaning to the word in italics.

11. *garrulous* (A) voluble (B) tautological (C) pithy (D) incongruous (E) insipid

12. *gargantuan* (A) titanic (B) Lilliputian (C) herculean (D) simian (E) leonine

13. *menial* (A) sanguine (B) physical (C) indifferent (D) supercilious (E) sycophantic

14. *quixotic* (A) mercurial (B) feasible (C) vapid (D) fashionable (E) irritable

15. *noisome* (A) boisterous (B) fetid (C) silent (D) fragrant (E) fulsome

16. *bellicose* (A) militant (B) outrageous (C) stupid (D) epigrammatic (E) pacific

17. *famished* (A) sated (B) cited (C) suited (D) starved (E) thirsty

18. *yielding* (A) flaccid (B) flatulent (C) impenetrable (D) conceding (E) compromising

19. *pusillanimous* (A) reticent (B) remiss (C) intrepid (D) introvert (E) extrovert

20. *mollify* (A) annoy (B) sympathize (C) soften (D) intimidate (E) liquefy

In each of the sentences below there is a blank space, indicating that a word has been omitted. Beneath the sentence are five lettered words; from these five words you are to choose the one word which, when inserted in the blank space, best fits in with the meaning of the sentence as a whole. In some sentences, two words are omitted: in these sentences, you will be given five pairs of words. Select the pair which best completes the sentence.

21. The present expansion of the military strength of our neighboring country must fill us with _____ (A) awe (B) amazement (C) admiration (D) apprehension (E) anger

22. The candidate's speech was filled with empty promises, _____, and cliches. (A) candor (B) platitudes (C) anger (D) ingenuity (E) threats

23. By dint of much practice, he became _____ and was able to sign his name with either hand. (A) practical (B) tricky (C) ambiguous (D) ambidextrous (E) ambivalent

24. This work, published _____, revived our interest in the author who had just died. (A) posthumously (B) anonymously (C) privately (D) prominently (E) synthetically

25. The hypocrite _____ feelings which he does not possess but which he feels he should display. (A) depicts (B) decries (C) betrays (D) simulates (E) intensifies

26. These are parlous times and we cannot afford to be too _____ about the future. (A) pessimistic (B) sanguine (C) sanguinary (D) salubrious (E) acclimated

27. A _____ person is not _____ (A) wanton—restrained (B) dissolute—dissipated (C) continent—dissolute (D) prodigal—extravagant (E) talkative—garrulous

28. He is so _____ that he cannot be disturbed by _____ matters. (A) involved—simple (B) excited—ordinary (C) spiritual—mundane (D) simple—complicated (E) happy—gloomy

29. _____ all his attempts to master the assignment, he failed. (A) After (B) Because of (C) Despite (D) Neglecting (E) Describing

30. He was able to mislead the gullible with his _____ arguments. (A) cogent (B) specious (C) incontrovertible (D) eleemosynary (E) contentious

Read the following paragraphs and answer the questions based on these paragraphs.

If you watch a lamp which is turned very rapidly on and off, and you keep your eyes open, "persistence of vision" will bridge the gaps of darkness between the flashes of light, and the lamp will seem to be continuously lit. This "optical afterglow" explains the magic produced by the stroboscope, a new instrument which seems to freeze the swiftest motions while they are still going on, and to stop time itself dead in its tracks. The "magic" is all in the eye of the beholder.

31. The "magic" of the stroboscope is due to (A) continuous lighting (B) intense cold (C) slow motion (D) behavior of the human eye (E) a lapse of time

32. "Persistence of vision" is explained by (A) darkness (B) winking (C) rapid flashes (D) gaps (E) afterimpressions

For centuries we have enjoyed certain blessings: a stable law, before which the poor man and the rich man were equal; freedom within that law to believe what we pleased; a system of government which gave the ultimate power to the ordinary man. We have lived by toleration, rational compromise and freely expressed opinion, and we have lived very well. But we have come to take these things for granted; like the air we breathe. They have lost all glamour for us since they have become too familiar. Indeed it is a mark of the intellectual to be rather critical and contemptuous of them. Young men have acquired a cheap reputation by sneering at the liberal spirit in politics, and questioning the value of free discussion, toleration, and compromise.

