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RETROACTIVE INTERFERENCE IN PROSE RECALL
AS A FUNCTION OF LEARNING DIRECTIONS.**

**The City University of New York, Ph.D., 1975
Education, psychology**

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RETROACTIVE INTERFERENCE IN PROSE RECALL

AS A FUNCTION OF LEARNING DIRECTIONS

by

VALERIE SASSERATH KREITZBERG


A dissertation submitted to the Graduate Faculty
in Educational Psychology in partial fulfillment
of the requirements for the degree of Doctor of
Philosophy, The City University of New York.

1975

This manuscript has been read and accepted for the Graduate Faculty in Educational Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

8-27-75


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Abstract

RETROACTIVE INTERFERENCE IN PROSE RECALL
AS A FUNCTION OF LEARNING DIRECTIONS

by

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The purpose of this study was to explore how instructional objectives (or learning directions) modify the effects of retroactive interference in prose retention and to relate the findings to instructional theory. Both a pilot study and a main investigation were conducted in which the following variables were manipulated: 1) type of learning direction--positively or negatively stated, 2) position of learning directions--before first or second reading passage, 3) retroactive interference--present or absent, and 4) type of delayed posttest--cued recall or multiple-choice. Several hypotheses were tested. One hypothesis was that information in the text that is relevant to learning directions will be recalled better than incidental information. Another hypothesis was that the recall of a first learned passage will be suppressed when subjects learn a second similar, but conflicting, passage (retroactive interference). Both of these hypotheses were confirmed, permitting further tests about the influence of learning directions on interference. There were two major

hypotheses about the effects of learning directions on interference. The first was that learning directions, given with the original passage, would have a significant influence on a learner's processing activities such that information from a second passage, which is similar but conflicting to the original, will not interfere with the direction-relevant information from the first passage. The second hypothesis was that learning directions would have a significant influence on a learner's processing activities such that direction-relevant information from the second passage interferes with corresponding information from the first, whereas incidental information from the second passage does not have an interfering effect. The passages used produced the interference necessary to test these hypotheses, but the two more specific interference hypotheses were not supported by the data. Instead, learning directions had a general effect of counteracting interference when the directions accompanied the first passage. Subjects receiving positive directions with the interfering passage experienced no differential learning loss. Furthermore, subjects receiving negative directions with the interfering passage had greater incidental, rather than relevant, learning loss after interference. In addition, relevant learning (learning of information related to learning directions) was higher than incidental learning for groups receiving directions with the first passage. This finding is consistent with previous work in the field. However, relevant learning in the experimental groups was lower than in the control groups which were instructed to learn the entire text. This finding is contrary to much of the work on adjunct aids, although some compatible research does exist.

There are several possible explanations for this finding which should be explored in future research. The research on adjunct aids, such as learning directions, has theoretical and potential practical value. In terms of theory, the mechanisms underlying the learning and memory of a prose passage are being elaborated and clarified through the manipulation of various study activities. In terms of instruction, the more knowledge that is gained through research on these adjunct aids, the more control the teacher can achieve over the educational process.

ACKNOWLEDGEMENTS

Ideally, the creation of a doctoral dissertation reflects more than the labors of its author. I have been fortunate to have had the support of individuals who were willing to contribute their wisdom, patience, time, and encouragement to this research.

I am grateful:

to Dr. Lawrence Frase, my advisor, whose dedication to research, enthusiasm for new ideas, continual encouragement, and openmindedness were instrumental in my formulating a relevant research problem and carrying it through;

to Dr. David Bearison, whose vast knowledge of the field of educational psychology helped me to integrate my research idea into a solid theoretical framework;

to Dr. Alan Gross, for giving me the benefit of his expertise in statistics and research design;

to Dr. James Royer and Dr. Nancy Hemmes, who provided input as outside consultants for the defense of my dissertation;

to Dr. Max Weiner, for his continual support throughout my doctoral studies;

to my parents, for the stimulating atmosphere they provided as I was growing up, for their encouragement and support throughout my academic career, and for their faith in me;

to my husband, Charlie, whose love and understanding have helped me to get through the worst of times and to fully enjoy the best of times.

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INTRODUCTION

For many years, theorists and investigators in the field of verbal learning paid little attention to the processes involved in the learning and retention of connected discourse. Rather, they concentrated on the learning and retention of nonsense syllables, lists of words, and paired associates. One reason for concentrating on simple tasks is that they are easier to control experimentally. A related reason is that theories of verbal learning and memory can be more clearly formulated with well defined tasks.

In recent years, however, attention has shifted to the study of more complex verbal materials. This new emphasis has forced educational psychologists to re-examine the theories of verbal learning and memory in order to see if the rules applying to simple verbal materials might generalize to more complex tasks. An important question is whether the underlying processing, storage, and retrieval mechanisms are similar or different for rote and meaningful verbal tasks.

The educational rationale for studying the behaviors involved in the learning and remembering of connected discourse is that, in general, the acquisition of knowledge in a school setting depends on the ability to read, understand, and remember meaningful material. Discovering the underlying processes involved in learning and memory for complex written material is thus important for the development of effective instructional techniques. The memorization of arbitrarily associated words, on the

other hand, appears less common in the classroom.

The purpose of the present study is to explore two major phenomena from the verbal learning literature and to investigate how they interact. These two phenomena are: 1) retroactive interference, which, in its most general terms, refers to the increase in forgetting that occurs when a person learns information which is similar to previously learned (to-be-remembered) information (Anderson & Myrow, 1971); and 2) mathemagenic behaviors, which are the information-processing activities upon which learning depends (Rothkopf, 1965). More specifically, the study will focus on how instructional objectives modify the effects of retroactive interference in prose retention. Before the study is described in detail, the literature concerning retroactive interference and mathemagenic behaviors will be reviewed.

CHAPTER I

REVIEW OF THE LITERATURE

Retroactive Interference and Related Issues

Psychologists have studied memory from before the time of William James whose observations about human behavior have had an impact on many aspects of modern psychology. Concerning memory, James (1892) noted that individuals differ in the amount and kind of information they are capable of retaining, that there is not necessarily a limit on capacity, and that memory capacity and quality can change within one individual over time. These basic assertions have been examined over the years, and one central question which has emerged is this: What are the factors (both within the individual and in the environment) that cause forgetting (i.e., apparent loss of information over time)?

The most widely studied theory of forgetting has been interference theory. One reason for this theory's popularity is that the principles which are claimed to govern verbal interference seem logical and have been demonstrated experimentally for almost fifty years. In general terms, interference theory states that competing responses (such as syllables or words) learned before the acquisition of criterion responses (proactive interference) or learned after the acquisition of criterion responses, but before a retention test (retroactive interference) can interfere with recall of the criterion responses. The end result is forgetting. The basic experimental paradigms which have been used for

studying the effects of proactive interference (PI) and retroactive interference (RI) are described in Table 1. A few examples might clarify how PI and RI are experimentally manipulated. In Table 1, each stimulus letter might be replaced by a nonsense syllable, where A becomes gub, B becomes lar, and C becomes pev. For proactive interference, the subject will first be asked to learn the association gub-pev; then to learn the association gub-lar. After a retention interval, he will be tested on the second association he was asked to learn. Because of the earlier relationship established between gub and pev, the subject may have difficulty remembering lar when asked what goes with gub. The first, earlier association interferes proactively with remembering the new association. For retroactive interference to occur, the newly formed association interferes retroactively with an earlier association. For retroactive interference, the subject will first be asked to learn the association gub-lar; then he will be asked to learn the association gub-pev. When the subject is tested on the first association, the second one (where stimulus A is still the same) will interfere retroactively and cause forgetting.

Although variations are found and more elaborate designs exist, especially in the recent literature, an understanding of the basic PI and RI designs is important for understanding interference theory. Investigations have concentrated more on RI than on PI, probably because PI was not considered when interference theory was originally developed. The importance of PI in memory processes was brought to the attention of psychologists by Underwood in 1957.

Table 1
Basic Interference Paradigms^a

For Proactive Interference					For Retroactive Interference			
					Retention Interval		Retention Test	
Learn	Learn	Retention Interval	Retention Test					
					Learn	Learn		
Experimental group	AC	AB	--	AB	Experimental group	AB	AC	AB
Control group	DE	AB	--	AB	Control group	AB	DE	AB

Note. The same stimulus A is used throughout, and B and C are different response terms which interfere with each other.

^aAdapted from Adams (1967).

Interference Studies: Nonprose Materials

The earliest work which tested the interference hypothesis using the RI paradigm was done by McGeoch (1929, 1936; McGeoch & McKinney, 1933a, 1933b). These early studies uncovered a phenomenon called response competition, one of the two mechanisms which underlies interference. Referring back to the RI paradigm, the decrement in the retention of AB is caused by direct competition between B and C, the two response terms. In other words, when stimulus A is presented during the retention test, the two responses (B and C) which have each at one time been associated with stimulus A, compete with each other. Whether response B or C is given by the subject depends on which response is stronger (the factors which determine response strength will be discussed later).

The second mechanism underlying interference is a phenomenon called unlearning. In the RI paradigm, unlearning refers to the extinguishing of the criterion response, B, when the learning of another response, C, is interpolated between original learning and the retention test. This mechanism was uncovered by the work of Melton and Irwin (1940). They found that RI was a direct function of the amount of interpolated learning but that intrusion errors (substitution of responses from the second list) accounted for much less of the decrement than did omissions. The investigators concluded that although response competition was at work, interference is also a process of weakening the bond between the original stimulus-response pair (Adams, 1967).

The degree of the effect of these two mechanisms of interference (response competition and unlearning) seems to depend on two factors:

1) the amount of training or practice on the criterion and interfering responses, and 2) the degree of similarity between criterion and interfering stimuli and responses (Cunningham, 1972). The experimental evidence dealing with each of these factors will be considered below.

Effects of practice. Concerning the effects of training or practice on RI, it was found in serial learning and paired-associate learning experiments that RI increases as a function of the number of repetitions of the interpolated list (McGeoch, 1929, 1936), and RI decreases as a function of the number of repetitions of the first list (the to-be-remembered list). These findings have been replicated (Briggs, 1957) and also demonstrated for PI (Thune & Underwood, 1943). Another study found a similar effect using the RI paradigm, but only up to an intermediate degree of interpolation (Melton & Irwin, 1940); RI tended to decrease slightly with a large amount of interpolation, but not enough to alter the original conclusions stated above. This finding was supported by Postman and Riley (1959) who used similar materials but a more sophisticated design. Thus in terms of the response competition mechanism, the response which is better trained will be stronger and will be associated with the original stimulus. In terms of unlearning, the response which is stronger due to training or reinforcement will extinguish the competing response (i.e., the competing response will be unlearned).

Proactive and retroactive interference are not only an increasing function of practice on the competing response, but are also a function of the number of interfering tasks (Underwood, 1945, 1949). In short, PI or RI increase when either the interfering task is reinforced through

training or when there are many different interfering tasks. Analogously, PI or RI decreases when the criterion task is reinforced through training.

Effects of similarity. The experimental evidence concerning the effects of stimulus similarity and response similarity on PI and RI have been integrated, elaborated, and summarized by Osgood (1949) who organized these findings around three basic principles. Rather than discussing every study which led to the development of these principles, the principles concerning the effects of similarity will be directly cited:

1. Where stimuli are varied and responses are functionally identical, positive transfer and retroactive facilitation are obtained, the magnitude of both increasing as the similarity among the stimulus members increases.

2. Where stimuli are functionally identical and responses are varied, negative transfer and retroactive interference are obtained, the magnitude of both decreasing as similarity between the responses increases.

3. When both stimulus and response members are simultaneously varied, negative transfer and retroactive interference are obtained, the magnitude of both increasing as the stimulus similarity increases.

For further comment on Osgood's principles, see Bugelski and Cadwallder, 1956; Martin, 1965; and Battig, 1966.

The theory of interference described above was developed through experimentation which used mainly rote materials: lists of nonsense syllables, lists of words, and lists of paired-associates. Thus the question asked at the start (What factors cause forgetting?) has been

answered primarily for rote tasks. Whether or not the same mechanisms and factors are operative when more meaningful materials are used is a complicated issue which will be considered next.