33. The title that best expresses the ideas of this paragraph is: (A) The value of free discussion (B) Respect for law (C) The weakness of the democratic way of life (D) Characteristics of democracy (E) Unappreciated advantages of democratic life

34. The writer resents the growing criticism of freedom—an attitude which results from (A) questioning the rightness of democracy (B) being too accustomed to freedom (C) too much freedom of speech (D) living in poverty too long (E) the conservatism of young intellectuals

35. The writer's attitude toward young intellectuals is (A) indifferent (B) critical (C) very contemptuous (D) generous (E) angry

A moment's reflection will make it clear that one can not live a full, free, influential life in America without argument. No doubt people often argue on insufficient evidence and for insufficient reasons; no doubt they often argue on points about which they should rather be thinking and studying; no doubt they sometimes fancy they are arguing when they are merely wrangling and disputing. But this is only proof that argument is employed badly, that it is misused rather than used skillfully. Argument, at the right moment and for the right purpose and in the right way, is undoubtedly one of the most useful instruments in American life; it is an indispensable means of expressing oneself and impressing others.

36. The title that best expresses the ideas of this paragraph is: (A) The usefulness of argument (B) Principles of argument (C) How to win arguments (D) Misuses of argument (E) Need for evidence in argument

37. Argument is an important factor in American life because it gives people a chance to (A) talk about things of which they know little (B) influence the ideas of others (C) develop sufficient evidence (D) have friendly conversations (E) use argument at the right time and in the right way

38. Argument is being used unwisely when it results in (A) understanding (B) compromise (C) deliberation (D) bickering (E) differences of opinion

In no field of history has the search for logical explanation been so diligent as in the study of the decline and fall of the Roman Empire. This is the only known instance of the decay of a more or less universal civilization, which might serve as something of an object lesson to our own; accordingly it has been very thoroughly studied, and the attempt to explain it has engaged some of the ablest historians who ever wrote. Almost any orator or politician can tell you why Rome fell, but the men who know most about it are not so ready with glib explanations. Even they must admit at critical moments the decisive interposition of Chance.

39. The fall of the Roman Empire has been thoroughly studied because (A) it may serve as a lesson to us (B) it affected the lives of so many people (C) it was so unusual (D) Rome was the greatest empire the world has known (E) detailed records were readily available

40. People who know most about the fall of the Roman Empire (A) think politicians were its chief cause (B) are uncertain as to its cause (C) prepare object lessons from it (D) give ready explanations of it (E) have been able to learn little about it