Interference Studies: Prose Materials

It has been argued that although the principles of interference theory may provide an adequate explanation of rote verbal learning and forgetting, it is unreasonable to assume that these same principles can be applied to learning from meaningful text material in school settings (Ausubel, 1968). Ausubel's theory of meaningful verbal learning is based on distinctions made between rote learning and meaningful learning in terms of the learning and retention processes involved. According to this theory, rote learning, which involves the memorization of discrete verbal units, can be governed by the laws of interference (where forgetting is conceptualized in stimulus-response terms). Because rote learned verbal tasks are never integrated into an individual's store of knowledge in the first place, they are easily interfered with and forgotten. Meaningful learning, according to Ausubel, does involve integration of the new material into an individual's cognitive structure, and learning and retention in this case are conceptualized in terms of the dissociability strength of the newly learned material from the already established ideas an individual possesses. Forgetting, rather than being an interference process, is a process of obliterative subsumption in which less inclusive concepts (details) become subsumed under the more clear and stable general concepts; the less inclusive concepts are considered forgotten when they lose all their dissociability strength, when they become completely subsumed under the more general ideas (Ausubel,

1963, 1968).

A series of studies has been conducted which attempted to demonstrate that subsumption theory rather than interference theory is a more accurate explanation of forgetting when meaningful learning had taken place.

Ausubel, Robbins, and Blake (1957) and Ausubel, Stager, and Gaité (1968) conducted experiments whose purpose was to determine whether RI could be demonstrated in a learning situation that involved the substantive retention of potentially meaningful material (connected discourse). It was found that when a "similar but conflicting" interpolated reading passage was learned after the original passage, the second passage had a facilitative effect. This finding is contrary to the principles of RI, and the investigators concluded that the failure to find an interference effect lends support to the subsumption theory of forgetting. Analogous conclusions were drawn concerning PI (Ausubel & Blake, 1958; Ausubel, Stager & Gaité, 1969).

The characteristics of the prose passages used in the Ausubel studies were not described in terms of specifying similarities and differences in structure and content. Rather, the passages were selected on the basis of experimenter judgments of the similarities and differences between them and their relationship to already existing ideas in cognitive structure (Ausubel, Robbins & Blake, 1957). Although in a later article (Ausubel, Stager & Gaité, 1968) the investigators state, "The material used to investigate retroactive interference consisted of two passages that on the basis of content analysis were thought to be highly similar and conflicting," the analysis is not described. A careful

description of this analysis would be useful. It would also be useful if the relationship between the multiple choice test and the prose passages were made explicit and the nature of the distractor items described. It is not clear whether the test items focused on the sentences or the main ideas in the prose passages. The derivation of distractor items (i.e., whether they are taken from the interpolated passage or are designed to tap misconceptions) might also be usefully stated. Although in actual classroom settings this degree of specification may be impractical, specifying these factors in research on learning processes would contribute to the replicability of the results and to understanding the mechanisms underlying retention.

Furthermore, rejection of the interference hypothesis is not adequate support for the subsumption hypothesis. Ausubel's studies have not necessarily demonstrated that a subsumption process is operative when meaningful material is used. For instance, Ausubel, Robbins and Blake (1957) found that when subjects read a passage in which the similarities and differences between the passage and "its presumed subsuming concepts" were delineated, retroactive inhibition did not occur and retroactive facilitation may be induced. But, since the experimental group and a control group, which read the criterion passage twice, performed equally well on retention, it is possible that repetition, rather than enhanced discriminability resulting in a reduction of the subsumption process, was the main factor in retention.

Ausubel's research, although it needs qualification, represents a significant contribution in RI and PI because it is concerned with the learning and forgetting of connected discourse which is more relevant to

school learning than the rote tasks which had traditionally been studied. Ausubel's concern that meaningful learning be studied, that real life situations be considered, and that interference theory be reexamined has been a stimulus to further RI and PI studies with prose materials.

A series of experiments by Slamecka (1959, 1960a, 1960b, 1962) demonstrated that the principles of retroactive interference and proactive interference which applied to rote tasks may also apply to the learning of meaningful connected discourse (Slamecka, 1961). To specify the similarities and differences between the criterion passage and the interpolated passage, Slamecka used a scaling technique to assess the perceived similarity of responses. This normative analysis is more objective than the intuitive approach used by Ausubel. However, it is still a subjective means of determining similarities and differences in structure and content. In the RI studies, the subjects learned one long, abstract sentence which was presented one word at a time in a serial anticipation procedure. Slamecka varied the number of presentations of the interpolated sentence, the number of interpolated sentences, and the degree of similarity between the criterion and interpolated sentences. His findings concerning practice and similarity support those of earlier studies on RI and PI.

Although Slamecka used meaningful connected discourse, the difficulty and abstractness of the material and the situation in which it was presented (one word at a time, rather than one idea unit or sentence at a time) could cause the subjects to treat the material as though it were rote in nature. However, Slamecka's studies set the stage for further prose learning studies.

An improvement on Slamecka's methodology was made by Jenson and Anderson (1970) who produced RI of a lengthy prose passage without rote memorization or serial presentation. These investigators point out that the number of experiments using prose materials which produce RI or PI or facilitation should not be a guide to the pervasiveness of these phenomena; rather, the studies must be examined in terms of the biases and procedures of the researcher.

A further improvement in methodology and an increase in the objective analysis of text is evident in two studies by Crouse (1970, 1971). In the 1970 study, Crouse used the traditional RI paradigm with connected discourse. This is material which has a logical, grammatical structure and can be understood (as evidenced by paraphrasing and answering questions) by persons with the appropriate background. Crouse specified the similarities and differences between the criterion and interfering material by constructing the passages in such a way that their macrostructures were the same, but there were differences and similarities in details. For example, one passage described a hypothetical poet named Fowler, who was born in Hampstead in 1810 whereas the second passage described a different hypothetical poet named Payton, who was born in Northshire in 1901. There were 22 sentences in each passage. Since the structures of the passages were parallel, each having the same syntax, same number of sentences, etc., a recall test could be constructed in which the stems of the incomplete sentences are the same (except for the name of the poet) but the answers which complete those sentences are different for each of the passages. For example:

Payton's father was a _____ (passage one)

Fowler's father was a _____ (passage two).

This type of test creates a situation in which the stimuli are similar but the required responses are different. In this way, a potentially interfering situation is established (see Osgood, 1949). It is important to note that the test questions were derived from the information in the passages and that the relationship between each question and elements in the prose passages was clearly indicated. This procedure can be repeated in future studies if the same rules for defining test items are followed. (See Bormuth, 1970, on the construction of valid test items.) The major finding of the Crouse (1970) study was that retroactive interference, but not proactive interference, was a significant factor in forgetting the criterion prose passage.

In another study, Crouse (1971) used degree of similarity as the independent variable. The passages and posttests were constructed in the same fashion as the 1970 study. Crouse found that interpassage similarity influenced RI in prose learning tasks--the most similar the interpolated passage, the greater the RI. Concerning the failure of previous studies to find retroaction effects in prose learning (Crouse cites the Ausubel studies), Crouse speculates that a specific content analysis of the passages used in these studies would reveal that the passages were not interfering in the first place, that they were different from each other.¹ In this same study, Crouse claims that unlearning, rather than response competition, is the major source of interference since forgetting was characterized by omission rather than the substitution of

¹Ausubel, Stager, and Gaite (1968) state that content analyses were performed, but these analyses are not described.

interfering material.

Even with the improvements in procedure, in specification of the relationships among the passages, between each test question and each passage, and in the nature of the prose passages themselves, it can still be said that the subjects were being asked to learn rotely because the posttest demanded verbatim (word-for-word) recall. Of course, a verbatim answer does not necessarily indicate that the subject does not understand what he has read. Verbatim learning means that the subject learns material word for word, exactly as presented; this type of learning may or may not result in understanding of the material, where "understanding" can be tested by asking the subject to paraphrase or answer questions in his own words. Rote learning, like verbatim learning, involves word-for-word memorization of the material; unlike verbatim learning, however, rotely learned information is not understood by the subject. Rotely learned material does not become associated with information which a learner already possesses, cannot be paraphrased correctly, and is quickly forgotten (Ausubel, 1968). Thus, exact answers on a posttest may indicate memorization without understanding (rote learning), or they may indicate meaningful learning (as evidenced by paraphrasing, association with similar concepts, putting information in other words) in addition to word-for-word recall. It is important to realize that rote and meaningful are terms at opposite ends of a continuum. Prose learning is seldom completely rote in character, although it may contain rote elements. The type of posttest given to a subject may provide an answer as to the type of learning which occurred as a result of having read the text material. A basic difficulty in prose learning research is that learning can only

be evaluated in an indirect way. Thus, the wording and level of posttest questions would seem to be important variables in evaluating the type of learning achieved by subjects.

Some methodological considerations. Studies have been conducted to explore the effects of the type of questions given on a posttest. In a factor analytic study, King (1960) found that verbatim recall measures (which require word-for-word recall), substance recall measures (which require recall of the general meaning), verbatim recognition measures (which require selection of the word-for-word answer from a set of alternatives), and substance recognition measures (which require selection of the correct general meaning or paraphrase answer from a set of alternatives) correlate highly (about .80) with each other. The implication is that these measures can be used interchangeably to some extent. Studies on RI using prose materials and procedures similar to those of Crouse except for the nature of the posttest (multiple choice instead of fill-in) found similar results (Anderson & Myrow, 1971; Myrow & Anderson, 1972). Unlike Crouse's data, which pointed to unlearning, rather than response competition as the mechanism underlying RI, the studies using multiple-choice tests indicate that response competition is a more important factor than response unavailability (unlearning) in RI with prose. This latter conclusion was drawn (Myrow & Anderson, 1972) because the subjects most often chose the distractor which was derived from the interfering passage, rather than the other distractors, when they were being tested on the criterion passage. This could mean that recognition tests are more sensitive to the mechanisms by which interference operates. That is, the alternatives provided on a recognition or multiple

choice test elicit potentially competing responses from the subject. Both the correct response and the interfering response will be recognized as familiar since both of these have been experienced by the subject. The subject's task is to select not just the familiar response (there are two of these, but only one is correct), but the response which is appropriate to the stem of the question, which can be thought of as the stimulus.

It may be the case that when the subject is confronted by two familiar alternatives, response competition occurs. The response selected depends on the strength of the association between each response and the stimulus (stem of the question). The stimulus-response association which is the strongest (due to overlearning, recency of learning, or other factors) will determine which alternative is chosen. If the interfering association is strongest, then the interfering response will be selected. In a recall format, a response competition situation is not created by the test, and may therefore not be a problem for the subject.

Whether the mechanism of unlearning or that of response competition is the major factor underlying RI is still debatable. A study by VanMondfrans, Hiscox and Gibson (1973) indicates that whether response competition or unlearning is observed to be the more active mechanism is a function of the type of posttest used. When multiple-choice tests are used and the distractors are derived from the interfering passage, it will seem that response competition causes RI; when fill-in tests are used, there will be many omissions which implies that an unlearning mechanism causes responses to become unavailable. This is one issue explored in the present study. It is clear that methodology plays a

strong role in determining theoretical interpretations.

Further evidence of the ability to manipulate RI through operationalizing passage similarity on the basis of test item stimuli and responses is provided by Bower (1974). Aside from replicating previous findings (Crouse, 1970, 1971; Anderson & Myrow, 1971; Myrow & Anderson, 1972) Bower went a step further and demonstrated that an interpolated prose passage can facilitate retention of some details of a criterion passage while interfering with the retention of other details. As in Crouse's materials, the general structure of the criterion and interfering passages was the same. The interference and facilitative effects were embedded in the passages' microstructures (detailed content). Bower used two kinds of posttests--free recall and fill-in--and found the same effects with each test. This offers further confirmation for King's (1960) contention that verbatim recall and substance recall measures reveal similar data.

Summary. Studies on retroactive interference with prose materials yield findings similar to studies using nonprose materials provided that the content and structure of the prose materials are operationally defined. When operationally defined, the relationships among the passages and between each posttest item and each passage are made clear. This clarity of definition allows for accurate replication, for meaningful extensions of previous work, and for insights into the processes involved in the retention and forgetting of connected discourse. The present study will use prose materials whose content and structure are operationally defined for the above reasons.

After examining the extensive work done in the past fifty years

on the phenomenon of retroactive interference, one is left with the feeling that psychologists have defined the concept, and set up situations in which the effect will occur, but have neglected to address themselves to the problem of minimizing retroactive interference. If retroactive interference is potentially prevalent in instructional settings and is a major cause of forgetting, it seems reasonable, then, that methods of controlling RI are needed. Students are, in fact, asked to remember large amounts of material which, at first, is new and unfamiliar to them, then to learn more material which is different from but related to the first material, and then to take a final examination on the semester's work. Clearly, this new material may conflict with the previously learned material and cause a decrement in retention. What is not obvious is how to counteract that effect. One solution might be to provide information, or a task, either before the original material or before the interfering material, which will direct a student's attention, or encoding activities, in such a way that the effects of RI will be modified. This supplementary material, whose function is to alter the direction of reading behaviors, is called an adjunct aid.

Adjunct aids, in the form of organizers, questions, learning directions, and objectives have been shown to systematically affect retention. The purpose of the present study is to demonstrate how adjunct aids (in particular learning directions) can be used to modify retroactive interference in prose retention, and to relate these modifications to instructional theory. However, before explaining how learning directions may be able to reduce interference, the field of adjunct aids will be reviewed.

Effects of Adjunct Aids on Prose Learning

Unlike the theory and research pertaining to retroactive interference which dates back many years, the theoretical basis for the study of adjunct aids and the research which followed is relatively recent. Two influential figures stand out in prose learning research: Ausubel and his model of meaningful verbal learning, and Rothkopf and his concept of mathemagenic behaviors. The research derived from both Ausubel's and Rothkopf's conceptions has investigated the use of adjunct aids to facilitate the learning of prose material. Their approaches differ, however, in their description of how an adjunct aid interacts with both the prose passage to be learned and with the learner's processing activities. One difference is that Ausubel believes that the key to understanding how newly presented information is learned and retained lies in the analysis of the interaction of the new material with material already stored for long-term use, whereas Rothkopf emphasizes the stimulus controls involved in prose processing. A second difference in the approaches of these two investigators concerns how the effects of adjunct aids should be studied, and the types of adjunct aids which might be useful theoretically and practically. These different approaches stem from the different theoretical conceptions concerning the interactions among text, adjunct aids, and processing activities.

An information processing model suggested by Frase (1975) helps to clarify the differences and similarities between these two approaches to prose learning. This model will be discussed after reviewing Ausubel's work on meaningful verbal learning.

Ausubel's Model of Meaningful Verbal Learning

The increase in prose learning research which has occurred in the past fifteen years or so can be partly attributed to Ausubel's approach to meaningful verbal learning. His approach specifies a theoretical superstructure within which to examine the determinants of meaningful prose learning. By meaningful learning, Ausubel refers to learning which is not rote or arbitrary but which involves the substantive integration of newly acquired ideas with relevant, already established ideas in the individual's cognitive structure. A cognitive structure is defined by Ausubel as a learner's idiosyncratic structure of knowledge, which is a permanent store of knowledge analogous to long-term memory. This structure is hypothesized by Ausubel (1963, 1968) to be organized hierarchically with the most general, abstract and inclusive ideas serving as anchors for the progressively more specific and concrete ideas which they subsume. If we think of this as a class inclusion relation, then an abstract idea might be the concept of car, within which are included Fords, Buicks, etc., which are more concrete than car. Within the category of Fords, particular types of Fords might be included, which are more concrete than the inclusive concept Ford. This structure of knowledge continually increases in order to accommodate to newly acquired, meaningfully learned information. In order for meaningful learning to take place, it is necessary that the material to be learned be structurally compatible with the learner's knowledge structure. That is, the learner must have a general and inclusive idea already in his knowledge store which is relevant to the new to-be-learned idea so that the new idea has an anchor which will allow it to be remembered and integrated.

If a new idea does not have an anchor (that is, if it is not structurally compatible) it will be rote learned and quickly forgotten. Therefore, optimal learning and long-term retention require that the new information be relatable in a substantive (nonverbatim) and nonarbitrary fashion to information the learner already possesses.

Ausubel emphasizes that rote and meaningful learning are not dichotomous. Rather, they fall on opposite ends of a continuum, and the type of learning which individuals exhibit is usually somewhere on this continuum, but not at either extreme. However, there are aspects of Ausubel's notion of meaningful learning which remain to be specified. For example, Ausubel does not elaborate on how one empirically determines whether new and old ideas are "structurally compatible." The theory also does not clearly outline the processes, such as encoding and rehearsal, which the learner engages in before relating new material to already existing ideas.

Unfortunately, optimal learning may not take place because the learner may not recognize how, or if, new information is related to information he already knows. Hence he may not be able to integrate this new information effectively into his cognitive structure. An even more serious situation is the attempt and subsequent failure of a student to meaningfully learn a new idea when he does not have the prerequisite knowledge to use as an anchor. The student in this case may resort to rote memorization of the new material, a process which results in rapid forgetting. Ausubel proposes that adjunct aids, in the form of advance organizers, are useful in bridging the gap between the knowledge the learner possesses and the information he is to acquire. By providing

superordinate concepts, advance organizers assure the presence of the anchoring ideas needed for meaningful learning of the new material.

Organizers as adjunct aids. The research on advance organizers and their effectiveness has been equivocal. One set of studies found that advance organizers facilitate learning for students with low verbal ability or low analytic ability (Ausubel, 1960; Ausubel & Fitzgerald, 1961, 1962; Schultz, 1967), but no generally facilitative effect of organizers was found. One explanation given (Ausubel, 1960) for the limited effect was that the prose passages used were so well organized themselves that the organizers' effect was minimal.

With social studies prose materials, Allen (1970) found that advance organizers affect the learning of students of differing ability in different ways: low-ability students with organizers performed better on a short-term retention test than did low-ability students without organizers; above-average-ability students with organizers performed better on a long-term retention test than did above-average students without organizers. A more recent study, using anthropology prose materials (Clawson, 1973) found that organizers had no effect regardless of ability level or grade level. Another study (Proger, Carter, Mann, Taylor, Bayuk, Morris & Reckless, 1973) using advance organizers and concurrent² organizers with elementary school pupils, found no effect. In the field of abstract mathematics, advance organizers did facilitate learning (Scandura & Wells, 1967), but the organizers used appeared not to follow Ausubel's definition of an organizer.

²A concurrent organizer is used along with a prose passage instead of being learned in advance of the criterion passage.

When closely examining the aforementioned studies testing the effectiveness of advance organizers, it is clear that the results have varied. The problem may lie in the procedures used to construct this adjunct aid.

Investigators (Clawson, 1973; Scandura & Wells, 1967) have relied on their own judgments rather than on operational definitions in their construction of advance organizers. This lack of standardization is a problem in determining the exact relationship between the advance organizer, the prose passage, and the posttest. An algorithm or normative procedures would be useful in constructing this adjunct aid.

The time needed for learning an adjunct aid should be considered (Peeck, 1970). In the Ausubel and Fitzgerald (1962) study, subjects spent first 8 minutes then 6 minutes studying an organizer. Immediately after the 6-minute session, subjects spent 25 minutes studying a first pubescence passage for which a suggestive facilitative effect ($p < .07$) was reported. At a later session, a second pubescence passage was studied for 26 minutes, for which no overall enhancement of retention occurred. Perhaps the total of 14 minutes spent studying the organizer could have been productively spent rereading the content to be learned.

In addition, Ausubel does not specify, in an empirically testable way, the information processing mechanisms which might be involved in transforming the printed words in the prose passage into the learner's idiosyncratic language and then into concepts which are integrated into the existing knowledge structure. In a more specific approach, such processes as encoding, rehearsal, and the transfer of information from short-term to long-term memory would be more fully elaborated.

Summary. The theory of meaningful verbal learning proposed by Ausubel was instrumental in stimulating research in the area of prose learning. The theory describes how new information becomes integrated into a learner's already existing structure of knowledge to become a meaningfully acquired and retained concept. Although Ausubel describes the hierarchical arrangement of ideas in cognitive structure and describes certain criteria for meaningful learning, the theory does not pinpoint the information processing mechanisms (such as short- and long-term memory) involved in processing written materials. The research on advance organizers would be more generalizable if the theory were more explicit in analyzing the subprocesses involved in prose learning.

One way of remedying this problem is through the operationalization of the prose materials themselves by defining the passages in terms of "idea units." Meyer and McConkie (1973) report this kind of analysis in which "each resulting idea unit was felt to be a single, meaningful piece of information conveyed by the passage, whether it consisted of a word, a definition, or a phrase in the passage." These idea units were then given to judges who arranged them into a hierarchical structure and judged the importance of each item to the rest of the structure. This type of operationalization of materials allows an investigator to specify more clearly, through quantification, the semantic structure under investigation.

Another approach to the prose learning process is Rothkopf's concept of mathemagenic behavior.

Rothkopf's Concept of Mathemagenic Behavior

While Ausubel's (1963, 1968) model of meaningful verbal learning emphasizes the role of the learner's existing structure of knowledge in acquiring new information, Rothkopf's (1965, 1970) concept of mathemagenic behaviors³ emphasizes the role of the learner's activities, both overt and covert as they are controlled by various stimulus events in acquiring new information. Rothkopf defines three classes of activity with mathemagenic significance. Class I activities involve orientation, that is, bringing the learner in contact with the instructional materials in a quiet setting for a suitable time period. Class II activities involve object acquisition, that is, selecting and attending to appropriate instructional objects. Class III involves translation and processing, that is, scanning the instructional materials, translating the new information into internal speech, breaking down the string of vocal articulations produced by translation, and other processes associated with reading. Class I and II activities are directly observable and relatively susceptible to empirical measurement. However, Class III activities are only observable indirectly. It is believed (Rothkopf, 1965) that prose learning outcomes can be controlled by manipulating these covert Class III activities. In other words, if the learner's attention can be directed (by the use of adjunct aids) to salient aspects of a prose passage so that he concentrates further processing activities on those aspects, he will learn more efficiently.

A conceptual model of prose processing developed by Frase (1975)

³Rothkopf (1965) defines mathemagenic behaviors as "behaviors that give birth to learning."

elaborates more fully the classes of mathemagenic activities outlined by Rothkopf.

A conceptual model of prose processing. Frase (1975) has recently suggested a model of prose processing which attempts to outline learner behaviors more fully. This model is based on the results of research in prose learning, although Frase (1975) states that the characterization of performances at the deeper semantic levels of the model has a less definitive experimental base.

The model describes four levels of processing, the learner behaviors at each level, and their interactions with short- and long-term memory. Level I is labeled content and performance set and is analogous to the Class I and II activities described by Rothkopf (1970). At Level I, the reader sets goals concerning his learning activities which depend upon the text and its accompanying directions. The learner's prior experience may have an impact on his performance set, and therefore, long-term memory influences this level of activity. In addition, Level I activities determine, in part, the representation of the stimulus (which consists of letters, words, phrases) in short-term memory, and also determine the content available for higher processing.

Level II is called encoding and is analogous to the Class III activities (translation and segmentation) described by Rothkopf (1970). Encoding involves the translation of stimulus items (according to their goal relevance) into an internal representation which is idiosyncratic to the learner. What is encoded, and the efficiency and accuracy of encoding all affect short-term memory and learning.

The last two levels of the model describe what happens to

stimulus items once they are encoded. Level III is labeled rehearsal and integration. Performance at this level is dependent upon the encoding process which takes place earlier in the sequence. Text items are rehearsed in conjunction with short-term memory activities. For example, if a learner is exposed to a prose passage which contains many facts, the facts encoded first will be rehearsed in short-term memory while subsequent items become encoded. It is possible that rehearsal of earlier items may limit the input of subsequent items. It should be noted that short-term memory is considered a temporary storage place where newly encoded information is rehearsed; short-term memory interacts with long-term memory where the learner's store of previously acquired knowledge resides. Integration of text material comes next in the sequence after rehearsal, but integration need not always occur and is not necessarily an automatic process, according to Frase (1975).

Level IV is called retrieval and relation, and is analogous to the meaningful learning process described by Ausubel. At Level IV, new material is related to previously learned material, stored in long-term memory. This process can occur whether or not the text material was integrated at Level III. Frase (1975) considers the retrieval activities of Level IV analogous to the rehearsal activities of Level III in that both types of activities handle ideas as they are encountered sequentially. Integration at Level III is analogous to relation at Level IV. It is possible for a reader to rehearse newly encoded items and to retrieve long-term memory items without integrating text items with each other and without relating the new material to already existing concepts. Although Rothkopf's concept of *mathemagenic behaviors* deals with activities

on Levels I, II, and III, Ausubel's theory of *meaningful verbal learning* would consider Level IV activities (especially relation) essential to learning and long-term retention.

In short, Frase's (1975) conceptual model of prose processing provides a *summary framework for study activities*. In reviewing the literature on the mathemagenic concept, an attempt will be made to relate the findings to the model proposed by Frase.

Research strategies and the mathemagenic concept. In order to explore the mathemagenic concept experimentally, investigators have presented adjunct aids along with the prose passage to be learned. It is believed that adjunct aids (in the form of underlining, questions, directions, and objectives) serve as "orienting directions" (Frase, 1970a) which guide the learner's processing activities partially making him aware of those aspects of the material he should learn best. It will become clear that different types of adjunct aids affect learning activities and outcomes differently depending on such variables as their position, frequency, level of difficulty, and specificity. A procedure common to studies in this area is to present orienting directions which pertain to only part of the information in the text to be studied so that part of the information is relevant (referred to by the adjunct questions or learning directions) and part of the information is incidental (not referred to by the adjunct aids). By administering a posttest on all of the information contained in the passage (both relevant and incidental) one can measure the effect of an adjunct aid, within the same learner, passage (or set of passages), and time period. The adjunct aids most frequently manipulated in experiments have been questions (also

called test-like events)⁴ and learning objectives.