APPENDIX G

A SAMPLE OF THE VISUAL DELAY TASK

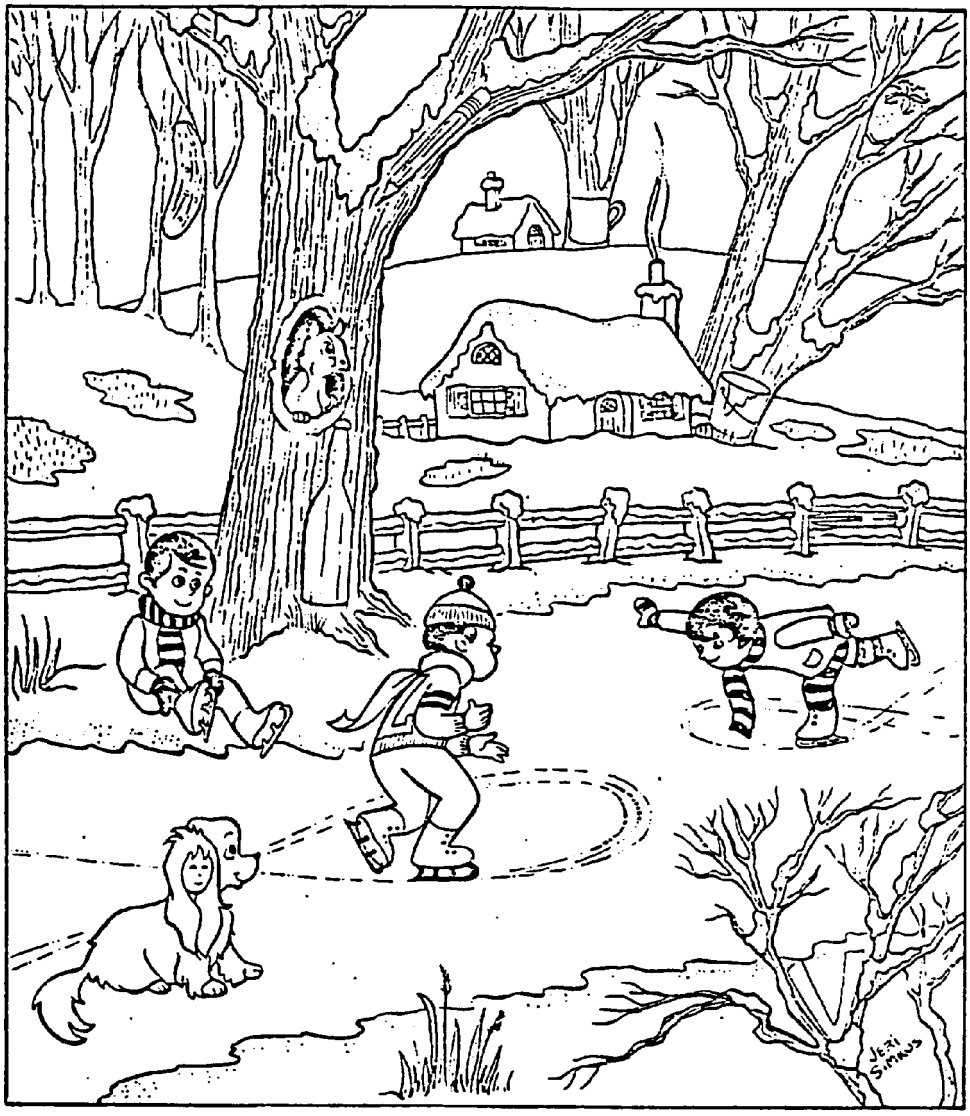


Appendix G Sample



Appendix G Sample

10



Appendix G Sample

APPENDIX H

ANALYSES OF VARIANCE TABLES FOR RECOGNITION CHOICES AND CONFIDENCE SCORES FOR THE IDENTICAL PROBE CONDITION

Appendix H

Source	ET	Recognition Choices df	MS	F	p	Confidence Scores MS	F	p
Between Subjects (S)								
Task (T)	a	1	.067	<1		1.926	<1	
Group (G)	a	11	.061	<1		5.756	<1	
T x G	a	11	.196	1.78	.10	14.532	1.68	.10
Error Term (ET $S(T \times G)_a$)		96	.115			8.654		
Within Subjects								
Delay (D)	b	1	.417	5.25	.025	39.610	8.17	.01
Redundancy (R)	c	1	.704	10.06	.005	44.634	10.33	.005
Trial Block (X)	d	1	1.504	16.67	.001	141.834	23.41	.001
T x D	b	1	.204	2.55	.11	17.334	3.58	.10
G x D	b	11	.137	1.71	.10	11.110	2.29	.025
T x R	c	1	.067	<1		2.710	<1	
G x R	c	11	.225	3.21	.001	15.241	3.52	.001
D x R	e	1	.017	<1		.176	<1	
T x X	d	1	.067	<1		3.151	<1	

Appendix H (Continued)

Source	ET	Recognition Choices df	MS	F	p	Confidence Scores MS	F	p
G x X	d	11	.129	1.43		9.937	1.55	
D x X	f	1	.150	2.14		12.376	2.32	
R x X	g	1	.504	6.25	.025	56.551	10.47	.005
T x G x D	b	11	.061	<1		2.891	<1	
T x G x R	c	11	.114	1.63	.10	5.339	1.24	
T x D x R	e	1	.004	<1		.876	<1	
G x D x R	e	11	.273	2.45	.025	20.896	3.65	.001
T x G x X	d	11	.092	<1		3.240	<1	
T x D x X	f	1	.038	<1		5.251	<1	
G x D x X	f	11	.230	3.27	.001	18.365	3.44	.001
T x R x X	g	1	.150	1.88		7.176	1.33	
G x R x X	g	11	.220	2.75	.005	16.185	2.99	.005
D x R x X	h	1	.000	<1		1.001	<1	
T x G x D x R	e	11	.197	1.84	.10	11.956	2.09	.025
T x G x D x X	f	11	.198	2.84	.005	10.216	1.91	.05
T x G x R x X	g	11	.084	<1		5.478	<1	
T x D x R x X	h	1	.038	<1		3.151	<1	