Questions as adjunct aids. Questions have been used in prose learning studies under a variety of conditions so that investigators could determine which aspects of questions influence learning outcomes. These conditions include position of questions, frequency of questions, and type of questions. The effect of questions, or test-like events, on learning in any of these conditions or combinations of conditions is measured by a posttest of both the question-relevant and incidental information covered by the prose passage. The amount and type of information recalled gives an indication of how the adjunct aid influenced the mathemagenic behaviors of the learner.

The earliest work on the positional effect of questions suggested that under certain conditions, adjunct prequestions exert a selective effect on learning in that the information in the text which is referred to by the questions is learned better than information with no reference. In fact, retention is even more restricted to question-relevant information when the questions exerting control over learner activities occurred in close contiguity to the related text information. The contiguity effect was stronger when adjunct questions preceded a portion of text than when questions followed a portion of text (Fraser, Patrick & Schumer, 1970). In short, the effects of prequestioning can be question-specific.

In some cases, prequestions not only enhance the learning of

⁴Questions as adjunct aids are sometimes called test-like events because in most of the studies using text-inserted questions, the subjects must answer the questions--before the posttest is given. When objectives are used, however, overt responses are not usually required until the subject encounters the posttest.

question-specific information, but they also depress incidental learning significantly below control group scores (Fraser, Patrick & Schumer, 1970). This effect of prequestions also holds in a delayed retention situation (Peeck, 1970). Thus, prequestions have the power to control the learner's attention to such an extent that the range of text stimuli to which effective learning responses are made is limited (Fraser, 1970a).

Postquestions, however, do not have the limiting effect of prequestions. Rather, postquestions tend to facilitate retention of both question-relevant and incidental information (Fraser, 1967, 1968a, 1968d; Rothkopf, 1966; Rothkopf & Bisbicos, 1967). The use of postquestions may enhance the already strong effect of review statements (Bruning, 1968). The function of postquestions is twofold: 1) they work in a specific manner to elicit review, or rehearsal, of the material already read, and 2) they work in a general manner as cues for certain processing skills to be used (Fraser, 1968a, 1970a). The spacing of postquestions with respect to text material is another factor which can affect review and processing behaviors. Postquestions, in close conjunction with relevant text, increase the difference in recall between relevant and incidental information (Fraser, 1968b) and have a depressing effect on incidental material similar to that elicited by prequestions. Thus position and spacing of questions are factors that interact to determine which aspects of text material (relevant, incidental, or both) will be remembered.

Another question variable which interacts with positional effects is the type of question used as an adjunct aid. Type refers to the nature of the information the questions ask about, the specificity of the

questions, and the cognitive level of the questions. Cognitive level refers to the extent to which the material must be meaningfully understood and integrated with other text items and long-term memory items in order to answer the questions; questions requiring a verbatim response are on a lower cognitive level than questions requiring the learner to give an example of a concept. The type of question asked can determine the behavior a learner will exhibit during reading (e.g., Level III and Level IV in the Frase [1975] model) and during test performance. Investigators have compared the effects of different types of questions on the learning of text and have studied how type interacts with the position of questions in text.

In one such study (Rothkopf & Bisbicos, 1967) two types of questions were inserted throughout the text--some related to common terms and others to technical terms. Recall of technical terms (both question-relevant and incidental) was higher for the postquestion group which had seen technical term questions than for the prequestion group which had seen the same questions. This finding indicates that inserted questions have a selective facilitative effect on *mathemagenic* behaviors. The type of information that will be processed and recalled depends both on the type and position of the adjunct questions.

The way in which question type will affect what is learned from prose is not always predictable. One such unpredictable effect was found in a study by Frase (1968c) in which general and specific questions (placed before the text information to which they referred) were the types compared. It was predicted that a general question would require that learners process more information from a prose passage than would

specific questions. However, retention was significantly lower with general questions. This finding has implications for the theoretical conceptions of how prose material is processed. It is possible that the general questions, instead of eliciting greater processing activity, made the subjects adopt a partial encoding strategy, and effective control over full sentence processing was lost. A group of subjects, who were used to obtaining norms on the content perceived to be relevant to the questions, indicated that this was, in fact, what had happened. General questions did not constrain subjects to rehearse the stimulus, the response, and the association between the two. The specificity dimension and its consequences has also been studied with regard to learning directions, to be discussed in a later section.

Recent studies on the effects of adjunct questions have dealt with higher-order questions which ask the learner to make inferences or apply the information he has learned from the prose passage. Since these types of questions require more than specific factual learning, they force the learner to go beyond the information provided in the passage. He must process the text information at a higher cognitive level. Studies have shown (Fraser, 1970b, 1971) that retention of specific factual information (*reproductive memory*) and retention of inferences based on that information (*productive memory*) can be influenced by the cognitive level of the questions inserted in a text. Factual questions resulted in poor recall of incidental factual information and nearly no recall of incidental inferential information. Higher-order questions were significantly better than fact questions for recall of both factual and high-order relevant information. It was concluded, therefore, that

responding to inferential questions enhances overall learning because these questions subsume the factual material (Fraser, 1970b).

Contrary to this finding, another investigation (Denzel, 1971) on a similar issue found no significant differences in recall when comparing questions defined according to Bloom's (1956) taxonomy of the levels of cognitive functioning. That is, there were no differences in recall whether the questions required verbatim answers, paraphrased answers, or applying the information in a new situation. As pointed out by the author, the prose passages used in this study, consisting of economics material, may have been very difficult. One problem was that the prose passages used were not assessed for readability or level of difficulty. The second problem was that the higher-order questions referred to information not tested on a factual level. Since the ability to answer higher-order questions is dependent on knowledge of the specific facts on which the higher-order questions are based (Gagné, 1970), it may be the case that passage difficulty influenced the effect of higher-order questions. However, since the facts were not tested, it was not possible to determine whether or not the facts were learned.

Other investigators (Anderson, 1972; Richards & DiVesta, 1974), in an attempt to uncover the mechanisms underlying semantic encoding,⁵ investigated the facilitative effects of substantive (in the subjects' own words) questions on memory. It was found that the substitution of

⁵Semantic encoding of verbal information refers to the substantive (nonverbatim) and long-term storage of verbal material which occurs over the retention interval. When information is first learned, it is phonologically (in a verbatim fashion) encoded. The nature of this transfer from one type of encoding and storage to another is not fully understood.

semantically related words for the verbatim language of the original sentences increases over the retention interval (Anderson, 1972). This finding indicated that information may be transferred from a phonological (short-term) to a semantic (meaningful and long-term) store over time. In addition, sentences were almost always recalled as a whole, if they were recalled at all, which indicates that sentences are learned and remembered as complete ideas rather than as sets of independent associations among words.

Also concerned with substantive versus verbatim encoding, Richards & DiVesta (1974) compared the recall scores of learners exposed to questions requiring a verbatim response to the scores of those exposed to higher-order questions. They found that type of question interacts with question position. Factual questions given after the material aided more in the recall of incidental information than these same questions placed before the material (confirming the findings of Rothkopf, 1966; and Frase, 1968a), but higher-order questions were more effective in facilitating recall of both relevant and incidental information when they were placed in a pre-text position. In this position, higher-order questions may serve the controlling function referred to earlier by Frase (1970b). It should be noted that presenting a set of higher-order questions before text material is read may be superficially similar to Ausubel's presentation of advance organizers before text material (see the previous section for a review of this work). The hypothetical mechanisms by which learning is influenced can be, however, quite different. In Ausubel's view, a subsumption process takes place in which the higher order (more abstract, general, and inclusive) ideas provide

anchors, or a context, for the new information so that this new information may be integrated into the learner's already existing and well-organized structure of knowledge. Higher-order questions might function, however, to modify the inspection behaviors of the learner, making him more alert, encoding the text material for purposes of integration as well as rehearsal, etc.

In a follow-up study, Rickards and DiVesta found that closely spaced substantive questions inserted after the prose material produced more recall of both relevant and incidental information than did questions requiring a verbatim response. This finding might be explained by the interpretations offered earlier (Fraser, 1968a, 1970a) which described the specific and general manner in which postquestions influence learner behaviors. Thus questions, both factual and higher-order, seem to operate in both a forward and backward fashion to influence processing activities, and it is believed (Anderson, 1972) that the level of these processing activities determines whether information will be transferred from temporary, phonological storage to a more long-term, semantic storage.

Aside from substantive and inferential questions, other types of higher-order questions have been found to have mathemagenic positive effects.⁶ When asked to apply factual information from a prose passage to a new situation by giving an example, high school seniors outperformed on a posttest (which asked all levels of questions) those students who

⁶A mathemagenic positive effect results in behaviors which promote learning from prose. A mathemagenic negative effect results in behaviors which interfere with learning from prose.

were given specific factual questions as adjunct aids (Watts & Anderson, 1971). Application questions as adjunct aids not only enhanced recall of text information, but also led to superior performance on new application questions. The investigators hypothesized that the inserted application questions elicited more thorough processing of the text. Specifically, the inserted questions may have exerted a forward or shaping influence on the subjects' study activities by providing a guide for adjusting study behavior on succeeding passages. It is also possible, however, that the adjunct application questions had a backward or review influence on learner activities; in order to construct a new example, subjects would have to mentally review the content of the passage to a greater degree than subjects who had specific factual questions which could be answered with a word or two directly from the passage. This latter hypothesis is consonant with the findings concerning postquestions and inferential questions. The direction of the influence (forward or backward) of the application questions could not be determined, however, from the Watts and Anderson (1971) study.

A subsequent study (McGaw & Grotelueschen, 1972) clarifies the issue concerning the direction (forward or backward) of the effect of inserted questions. These investigators examined the direction of the facilitative effect of questions inserted at intervals in prose material. They varied the distance of information in the passage from the inserted questions, and the relationship between the information tested by the inserted questions and the information tested by the criterion test items. It was found that inserted questions had a forward effect which shaped appropriate inspection behaviors. It was suggested that this forward

effect was mediated through increased attentiveness as evidenced by the superior performance on pages immediately after adjunct questions. A backward review effect also seemed to operate because subjects performed well on those items on the criterion test which referred to information near to the information referred to by the inserted questions (relevant material). It was concluded that the facilitation of the adjunct questions on prose recall probably resulted from the memory search, or prompted review, initiated by these questions.

The forward and backward effects of question placement can be examined in terms of the prose processing model discussed earlier (Fraser, 1975). When a test-like question is presented after reading, it is held in short-term memory and activates associated material in long-term store (both text material and previously learned material). This is then transferred to short-term memory where the content is rehearsed, and general performance is facilitated. In contrast, a question presented before reading would enter short-term memory and activate associated material in long-term memory--but only prior, narrow associations would be activated. During reading, material entering short-term memory is enhanced only if it is associated with this initially activated material, resulting in question-specific facilitation only. In conclusion, the types of questions placed in text material, and the position and frequency of questions in text, affect learning strategies and outcomes.

Issues similar to those investigated through the use of adjunct questions have also been explored with learning objectives. The types of learning objectives and their position in textual material can be as varied as the dimensions of adjunct questions that have been studied.

The investigation of the role of objectives, or directions, in modifying learning activities and outcomes is important for both theoretical and practical reasons. In a theoretical sense, noting how learning directions affect performance can supply clues to the nature of the covert processing activities that readers engage in. In a practical sense, objectives as well as other adjunct aids, may prove useful for directing students' attention to relevant information, for encouraging students to concentrate and think about what they read, and for long-term retention of information. However, before adjunct aids can be used effectively and efficiently in instructional settings it is necessary that the theory on which their functional properties are based be further clarified and elaborated. The following section describes and evaluates experiments with objectives which address some major theoretical and practical issues.

Objectives as adjunct aids. Instructional objectives in a variety of forms have proven to be effective in directing the reading behaviors of learners. The major consistent finding in this regard is that objectives or learning directions enhance intentional (objective-relevant) learning (Kaplan, 1973; Kaplan & Rothkopf, 1973; Rothkopf & Kaplan, 1972; Frase & Kreitzberg, 1975). The use of instructional objectives as orienting directions which specify intentional, or relevant, content (content to be learned) is analogous to the use of directions in Postman's (1964) Type II incidental learning studies (Rothkopf & Kaplan, 1972). In the Type II design, subjects are given orienting tasks (a set of instructions describing what to do with the materials) in conjunction with lists of words or nonsense syllables. These tasks direct the

subjects' attention to aspects of the tasks which do not involve remembering the list of words per se. Recall of the words involves incidental learning. Since much natural memory is likely to be incidental, Postman's designs may be viewed as providing important data concerning memory processes. Hyde and Jenkins (1973) have extended the range of tasks used by Postman to include semantic, graphic, and syntactic orienting tasks, and have found that semantic tasks result in the highest recall and the greatest amount of clustering of stimulus words in recall.

In general, the objectives used in prose learning studies direct the learner to relevant material (as defined by the investigator); objectives of this form serve the same purpose as unanswered questions which influence the learner's inspection behaviors and subsequent performance. It is likely that questions or objectives used as orienting stimuli might function through causing the learner to selectively attend to the objective-relevant material (Fraser, 1972). The manner in which objectives are stated can have an impact on these attentional behaviors and ultimately on the degree of relevant and incidental learning.

One study in this area (Rothkopf & Kaplan, 1972) examined intentional and incidental learning in terms of the density of relevant information in the text and the specificity with which the objectives were stated. Density was defined as the proportion of sentences in a text that were relevant to at least one instructional objective. The investigators tested the possibility that high-density mapping of objectives on text may limit the likelihood that any single objective is achieved. The study also explored the role of specificity of objectives

in determining both relevant and incidental learning. Each specific objective was relevant to only one text sentence, whereas broad or general objectives were relevant to several. An example of specific directions would be, "Learn about the Roman type-face. Learn about the Gothic type-face." An example of a general direction would be, "Learn about type-face."

It was found that more intentional learning resulted from specific rather than broad objectives, but incidental learning was not affected by this factor, and that increases in density of instructional objectives resulted in decreases in the likelihood that any intentional item was learned, but did not affect incidental learning. In general, intentional learning was greater than incidental learning. Overall performance (both relevant and incidental learning) was higher when instructional goals were explicitly described than when "learn everything" directions were given.

It will be recalled that, with reference to the specificity dimension, Frase (1968c) had found that specific prequestions enhanced overall prose recall more than did general questions. The investigator suggested that this unpredicted finding resulted from the lack of clarity of the general questions in terms of the text information that they mapped on to and from the subsequent loss of precise control over the learners' reading behavior. With specific questions there was an increased probability that the learners would meaningfully encode all stimuli.

That loss of control over the subjects' covert activities can result from the use of general questions as adjunct aids was supported by

the Rothkopf and Kaplan (1972) study in which general learning directions were less effective than specific directions. It should be noted that incidental learning was not adversely affected by specific instructions. Even though learners selectively attended to the objective-relevant content of the passage, incidental learning was still higher in this group than in the control group. Thus it seems that specific directions are mathemagenic positive because they allow for precise control over the learners' attentional and processing activities without sacrificing the acquisition of some incidental information. However, there was a methodological problem in that specific learning directions were very similar to the posttest questions. Thus the superior performance of the specific group might have been partially due to the positive transfer from adjunct aid to posttest items rather than from the orienting power of the learning objectives. This problem is dealt with in a later study (Frase & Kreitzberg, 1975). The results of the Rothkopf and Kaplan (1972) study were useful in generating a number of follow-up studies using objectives in various forms.

The purpose of one such follow-up study (Kaplan & Rothkopf, 1973) was to replicate the previous experiment with an extended range of text lengths and densities of objective-relevant text components, in order to determine whether the number of relevant sentences in the text and the ratio of relevant sentences to the total number of sentences in the text could influence the likelihood of mastering any given objective. Another goal of the study was to determine whether the specificity and number of objectives could affect the amount of time used for studying the text. The materials and procedures were analogous to those employed in Rothkopf

and Kaplan (1972).

As in the previous study, specific objectives resulted in greater intentional learning than generally stated objectives, and the likelihood of mastering any given objective (intentional learning) decreased with density. However, this latter finding was not related to passage length although longer passages resulted in a decrease in incidental learning. As expected, study time increased with the number of objectives and with passage length. The investigators concluded that when instructional objectives are made known to students with reading assignments, learning may be optimized.

The findings of Rothkopf and Kaplan (1972) were replicated again, with another dimension of the objective variable manipulated. In this study (Kaplan, 1974a) the manner of presentation of the objectives was varied so that one group received the entire list of objectives in conjunction with the passage whereas another group received a passage that was interspersed with objectives. In this latter condition, the objective lists were divided into thirds for part presentation, and the passages were divided into corresponding segments. Thus inspection of the passage and corresponding objective segments was permitted. The results indicated that the part presentation facilitated the learning of intentional items more than did the whole presentation, and the part presentation did not decrease incidental learning. In addition, more study time was used for part presentations, longer passages, specific objectives, and larger densities.

This investigation was extended by a further study (Kaplan, 1974b) which added the dimension of type of response (overt or covert)

demanded by the adjunct aid. It will be recalled that in the studies on adjunct questions, overt responses are often required whereas in the studies on objectives, the responses are usually covert. Kaplan (1974b) found that with respect to intentional, or relevant, learning, there was no difference between covert and overt responding; as for incidental learning, overt responding was inferior to covert responding, especially when objectives were interspersed. In addition, more time was required for overt responding. The lack of a significant difference between overt and covert responding is important because it indicates that orienting instructions are followed equally when subjects verbalize or simply think of their answers. The fact that overt responses resulted in less incidental learning than covert responses is an indication that the subjects in the overt group were more strongly constrained to direct their inspection behaviors to learning the relevant material. This conclusion was supported by the greater amount of time the overt subjects required to complete the task. According to the investigator, this time was not efficiently used since incidental learning was low.

Another study in this series (Kaplan & Simmons, 1974) compared the effect on prose learning of instructional objectives as orienting stimuli with their effect as a summary or review. The investigators also varied the amount of information contained in each set of objectives. For example, an objective without information would be, "Learn how many years 75% to 100% Rag paper will last." An example of an objective which contains the relevant text information necessary to answer test questions about those objectives would be, "Learn that 75% to 100% Rag paper will last 30 to 40 years."

Kaplan and Simmons (1974) paid particular attention to the inspection behaviors that each type and position of objective would elicit. The no objective control group was expected to read nonselectively, giving equal attention to each text sentence, the outcome being equal performance on material that was used to measure relevant and incidental learning for the treatment groups. Objectives without relevant information (presented with the text) were expected to elicit a search strategy which involved partial repetition (the objective is repeated as part of the text sentence), search (searching the text for relevant sentences), and selection (focusing attention on objective-relevant text sentences). It was expected that this group's intentional learning would exceed that of the control while incidental learning would be less than that of the control. The group with the most information in the objectives (presented with the text) was expected to equal the control group in relevant learning but be inferior to the control in incidental learning. The reasoning behind this hypothesis was that the processes of search and repetition in this treatment group would not be operative as they were in the group whose objectives did not contain relevant text information. The subjects would adopt only a selection strategy. When objectives were presented after the text, they were expected to function in much the same way as postquestions. The more information contained in the objectives, the higher the learning was expected to be. The results of this study confirm the predictions. The findings of this study imply that giving objectives before the text which serve as directional cues and giving objectives after the text which contain review information would result in more learning than giving either type of objective alone because of

the advantages of the search and selection strategies elicited by adjunct objectives and review and repetition. However, these advantages might be offset by the increased time spent studying the adjunct aids and inefficient presentation of the text to be mastered. Again, as Peeck (1970) points out, it is possible that when adjunct aids require large amounts of inspection time, this time may have been spent equally well on studying the text alone.

In the series of studies just described which was generated by the Rothkopf and Kaplan (1972) study, the problem mentioned earlier concerning the similarity between the specifically stated objectives and the posttest items corresponding to objective-relevant text information was not eliminated. In the replications of this study (Kaplan, 1974a, 1974b; Kaplan & Rothkopf, 1973; Kaplan & Simmons, 1974) there is the possibility that the superiority of the specific over general objectives was a result of a direct correspondence between the objectives and posttest items. This problem is dealt with, however, in an investigation of the effects of topical and indirect learning directions on prose recall (Fraser & Kreitzberg, 1975).

This investigation included a condition in which direct reference to sentences was avoided by phrasing the learning directions in both a positive and a negative form. For instance, imagine a two-sentence passage composed of sentences A and B. A positive learning direction would be, "Learn the information in sentence A." A negative direction would be, "Learn the information in the sentence other than sentence B." In this way, the level of recall for sentences which were never explicitly identified could be compared with the level of recall when those sentences

were referred to directly and thereby avoid the possibility of positive transfer between objectives and test items.

A second difference between the objectives in this study and the Rothkopf and Kaplan (1972) study concerned how the directions were phrased. In the Rothkopf and Kaplan study, there were more specific learning directions than there were general directions. However, the two sets of directions referred to the same number of sentences. In the Frase and Kreitzberg (1975) study, general learning directions were thought of in a semantic sense where general implies the topic of the sentence, and specific refers to some particular unique nonsemantic cue in the same sentence. These general directions were called topical directions and the specific directions were called word directions. For such learning directions, there would be an equal number of directions when referring to sentences in a specific or general way. The consequences of these two different types of references to information in a text should be readily apparent in recall. Positively stated specific objectives should result in high relevant learning because the subjects' search activities are clearly directed to objective-relevant information. Topical reference, however, does not allow for such selective text inspection because the subjects must find the relevant information by searching the semantic information in the text. In doing so, incidental learning in this group might be elevated. Furthermore, test items did not correspond to learning directions. This was especially the case for the word directions group.

The study clearly demonstrated that facilitation and inhibition of learning occurred, but only when words in the learning directions

matched words in the sentences. Word directions, both positive and negative, apparently function by selecting, for the reader, clear cues which allow the control of reading/study activities in specific ways. For positive directions, they signal where to study, but they do not directly signal where not to study. In the case of negative directions, the sentence cues signal where not to study, but they do not signal, directly, where to study. Some control over the reader's learning behaviors is lost in regard to the sentences that are not directly referred to in the learning directions. These results are consistent with the findings of Rothkopf and Kaplan (1972), who found that specific directions (that refer to individual sentences) led to higher recall than did general directions (that referred to several sentences). In short, the results of the Frase & Kreitzberg (1975) study suggest that verbal directions achieve more effective control over learning processes if they refer specifically to words occurring in a text. It has been proposed that the phenomenon of intentional forgetting is related to efficient remembering (Bjork, 1968; 1970).

Intentional forgetting. Intentional forgetting was examined in a series of studies by Bjork (1968, 1970). The experiments demonstrated that information no longer needed can be prevented from interfering proactively with the handling of new information. In a series of paired-associate experiments, Bjork (1970) demonstrated that subjects could take advantage of a signal (a nonsemantic cue) to forget some or all of the pairs of words presented prior to the signal. Not only did they forget the items they were cued to forget, but these forgotten items did not interfere at all with the recall of the to-be-remembered pairs.

The effect was so strong that Bjork (1970) proposed a theory of intentional forgetting which postulates that learners organize the remember items into a grouping that functionally separates them from the forget items, and subsequently, devote all rehearsal and review activities following the forget instruction to the remember items.

More recently, other investigators have confirmed that intentional forgetting is a memory aid. In one study (Burwitz, 1974) instructions to forget prior motor responses significantly reduced proactive interference, although the to-be-forgotten prior items were not completely "discarded"; they were recalled as well as to-be-remembered items. In another study (Woodward, Park, & Seebom, 1974) a list of explicit forget items were far less likely to intrude into immediate recall or delayed recall due to differential rehearsal.

It is possible that such an intentional forgetting strategy was operative in the word-negative directions group of the Frase and Kreitzberg (1975) study. The word-negative directions served to define a text signal or nonsemantic cue (like Bjork's signal) to ignore the incidental information or to forget it. A nonsemantic cue, in this context, is a signal which indicates or pinpoints which information to learn or not to learn without providing any information as to the meaningful content of the information. A nonsemantic cue in text could be underlining, highlighting, or reference to the first words of sentences to be studied. Nonsemantic cues and their effect on learners' inspection behaviors and learning outcomes will be considered in the present study.

In conclusion, the effects of learning directions on learning strategies and outcomes are analogous to those of questions placed in

text. The specificity dimension is important in both types of adjunct aids (questions and learning directions) in terms of gaining control over the information to be learned. In addition, telling a learner which information not to learn can affect strategies and retention.

Summary of Major Theoretical Issues

The two lines of research reviewed in this paper (retroactive interference, and the use of adjunct aids in instruction) have been treated as separate issues in the educational research literature. The present study brings these issues together. The purpose of this study is to examine how instructional objectives modify the effects of retroactive interference in prose retention. In order to examine this interaction, the processes of interference and prose learning must be understood. However, the literature reviewed reveals that the mechanisms underlying interference and prose learning are neither completely understood nor agreed upon.