Appendix H (Continued)

Source	ET	Recognition Choices df	MS	F	p	Confidence Scores MS	F	p
G x D x R x X	h	11	.189	3.14	.001	14.803	3.94	.001
T x G x D x R x X	h	11	.090	1.50		7.685	2.04	.05
Error Terms								
S x D(T x G)$_b$		96	.080			4.848		
S x R(T x G)$_c$		96	.073			4.324		
S x X(T x G)$_d$		96	.094			6.057		
S x D x R(T x G)$_e$		96	.107			5.723		
S x D x X(T x G)$_f$		96	.074			5.337		
S x R x X(T x G)$_g$		96	.083			5.405		
S x D x R x X(T x G)$_h$		96	.061			3.764		

APPENDIX I

ANALYSES OF VARIANCE TABLES FOR RECOGNITION CHOICES AND CONFIDENCE SCORES FOR THE DIFFERENT PROBE CONDITION

Appendix I

Source	ET	Recognition Choices df	MS	F	p	Confidence Scores MS	F	p
Between Subjects (S)								
Task (T)	a	1	.126	<1		1.751	<1	
Group (G)	a	11	.287	2.23	.025	19.740	1.89	.10
T x G	a	11	.260	2.0	.05	20.451	1.96	.05
Error Term (ET)								
$S(T \times G)_a$		96	.127			10.428		
Within Subjects								
Delay (D)	b	1	.001	<1		20.709	3.37	.10
Redundancy (R)	c	1	.026	<1		5.551	<1	
Trial Block (X)	d	1	.009	<1		4.676	<1	
T x D	b	1	.026	<1		3.151	<1	
G x D	b	11	.267	3.0	.005	22.187	3.61	.001
T x R	c	1	.001	<1		.551	<1	
G x R	c	11	.301	3.75	.001	26.392	4.67	.001
D x R	e	1	.459	4.18	.05	32.634	4.10	.05
T x X	d	1	.126	1.18		11.051	1.50	

Appendix I (Continued)

Source	ET	Recognition Choices df	MS	F	p	Confidence Scores MS	F	p
G x X	d	11	.257	2.36	.025	24.344	3.30	.001
D x X	f	1	.176	2.0		21.901	4.12	.05
R x X	g	1	.026	< 1		1.926	< 1	
T x G x D	b	11	.060	< 1		3.774	< 1	
T x G x R	c	11	.126	1.63		9.128	1.62	.10
T x D x R	e	1	.376	3.45	.10	11.051	1.39	
G x D x R	e	11	.098	< 1		9.198	1.15	
T x G x X	d	11	.087	< 1		7.683	1.04	
T x D x X	f	1	.234	2.56		15.759	2.96	.10
G x D x X	f	11	.296	3.33	.001	23.328	4.39	.001
T x R x X	g	1	.051	< 1		.376	< 1	
G x R x X	g	11	.337	4.25	.001	28.199	5.47	.001
D x R x X	h	1	.051	< 1		9.801	1.93	
T x G x D x R	e	11	.092	< 1		5.496	< 1	
T x G x D x X	f	11	.114	1.22		6.678	1.26	
T x G x R x X	g	11	.076	< 1		4.294	< 1	
T x D x R x X	h	1	.051	< 1		8.251	1.63	

Appendix I (Continued)

Source	ET	Recognition Choices df	MS	F	p	Confidence Scores MS	F	p
G x D x R x X	h	11	.290	3.22	.001	26.251	5.18	.001
T x G x D x R x X	h	11	.049	< 1		4.092	< 1	
Error Terms								
S x D(T x G)$_b$		96	.094			6.148		
S x R(T x G)$_c$		96	.082			5.649		
S x X(T x G)$_d$		96	.106			7.386		
S x D x R(T x G)$_e$		96	.111			7.967		
S x D x X(T x G)$_f$		96	.085			5.317		
S x R x X(T x G)$_g$		96	.078			5.155		
S x D x R x X(T x G)$_h$		96	.086			5.071		