The phenomenon of retroactive interference has been studied with both nonprose and prose materials. It remains unclear whether response competition, unlearning, or a combination of both is responsible for the interference effect. Comparing the studies on this issue is not always feasible because of the varying methodologies and materials used. According to Ausubel (1963), retroactive interference is a phenomenon that does not exist when information is learned in a meaningful way. Only unstable information which remains unintegrated with what the learner already knows is susceptible to response competition or unlearning. Bower (1974), however, has shown that retroactive interference can occur with prose materials if the prose passages and the posttest items

are operationally defined in terms of their content and structure.

Rothkopf's concept of mathemagenic behaviors has been central to the use of adjunct aids in modifying learning and retention from prose. Recently, Frase (1975) has developed a model of the information processing sequence involved in learning from written materials which has helped to clarify the research on the mathemagenic concept, or more broadly speaking, attentional processes. This model can be used to relate the meaningful learning process as described by Ausubel (1963) as well as the less semantically oriented mathemagenic behaviors described by Rothkopf (1970).

The use of questions, learning directions, and objectives as adjunct aids has also contributed to pinpointing the processes involved in prose learning, including the orienting and review behaviors of learners which can be modified by the placement and type of adjunct aid. The effects of specific versus general directions and direct versus indirect reference to text information have been reviewed and will be further considered in the present study. The phenomenon of intentional forgetting discussed by Bjork (1970) is relevant to understanding how telling a learner what not to learn will affect his processing of prose material.

How these theoretical issues relate to the present study will become clear once the hypotheses of the study are stated. They are presented in the next section.

CHAPTER II

PURPOSE OF THE PRESENT STUDY AND HYPOTHESES

As stated earlier, the two lines of research reviewed in this paper, although they have traditionally been treated as separate issues, will be brought together in the present study. The purpose of this study is to examine how learning directions modify the effects of retroactive interference in prose recall.

Investigations of RI in prose retention (Anderson & Myrow, 1971; Bower, 1974; Crouse, 1971; and Myrow & Anderson, 1972) have demonstrated that RI can be a major cause of forgetting. The implication of this finding for instruction is clear. Students are consistently confronted with new, unfamiliar information in the form of text material and are frequently tested for factual retention. It is probable that before students can understand and integrate new information, these new learnings will be susceptible to the effects of retroactive interference. If there were a way of decreasing the forgetting caused by interference, students could learn more efficiently (without constant repetition and cramming) and teachers could devote more class time to developing new topics and less time to rehashing already presented information. The research on the use of learning directions (or instructional objectives) in guiding learners' inspection behaviors when reading text material seems to offer at least a partial solution to this problem. It has been experimentally demonstrated (e.g., Kaplan & Simmons, 1974) that

instructional objectives have the power to direct a learner's attention and processing activities and thereby determine which information in text will be remembered and which will not. It has also been shown (Bjork, 1970) that a nonsemantic cue which signals a learner to intentionally forget information will cause the signaled information to be forgotten to such an extent that it might not interfere with subsequent information.

The hypotheses which will be tested in the present study are:

1. The learning of relevant material will be greater than the learning of incidental material for subjects who receive learning directions with their first reading passage. For subjects who do not get directions with passage one, there will be no difference between relevant and incidental learning (as defined by the set of learning directions given to the other subjects). This effect is necessary in order to test the major questions of this study.

2. A second passage will interfere with the retention of a previously learned passage when the second passage contains competing information. The second passage will not interfere with the retention of the first passage if the second passage is neutral. This is a replication of studies by Bower, 1974; Anderson and Myrow, 1971, and others. This effect is also necessary to test other hypotheses of this study,

3. Nonsemantic cues in the forms of positively and negatively stated learning directions (analogous to those developed by Frase and Kreitzberg [1975]) will have a significant influence on a learner's processing activities such that information from a second passage, which is similar but conflicting to the original, will not be able to interfere with the direction-relevant information from the first passage. An

example of a nonsemantic cue is the following: Learn the information in the sentence which begins, "Payton was" The cue signals which sentences to learn without providing any information as to the meaningful content of the sentence.

Although the effects of inserted questions on retroactive inhibition in meaningful verbal learning has been investigated (Walker, 1974), these effects have not been dealt with in terms of the concept of mathemagenic behaviors. The third hypothesis is actually an attempt to test the strength of learning directions in the face of interference. Whether learning directions affect memory and processing in a mathemagenically positive or negative way on an immediate recall test is important to know. It is also important to know if learning directions strengthen and control learning to the extent that text information referred to by these directions will be retained (1) after an interfering passage is studied, and (2) one day later.

4. Nonsemantic cues in the forms of positively and negatively stated learning directions, when used in conjunction with a second interfering reading passage, will have a significant influence on a learner's processing activities such that direction-relevant information from the second passage interferes with corresponding information from the first whereas incidental information from the second passage does not have an interfering effect.

This hypothesis provides another way of looking at the effectiveness of learning directions. According to the early work in retroactive interference, when information is overlearned or emphasized, it acquires greater interfering power than if it is learned to a less stringent

criterion. In this study, direction-relevant information will presumably be better learned than incidental information if past findings are replicated (e.g., Rothkopf & Kaplan, 1972; Frase & Kreitzberg, 1975). In addition, incidental learning will be lower than the control group, and relevant learning will be higher than the control. Thus, the third hypothesis tests whether direction-relevant information, since it is more readily acquired than incidental information, is also more stable and will therefore endure after interference. Hypothesis four tests whether direction-relevant information, if it conflicts with what has already been learned, has the power, through retroactive interference, to cause the previously learned information to be forgotten, either through response competition or response unavailability.

5. Positively stated learning directions will be significantly more effective than negatively stated directions (when given in conjunction with the first passage) in counteracting the effects of retroactive interference.

If past findings concerning the effects of positive and negative learning directions are replicated (Frase & Kreitzberg, 1975), then negative directions will suppress incidental recall, and positive directions will result in high relevant recall. It is therefore hypothesized that before original learning (in position one) positive directions will be more effective than negative directions in counteracting interference because of the magnitude of relevant learning which occurs with this type of learning direction.

6. Retention will not decrease over a one-day period. If no new information is learned which might interfere with information learned

under experimental conditions, there is no reason to believe that there will be a learning loss on the following day. In fact studies with adjunct aids have shown that retention can increase on a delayed test because the high arousal level caused by the unfamiliar experience of having adjunct aids with text decreases over time and results in higher later performance (Natkin & Stahler, 1969).

7. Intrusion errors (giving the interfering answer rather than the correct answer due to response competition) will increase over time due to response competition for all interference groups. However, these intrusions may take the place of omitted responses or wrong answers from the immediate recall test rather than taking the place of previously correct answers.

Ausubel (1963, 1968) postulates that newly learned information, if it does not become integrated with the learner's store of knowledge, will be unstable and susceptible to confusion with similar information. The interfering passage is designed to make the information in the criterion passage unstable, and thus response confusion may result.

It is likely that response competition will be more clearly demonstrated on the multiple-choice test than on the fill-in test since one of the alternatives for each multiple-choice item is the interfering answer. It has been demonstrated (VanMondfrans et al., 1973) that the type of test given affects the mechanism of interference operative at a given time.

Two experiments were performed to test these hypotheses.

CHAPTER III

EXPERIMENT 1: PILOT STUDY

In order to test the seven hypotheses, the following variables were to be manipulated: 1) type of learning direction--positive or negative, 2) position of learning directions--before first passage or before second passage, 3) interference--present or absent, and 4) type of delayed posttest--cued recall or multiple-choice.

A pilot study was conducted before the main investigation for three reasons: 1) to try out the experimental materials on a relatively small sample of subjects in order to clarify ambiguities in the instructions and to insure that the procedures were efficient, 2) to determine the amount of time that subjects need to complete all aspects of the experiment, and 3) to investigate whether underlining relevant text sentences aids in remembering them.

Method

Subjects

Sixty Trenton State College freshmen were randomly assigned to experimental conditions. About half of the subjects were male. The students participated in the study as part of their class activities.

Materials

Prose passages. Three prose passages adapted from Crouse⁷ (1971) were used. Two of these have been demonstrated by Crouse (1971) to produce retroactive interference. The third passage was neutral (i.e., did not interfere with the recall of information in either of the other two passages). The two interfering passages had the same structure and format but differed in their detailed information. The first few sentences of each passage are illustrative. See Appendix A for the complete passages.

From Payton passage:

John Payton was one of the finest poets England has ever known. Payton was born in Northshire at the end of October, 1810. His father was a servant who worked in the nearby town of Blackrock.

From Fowler passage:

Robert Fowler was one of the finest poets England has ever known. Fowler was born in Hampstead at the end of October, 1795. His father was a blacksmith who worked in the nearby town of Newland.

The third passage described the fictitious island of Karisoon and has been demonstrated (Crouse, 1971; Bower, 1974) to be neutral, in terms of interference, with regard to the Payton and Fowler passages. Each passage was 12 sentences in length.

There were two orders in which the reading passages could be presented: Payton first or Fowler first.

Learning directions. Two types of learning directions were constructed. Subjects who received learning directions received only one

⁷The author wishes to thank James Crouse for permission to use his experimental materials in this investigation.

set for which half the sentences in the passage were relevant, and for which the remaining sentences were incidental. In this way, the incidental and relevant information to be recalled could be counterbalanced within learning conditions.

The two types of learning directions were:

1. Positive--"Learn the information in all of the sentences which begin as follows. . . ."

2. Negative--"Learn the information in all of the sentences except those which begin as follows. . . ."

For these directions, the first three or four words in the relevant sentences were given in the learning directions. The directions were given as a list, in the order in which the information occurred in the text. The reasons for selecting these two types of learning directions were: 1) they have previously been demonstrated to exert strong control over a learner's attending and processing activities and thus to discriminate between relevant and incidental learning in their functioning as nonsemantic cues (Fraser & Kreitzberg, 1975), and 2) the investigation of directions to forget or ignore (negative) has useful theoretical (intentional forgetting hypothesis) and practical (teacher directions) value.

There were two sets of learning directions constructed for each reading passage which was to be accompanied by learning directions--two sets of parallel learning directions so that the information which was relevant for some subjects was incidental for others.

Posttests. A completion recall test was constructed for each interfering passage in which factual recall of the text material was required. The items on the recall tests were scrambled so that every subject received the items in a different order. A multiple-choice test was given to all the subjects the next day. Each question on this test had five alternatives--the correct answer, the interfering answer, "none of these," and two neutral choices. The test items were designed in such a way that although facts from either the Payton or Fowler passage would seem plausible, only the facts contained in the criterion passage were correct responses. See Appendix A for the posttests.

Procedure and Design

There were seven groups of subjects--four experimental groups and three controls. The groups were as follows:

1. positive directions before passage one where passage two is interfering: P1;
2. positive directions before passage two where passage two is interfering: P2;
3. negative directions before passage one where passage two is interfering: N1;
4. negative directions before passage two where passage two is interfering: N2;
5. no directions before either passage (0), to demonstrate the interfering effect;
6. positive directions before passage one where passage two is neutral, to examine the effects of time on relevant and incidental

learning without deliberate interference: P1'; and

7. no directions before either passage, where passage two is neutral (O') to examine the effect of time on general learning without deliberate interference.

Thus, there were seven different groups of subjects: P1, P2, N1, N2, O, P1', and O'.

Experimental materials were presented to the subjects in a written, text format. These materials were in envelopes that were marked with large numerals indicating the sequence in which they were to be opened. Learning directions were available during study of the passage for those Ss who received them. Table 2 summarizes the experimental groups, the control groups, and the dependent measures used in the design of this study.

Groups P1, N1, and P1' were given a set of learning directions with passage one. They were then given a cued recall test on passage one. Then they were given passage two without any learning directions. For group P1', passage two was neutral, but for groups P1 and N1 it was interfering. Then a second cued recall test on passage one was given. A day later, a third (delayed) test on passage one was administered. This was a multiple-choice test.

The procedure for groups P2 and N2 was the same except that these subjects received learning directions with passage two, but no learning directions with passage one.

Group O was treated in the same way as the other groups in terms of presentation of passages and recall tests. However, this group received no learning directions for either passage. Group O' was treated

Table 2
Experimental Design

		Interference					No Interference	
		P1 ^a	P2 ^b	N1 ^c	N2 ^d	O ^e	P1' ^f	O' ^g
Test 1 (learning)	R ₁							
	I ₁							
Test 2 (learning after treatment)	R ₂							
	I ₂							
Test 3 (delayed retention)	R ₃							
	I ₃							

^aP1 = positive objectives before passage 1.

^bP2 = positive objectives before passage 2.

^cN1 = negative objectives before passage 1.

^dN2 = negative objectives before passage 2.

^eO = no objectives before either passage.

^fP1' = positive objectives before passage, where passage 2 is noninterfering or neutral.

^gO' = no objectives before either passage where passage 2 is noninterfering or neutral.

Note. Relevant learning (R₁, R₂, and R₃) is defined as the percentage correct of those test items which correspond to the learning directions developed for the passage they accompany. Incidental learning (I₁, I₂, and I₃) is defined as the percentage correct of those test items which do not correspond to the learning directions developed for the passage they accompany.

in the same way as group 0 except that passage two was neutral. For all groups except groups P1' and 0', passage two was interfering.

All subjects were told to learn the information in the sentences referred to by the learning directions for the passages which were accompanied by learning directions. For the passages not accompanied by learning directions, subjects were told to learn as much information as they could. When learning directions were given, subjects were permitted to look at them along with the text. Half of the subjects were told to underline (in the text) the information to which the list of directions referred, and half were told not to write on the experimental materials. Sufficient time was given for all subjects to complete all aspects of the experiment.

Analysis

The data in the pilot study were analyzed with a priori t-tests. When comparing the performance of subjects within one group on the various posttests, a t-ratio of means for correlated samples was used. When comparing subjects across groups, a t-ratio of means for independent samples was used (Ferguson, 1959). Since there was an unequal number of subjects in each condition, the formulas for the t-tests were appropriately adjusted.

Results

The results concerning the effects of learning directions on the retention of relevant and incidental material support previous findings (Fraser & Kreitzberg, 1975) in that relevant learning with positive directions (70%) was higher than incidental learning (30%);

$t(12) = 2.85, p < .01$. Relevant learning with negative directions (57%) was higher than incidental learning (22%); $t(14) = 2.23, p < .025$. For subjects with no directions, relevant (71%) and incidental (69%) did not differ from each other. Unlike previous findings (Frase & Kreitzberg, 1975), relevant learning in the positive condition was not higher than the control mean. The finding that relevant learning was higher than incidental learning for groups which received learning directions with their first reading passage supports the first hypothesis.

There was no difference between underlining and no underlining groups when all subjects were compared overall and within each experimental condition. The underlining variable was, therefore, not manipulated in the main investigation. All subjects were instructed to underline.

There was a tendency toward interference when passage two was designed to contain information which conflicted with passage one, but the effect was not significant. Two factors which may account for the absence of a strong interference effect were: the small sample size, and the fact that the subjects were not prevented from rehearsing the information from passage one and were thus able to compare this information to the new information contained in passage two. These two factors were controlled for in the main investigation.

The pilot study results concerning the major hypotheses of the thesis were quite tentative due to the small sample size of the groups. Therefore, the results concerning the interactions between learning directions and retroactive interference will be reported for the main study only.

Hypothesis six, that retention will not decrease over a one-day

period, was confirmed. However, since the test given the next day was multiple-choice (and the tests on the previous day were cued recall) it was not possible to separate the effect of time from the test effect. This factor was controlled for in the main investigation.

Intrusion errors were not calculated for the pilot study. Thus hypothesis seven is dealt with only in the main investigation.

The pilot study indicated that none of the interactions of interest would be confounded in the design. In other words, the order of passage presentation (Payton first or Fowler first) and the objective set used did not affect learning.

The results of the pilot will be discussed more fully after the main investigation is reported.

CHAPTER IV

EXPERIMENT 2: MAIN INVESTIGATION

The main investigation was conducted to test the seven hypotheses stated earlier.

Method

Subjects

Two hundred forty-seven New York City high school sophomores and juniors were randomly assigned to experimental conditions. About one-fourth of the subjects was male. The students participated in the study as part of their class activities.

Materials

The prose passages and learning directions used in the main investigation were the same as those used in the pilot study.

Posttests. The cued recall tests used in the main investigation contained the same items as those used in the pilot study. However, instead of scrambling the order of the items of the test, two forms of each test were constructed. The sample in the main investigation was too large to permit everyone to receive a test in scrambled order each time a test was given. Rather than giving all subjects a multiple-choice test on the following day, half the subjects took a multiple-choice the following day while half the subjects took another cued recall test. In

this way, the effect of time alone on learning could be analyzed separately from the effects of a multiple-choice test.

Procedure and Design

The procedure and design of the main investigation were the same as those for the pilot study with the following exceptions. First, all subjects in the main investigation were instructed to underline relevant text information. Since underlining did not affect learning in the pilot study, it was felt that the subjects in the main investigation should be allowed the freedom to underline. Second, an irrelevant activity was interposed between the posttest on passage one and the studying of the second passage. This was done in order to insure that the subjects could not rehearse the information from passage one while examining the second passage. Third, time allotments were specified for each task of the experiment as follows: 7 minutes for studying the first passage, 5 minutes for test one, 8 minutes for an irrelevant activity, 7 minutes for studying the second passage, 5 minutes for test two, and 5 minutes for test three (the following day). The amount of time required to complete each task was determined in the pilot study. A time constraint had to be imposed in the main investigation because a high school class period was under 40 minutes.

A fourth difference between the pilot study and the main investigation involved the design. A fractional factorial design was used in the main investigation (see Cochran & Cox, 1960). In this design, two variables (the order of presentation of passages and the use of parallel objective sets) were partially counterbalanced instead of fully

counterbalanced. These two variables may be considered design variables rather than experimental variables since they were manipulated for the purpose of control rather than to confirm or disconfirm a hypothesis. Since the pilot study indicated that none of the interactions of interest (between learning directions and interference) would be confounded in this design due to order effects, the two design variables mentioned above were not completely counterbalanced in the main investigation. This procedure results in greater efficiency because as the number of factors in a 2^n design increases, the number of separate groups needed for complete counterbalancing becomes quite large. Therefore, since the pilot study indicated that the two design variables did not affect learning differentially, there was no need to fully counterbalance these variables in the design of the main investigation.

Analysis

One-way analyses of variance were performed which compared the performance of all groups on the following dependent measures: relevant learning on test one, incidental learning on test one, relevant learning on test two, incidental learning on test two, relevant learning on test three, incidental learning on test three, loss of relevant information from test one to test two and from test two to test three, loss of incidental information from test one to test two and from test two to test three. Repeated measures of one-way analyses of variance were performed on the within-group data in order to determine the differences in relevant and incidental learning within a group, and the differences in learning on tests one, two, and three within a given group. Appendix C

contains the analysis of variance tables.

An extensive series of Scheffé tests was then performed in order to test specific interaction effects which bear on the experimental hypotheses. A significance level of $p < .10$ was acceptable as the alpha level for the Scheffé tests. Because the Scheffé procedure is more conservative than other procedures, it will lead to fewer significant results. In order to compensate for the conservative nature of these tests and to increase their power, Scheffé (1959) recommends that the .10 level may be used instead of the .05 level. When using the Scheffé procedure, large F values do not always indicate a high level of significance. The F values reported in the Results correspond to the observed F in the overall analyses of variance, not to the subsequent Scheffé analyses, unless otherwise stated.

Proportions were converted by an arc sine transformation before analyses were performed.

Homogeneity of variance tests were performed in order to insure that the population variances did not differ significantly from equality.

Results

Basic Assumptions Concerning the Learning of the Criterion Passage

Before examining the results pertaining to the effects of learning directions on retroactive interference, it is important to note the results concerning the basic assumptions underlying the study. That is, any interaction found between learning directions and interference can be meaningfully understood only if the effects of learning directions alone

and the effects of retroactive interference alone are operative.

As shown in Table 3, for Ss who were given learning directions (positive or negative) with passage one, relevant learning was significantly higher than incidental learning on test one; for positive directions, $F(3, 78) = 14.29, p < .01$; for negative directions, $F(3, 105) = 6.22, p < .01$. For Ss who did not receive directions with passage one, relevant and incidental learning (that is, the learning of sentences in passage one corresponding to relevant and incidental sentences of groups receiving directions) did not differ significantly. This finding is consistent with the literature (Fraser & Kreitzberg, 1975; Rothkopf & Kaplan, 1972) and confirms hypothesis one that predicted that the learning of relevant material will be greater than the learning of incidental material for subjects who receive learning directions with their first reading passage.

Table 3

Mean Percent Correct on Cued Test One for Subjects with Positive, Negative, and No Learning Directions with Passage One (Criterion Passage)

Type of Recall	Condition		
	Positive	Negative	No Directions
Relevant	48.1	41.6	59.1
Incidental	24.4	31.1	59.7
	N = 64	N = 36	N = 147

The level of learning of the control group (No Directions group

in Table 3) was approximately at the level obtained in other experiments (Rothkopf & Kaplan, 1972).

Unlike the Frase and Kreitzberg (1975) study, the negative directions in this study did not suppress incidental learning to a greater degree than did positive directions; in fact, the incidental recall of the negative Ss was slightly higher than that of the positive Ss, but not significantly. The difference in relevant learning on test one for these two conditions was also not significant.

Also, unlike several previous studies on the effects of learning objectives in which relevant learning in the experimental groups was equal to, and in some cases higher than, learning in the control condition (e.g., Frase & Kreitzberg, 1975), relevant learning in the groups with learning directions with passage one was significantly lower than learning in the no directions groups; $F(6, 240) = 27.01, p < .01$.

To summarize, the present study showed that the learning directions produced higher relevant recall than incidental recall, but that learning with directions was actually lower than learning with no directions. This latter finding is especially important and has recently been found by other investigators (Shavelson, Berliner, Loeding, Porteus, & Stanton, 1974). Some possible explanations for this effect will be considered in the discussion section.

To calculate the results bearing on retroactive interference, the scores on posttests were converted in the following way before being converted by an arc sine transformation:

$$\frac{(\text{Score on test 1} - \text{Score on test 2})}{\text{Number of test items}}$$

Hypothesis two was confirmed, thereby replicating the effects of retroactive interference in prose recall (Crouse, 1971). Table 4 shows that for Ss whose passage two was designated as interfering, there was more loss of relevant ($F(6, 239) = 11.15, p < .01$) and incidental ($F(6, 239) = 13.90, p < .01$) information than for Ss whose passage two was designated as neutral. This result supports previous findings (Bower, 1974). In fact, the results indicate no loss for the noninterference groups.

Table 4
Mean Percent Correct on Cued Test 1 and Cued Test 2 for
Subjects with No Learning Directions

	Recall	Condition	
		Interference	No Interference
Test 1	Relevant	60.0	53.7
	Incidental	62.1	56.2
Test 2	Relevant	53.5	57.3
	Incidental	51.9	57.0

N = 74 for each mean.

Since the design used for this study is a fractional factorial design, there was the possibility of confounding the higher-order interaction effects (as described by Cochran & Cox, 1957, and Winer, 1971). Specifically, there was the possibility of confounding the type of learning direction, the position of learning directions, the set of learning

directions with the order of presentation of the reading passages. However, there was no evidence that such confounding existed. Comparisons of subjects, in the same experimental condition, who differed only in which set of parallel learning directions was used, revealed no significant differences; neither did comparisons of subjects who differed only in the order in which the interfering prose passages were read (Payton passage first or Fowler passage first). In addition, the pilot study (see previous chapter) indicated that there were no interaction effects which confounded the critical results. Thus, the results of this study can be considered free from confounding.

In addition, tests for homogeneity of variance revealed that the population variances did not differ significantly from equality.

Having shown evidence to support the basic underlying assumptions of this study--that the learning directions do direct learning, that the interfering passages do produce learning loss, that the design is not confounded, and that there is homogeneity of variance--it is appropriate to present the results pertaining to the effects of learning directions on retroactive interference.

The Retention of the Criterion Passage Following a Second Passage

There was no initial difference between interference and no interference groups (that is, prior to the presentation of a second reading passage). However, the retention scores on test two reveal that although interference groups without directions performed more poorly in comparison to noninterference groups without directions, interference groups with learning directions accompanying the criterion passage did not

differ significantly from noninterference groups with learning directions accompanying the criterion passage. This means that learning directions had a facilitative effect in terms of counteracting interference when these directions accompanied the criterion passage. Table 5 summarizes these findings. In Table 5, note that for the interference condition, scores for both relevant and incidental recall decrease when no directions were given (for relevant learning loss, $F(6, 239) = 10.34$, $p < .001$ (Scheffé, $p < .01$) for incidental learning loss, $F(6, 239) = 7.01$, $p < .008$ (Scheffé, $p < .01$). When directions were given, however, there was no significant learning loss for either relevant or incidental material.