APPENDIX J

ANALYSES OF VARIANCE TABLES OF RECOGNITION CHOICES AND CONFIDENCE SCORES CORRECTED FOR POSSIBLE RESPONSE BIASES FOR THE VERBAL DELAY TASK CONDITION

Appendix J

Source	ET	Recognition Choices df	MS	F	p	Confidence Scores MS	F	p
Between Subjects (S)								
Group (G)	a	11	.278	2.30	.025	14.240	1.83	.10
Error Term (ET)								
$S(G)_a$		48	.121			7.803		
Within Subjects								
Delay (D)	b	1	.234	3.83	.10	2.501	< 1	
Redundancy (R)	c	1	.126	2.60	.11	13.776	4.28	.05
Probe (P)	d	1	135.751	1068.98	.001	8936.501	1124.10	.001
Trial Block (X)	e	1	.759	7.60	.01	42.926	8.52	.01
G x D	b	11	.175	3.02	.005	9.051	2.63	.025
G x R	c	11	.226	4.26	.001	10.953	3.41	.005
D x R	f	1	.459	4.60	.05	12.834	2.64	
G x P	d	11	.169	1.33		12.592	1.58	
D x P	g	1	.376	4.22	.05	60.501	12.04	.005
R x P	h	1	.051	< 1		.551	< 1	
G x X	e	11	.150	1.52		12.031	2.39	.025

Appendix J (Continued)

Source	ET	Recognition Choices df	MS	F	p	Confidence Scores MS	F	p
D x x	i	1	.026	< 1		1.584	< 1	
R x X	j	1	.126	1.85		18.984	5.79	.05
P x X	k	1	.376	5.42	.025	31.901	8.41	.005
G x D x R	f	11	.196	1.96	.10	10.593	2.16	.05
G x D x P	g	11	.103	1.12		7.164	1.43	
G x R x P	h	11	.219	2.81	.01	13.587	3.46	.005
D x R x P	l	1	.379	2.72	.11	17.334	2.54	.13
G x D x X	i	11	.199	2.25	.05	11.116	2.16	.05
G x R x X	j	11	.158	2.29	.05	9.553	2.92	.01
D x R x X	m	1	.009	< 1		.026	< 1	
G x P x X	k	11	.126	1.77	.10	8.419	2.22	.05
D x P x X	n	1	.551	9.17	.005	42.084	13.22	.001
R x P x X	o	1	.551	6.87	.025	22.509	6.14	.025
G x D x R x P	l	11	.162	1.15		9.271	1.36	
G x D x R x X	m	11	.114	1.48		6.549	2.03	.05
G x D x P x X	n	11	.392	6.13	.001	19.566	6.15	.001

Appendix J (Continued)

Source	ET	Recognition Choices df	MS	F	p	Confidence Scores MS	F	p
G x R x P x X	o	11	.206	2.54	.025	13.228	3.61	.005
D x R x P x X	p	1	.009	< 1		.176	< 1	
G x D x R x P x X	p	11	.246	4.92	.001	15.440	7.52	.001
Error Terms								
S x $D(G)_b$		48	.058			3.443		
S x $R(G)_c$		48	.054			3.220		
S x $P(G)_d$		48	.127			7.949		
S x $X(G)_e$		48	.099			5.043		
S x D x $R(G)_f$		48	.100			4.905		
S x D x $P(G)_g$		48	.092			5.026		
S x R x $P(G)_h$		48	.078			3.928		
S x D x $X(G)_i$		48	.088			5.145		
S x R x $X(G)_j$		48	.069			3.276		
S x P x $X(G)_k$		48	.071			3.793		
S x D x R x $P(G)_l$		48	.140			6.818		

Appendix J (Continued)

Source	ET	Recognition Choices df	MS	F	p	Confidence Scores MS	F	p
$S \times D \times R \times X(G)_m$		48	.077			3.244		
$S \times D \times P \times X(G)_n$		48	.064			3.182		
$S \times R \times P \times X(G)_o$		48	.081			3.668		
$S \times D \times R \times P \times X(G)_p$		48	.046			2.053		

APPENDIX K

ANALYSES OF VARIANCE TABLES OF RECOGNITION CHOICES AND CONFIDENCE SCORES CORRECTED FOR POSSIBLE RESPONSE BIASES FOR THE VISUAL DELAY TASK CONDITION

Appendix K

Source	ET	Recognition Choices df	MS	F	p	Confidence Scores MS	F	p
Between Subjects (S)								
Group (G)	a	11	.231	2.08	.05	13.301	1.94	.10
Error Term (ET)								
$S(G)_a$		48	.111			6.848		
Within Subjects								
Delay (D)	b	1	.038	< 1		.234	< 1	
Redundancy (R)	c	1	.417	5.25	.05	18.984	4.79	.05
Probe (P)	d	1	138.017	1113.04	.001	8912.109	1112.62	.001
Trial Block (X)	e	1	.067	< 1		4.134	< 1	
G x D	b	11	.160	1.09		8.991	1.56	
G x R	c	11	.098	1.14		5.723	1.44	
D x R	f	1	.017	< 1		2.926	< 1	
G x P	d	11	.126	1.02		7.862	< 1	
D x P	g	1	.000	< 1		5.859	1.89	
R x P	h	1	.204	2.27		8.251	1.81	
G x X	e	11	.235	1.97	.10	12.323	1.84	.10

Appendix K (Continued)

Source	ET	Recognition Choices df	MS	F	p	Confidence Scores MS	F	p
D x X	i	1	.017	< 1		.009	< 1	
R x X	j	1	.038	< 1		1.426	< 1	
P x X	k	1	.504	4.58	.05	50.876	9.23	.005
G x D x R	f	11	.203	2.01	.10	13.687	3.27	.005
G x D x P	g	11	.083	1.69		6.780	2.12	.05
G x R x P	h	11	.222	2.39	.025	14.053	3.07	.005
D x R x P	l	1	.004	< 1		.301	< 1	
G x D x X	i	11	.126	1.35		7.175	1.46	
G x R x X	j	11	.115	1.44		7.737	1.83	.10
D x R x X	m	1	.104	1.05		16.801	3.53	.10
G x P x X	k	11	.054	< 1		3.465	< 1	
D x P x X	n	1	.004	< 1		.876	< 1	
R x P x X	o	1	.017	< 1		11.051	2.00	
G x D x R x P	l	11	.010	1.06		3.881	< 1	
G x D x R x X	m	11	.113	1.14		9.008	1.89	.10

Appendix K (Continued)

Source	ET	Recognition Choices df	MS	F	p	Confidence Scores MS	F	p
G x D x P x X	n	11	.122	1.67		8.106	2.20	.05
G x R x P x X	o	11	.239	2.57	.025	12.417	2.25	.05
D x R x P x X	p	1	.017	< 1		2.301	< 1	
G x D x R x P x X	p	11	.144	1.96	.10	11.590	3.07	.01
Error Terms								
S x $D(G)_b$		48	.147			5.785		
S x $R(G)_c$		48	.086			3.961		
S x $P(G)_d$		48	.124			8.010		
S x $X(G)_e$		48	.119			6.711		
S x D x $R(G)_f$		48	.102			4.719		
S x D x $P(G)_g$		48	.051			3.101		
S x R x $P(G)_h$		48	.093			4.572		
S x D x $X(G)_i$		48	.093			4.914		
S x R x $X(G)_j$		48	.080			4.230		
S x P x $X(G)_k$		48	.110			5.512		

Appendix K (Continued)

Source	ET	Recognition Choices df	MS	F	p	Confidence Scores MS	F	p
$S \times D \times R \times P(G)_l$		48	.094			5.403		
$S \times D \times R \times X(G)_m$		48	.099			4.764		
$S \times D \times P \times X(G)_n$		48	.073			3.678		
$S \times R \times P \times X(G)_o$		48	.093			5.535		
$S \times D \times R \times P \times X(G)_p$		48	.073			3.782		

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