Table 5

Mean Percent Correct on Cued Test 1 and Cued Test 2 for Interference and No Interference Subjects, with and without Learning Directions Accompanying the Criterion Passage (Passage One)

Recall		Condition			
		Interference		No Interference	
		Directions	No Directions	Directions	No Directions
Test 1	Relevant	44.0	60.0	48.9	53.8
	Incidental	29.0	62.1	22.7	56.2
Test 2	Relevant	40.6	53.5	48.1	57.3
	Incidental	26.4	51.9	25.8	57.0
		N = 64	N = 37	N = 36	N = 37

The only significant learning loss from test one to test two occurred in the interference groups without directions. The no interference groups gained slightly, but not significantly, from test one to test two. Since there were no differences in either initial learning or in learning loss between positive direction and negative direction groups (i.e., directions accompanying criterion passage), these groups were combined in Table 5.

Although Ss who received directions with the criterion passage did not exhibit interference, there was no difference between relevant and incidental loss for these groups. In other words, hypothesis three (that the drop in recall of relevant material would be less than the drop in recall of incidental material for those groups with directions with passage one) was not supported by the data.

As for the groups that received learning directions with the interfering passage (passage two), there were significant differences in the effects of negative and positive learning directions. Although there was no differential loss in relevant and incidental retention from test one to test two for positive groups, there was such a loss for negative groups. Subjects who received negative learning directions with their interfering passage experienced a greater loss of learning for sentences in passage one corresponding to incidental material than for relevant material; $F(3, 108) = 4.61, p < .01$ (Scheffé, $p < .10$) for incidental loss. Consequently, the relationship between relevant and incidental retention changed from test one to test two for interfered Ss with negative directions. Table 6 reveals that although there was no difference between relevant and incidental learning on test one for interfered Ss

who received negative directions with passage two, relevant retention was higher than incidental retention on test two, after interference; $F(3, 108) = 4.61, p < .01$ (Scheffé, $p < .01$).

Table 6

Mean Percent Correct on Cued Test 1 and Cued Test 2 for Subjects Who Received Learning Directions with the Interfering Passage

Recall		Condition	
		Positive Directions	Negative Directions
Test 1	Relevant	60.0	62.7
	Incidental	62.2	58.3
Test 2	Relevant	56.6	60.0
	Incidental	62.5	52.9

It was hypothesized that greater relevant than incidental loss would occur after interference for interference groups which received directions with passage two. However, as discussed above, with positive directions there was no differential loss; and with negative directions the differential loss was the reverse of the predicted loss. Thus, hypothesis four was not supported by the data. These unanticipated outcomes will be considered in the discussion section.

In addition, positively stated learning directions were not significantly more effective than negatively stated directions in

counteracting the effects of retroactive interference regardless of the position of the directions. Thus, hypothesis five was not supported by the data.

The Retention of the Criterion Passage the Following Day

For subjects whose test the following day (test three) was a cued recall test, there was no change in retention, except for subjects who had negative directions with the criterion passage. In this condition although incidental retention did not increase significantly from test two (29%) to test three (32%), it increased enough in order to not be significantly lower than relevant learning on test three (38%). This change in the relationship between relevant and incidental learning scores from test two to test three could have occurred because incidental learning was initially low, due to the experimental manipulation.

For subjects whose test the following day (test three) was multiple-choice, there was generally higher performance, apparently due to the nature of the test. In fact, relevant and incidental scores were elevated equally from test two to test three for all experimental and control groups, except for Ss who received negative directions with the criterion passage. Table 7 summarizes these results. Table 7 shows that the multiple-choice test resulted in facilitated performance (overall) for six of the seven conditions. For group N1, however, the increase in incidental scores was greater than the increase in relevant scores; $F(5, 75) = 7.35, p < .01$ (Scheffé, $p < .05$).

All Ss whose test three was multiple-choice had higher relevant scores on test three than on test one, except the interference Ss who

Table 7

Levels of Significance of the Increase in Relevant and Incidental Scores from Cued Test 2 to Test 3 (Multiple-Choice) for all Conditions

Condition	Relevant Increase			Incidental Increase		
	<u>F</u>	df	<u>p</u> <	<u>F</u>	df	<u>p</u> <
Interference						
P1 (positive directions with passage one)	17.96	5, 6	.05	15.78	5, 6	.10
P2 (positive directions with passage two)	33.24	5, 13	.01	21.94	5, 13	.05
N1 (negative directions with passage one)	ns			22.22	5, 10	.05
N2 (negative directions with passage two)	54.44	5, 13	.01	71.11	5, 13	.01
0 (no directions)	27.84	5, 12	.01	16.28	5, 12	.05
No Interference						
P1' (positive directions with passage one)	58.66	5, 14	.01	48.48	5, 14	.01
0' (no directions)	27.70	5, 12	.01	13.27	5, 12	.10

Note. The values reported in this table refer to the results of Scheffé tests performed after the overall ANOVA.

received positive or negative learning directions with passage one and the interference Ss with no directions at all. Table 8 summarizes the levels of significance of the differences in relevant and incidental scores from test two to test three for Ss whose test three was multiple-choice. Table 8 shows that all noninterference Ss had higher test three scores in

both relevant and incidental performance. As for the interference Ss, only those who received learning directions with passage two showed an increase in relevant performance. The interference Ss with no learning directions did not show an increase in either relevant or incidental performance from test one to test three, a result which indicates that not having learning directions was a disadvantage to the interfered Ss.

These increases from test two to test three and from test one to test three for Ss whose test three was multiple-choice were most likely due to test effects rather than to the effects of time or experimental manipulations. This is supported by the fact that there were no significant increases from test one to test three or from test two to test three for Ss whose test three was cued recall. Thus, the multiple-choice test, as a vehicle for measuring change, is not appropriate. However, the results from the multiple-choice test provide evidence that retrieval suppression may exist when cued recall is required. This conclusion will be considered in the discussion section.

The means which were compared in order to compute the F values displayed in Tables 7 and 8 are shown in Table 9. Table 9 shows that the relationship between relevant and incidental retention changed for interfered Ss who received negative directions with passage one. The superiority of relevant over incidental recall due to the learning directions which this group experienced on tests one and two no longer existed on test three because the significant increase in incidental retention for this group was not accompanied by an increase in relevant retention. The incidental information from the criterion passage may have been learned well enough for recognition, but not for recall.

Table 8

Levels of Significance of the Increase in Relevant and Incidental Scores from Cued Test 1 to Test 3 (Multiple-Choice) for All Conditions

Condition	Relevant Increase			Incidental Increase		
	<u>F</u>	<u>df</u>	<u>p</u> <	<u>F</u>	<u>df</u>	<u>p</u> <
Interference						
P1 (positive directions with passage one)	ns			ns		
P2 (positive directions with passage two)	21.94	5, 13	.05	21.94	5, 13	.05
N1 (negative directions with passage one)	ns			32.00	5, 10	.01
N2 (negative directions with passage two)	31.60	5, 13	.01	24.19	5, 13	.05
0 (no directions)	ns			ns		
No Interference						
P1' (positive directions with passage one)	48.48	5, 14	.01	69.81	5, 14	.01
0' (no directions)	53.11	5, 12	.01	19.83	5, 12	.05

Note. The values reported in this table refer to the results of Scheffé tests performed after the overall ANOVA.

The scores on the test three multiple-choice test were significantly higher than the scores on the test three cued recall test. Table 10 summarizes all test three scores so that a comparison of the recognition and recall measures can be made. Table 10 shows that there was a significant difference in both relevant and incidental performance for all

conditions (except for interfered Ss who received positive directions with passage two) when comparing performance on a recognition as opposed to a recall measure. Recognition performance was higher than recall performance.

Table 9

Mean Percent Correct on Cued Tests One and Two, and Test Three (Where Test Three is Multiple Choice) for Subjects in Every Condition

Recall		Condition						
		Interference					No Interference	
		P1	P2	N1	N2	0	P1'	0'
Cued Test 1	Relevant	48	59	41	62	58	53	54
	Incidental	32	62	28	58	65	29	62
Cued Test 2	Relevant	40	56	46	57	51	51	59
	Incidental	28	62	32	48	54	33	64
Multiple- choice Test 3	Relevant	56	53	72	78	68	73	72
	Incidental	43	52	75	72	67	53	73
		N=16	N=16	N=19	N=19	N=18	N=20	N=18

Note. The scores reported in this table are based on the data of only those subjects who received a multiple-choice Test 3.

conditions (except for interfered Ss who received positive directions with passage two) when comparing performance on a recognition as opposed to a recall measure. Recognition performance was higher than recall performance.

In summary, the multiple-choice test seems to have allowed for a general increase in performance, with the exceptions noted above. Hypothesis six (that retention will not decrease over a one-day period) was supported by both the recall and recognition data.

Table 10

Mean Percent Correct on Test 3 Comparing Multiple-Choice and Cued Recall Measures for Subjects in Every Condition

		Interference					No Interference	
		P1	P2	N1	N2	0	P1'	0'
Test 3 (multiple-choice)	Relevant	56	53	72	78	68	73	72
	Incidental	43	52	75	72	67	53	73
Test 3 (cued recall)	Relevant	45	55	38	58	59	49	57
	Incidental	22	55	32	57	56	15	51

Intrusion Errors

Intrusion data were collected for all interference Ss. Intrusion errors involving relevant and incidental information were higher on test three than test two generally when test three was multiple-choice. Table 11 shows which groups experienced the greatest increase in intrusion errors and the levels of significance of these increases. As shown in Table 11, the Ss who did not have an increase in intrusion errors were the Ss who received learning directions with passage one. All other interference groups experienced an increase in intrusions in either relevant, incidental, or both kinds of information.

Table 11

Levels of Significance of the Increase in Intrusion Errors from Cued Test Two to Test Three (Multiple-Choice) for Interfered Subjects

Condition	Relevant Increase			Incidental Increase		
	<u>F</u>	df	<u>p</u> <	<u>F</u>	df	<u>p</u> <
P1	ns			ns		
P2	23.53	3, 48	.01	ns		
N1	ns			ns		
N2	33.33	3, 45	.01	36.51	3, 45	.01
O	42.14	3, 48	.01	18.74	3, 48	.01

Note. The values reported in this table refer to the results of Scheffé tests performed after the overall ANOVA.

Only one group had an increase in intrusion errors where test three was cued recall, rather than recognition. This group received positive directions with passage one; $F(3, 30) = 5.47, p < .01$.

Generally, except for Ss with positive directions with passage one, increases in intrusion errors were a function of the multiple-choice test three, where each item contained the intrusion answer as an alternative. Thus, hypothesis seven, which predicted that intrusion errors would increase over time, was supported by some of the cued recall data, and by much of the multiple-choice data (which entail test item differences which are not exclusively related to changes across time).

Table 11 also reflects that, except for the interfered Ss who received positive directions with passage two, there was no difference between the degree of increase in relevant and incidental intrusions from

test two to test three for any group.

Further analyses revealed that Ss who received directions with passage two, particularly positive directions, had more relevant and incidental intrusions on test two than the other interference groups; $F(4, 169) = 2.78$, $p < .02$ (Scheffé, $p < .05$) for relevant; $F(4, 169) = 4.14$, $p < .003$ (Scheffé, $p < .01$) for incidental. Appendix C contains the analysis of variance tables derived from comparing all groups on relevant and incidental intrusions on test two, and from comparing the increase in relevant and incidental intrusions from test two to test three.

CHAPTER V

DISCUSSION

The present study brings together many theoretical and practical issues in the field of psychology. The concept of mathemagenic behaviors, although considered by some (Barry, 1974) to have developed in isolation, can be integrated into the broader context of psychological theory. Aside from its theoretical importance, the mathemagenic concept has implications for curriculum and instruction. Before discussing these issues, however, the results of the present study will be summarized.

Summary of Results

The main investigation of this study confirms hypotheses one, two, six, and seven; the data do not support hypotheses three, four, and five.

Hypothesis One

This hypothesis stated that the learning of relevant material would be greater than the learning of incidental material for subjects who receive learning directions with their first reading passage, and that no such difference would exist for subjects who did not receive learning directions with their first reading passage.

Both the pilot study and the main investigation confirm this hypothesis. Unlike previous studies, however, relevant learning in the groups with learning directions with passage one was significantly lower

than learning in the no directions groups.

Hypothesis Two

This hypothesis predicted that passage two would interfere with the retention of passage one when passage two was designed to contain competing information, and that passage two would not interfere with the retention of passage one when passage two was neutral.

The pilot study results were in the direction of confirming this hypothesis, and the main investigation supports this hypothesis with significant interference effects.

Hypothesis Three

This hypothesis predicted that learning directions would have a significant influence on a learner's processing activities that such information from a second passage, which is similar but conflicting to the original, will not be able to interfere with the direction-relevant information from the first passage.

Although learning directions had a facilitative effect in terms of counteracting interference when these directions accompanied the criterion passage, direction-relevant information was retained as well as direction-irrelevant information. Thus, this hypothesis was not supported by the data.

Hypothesis Four

This hypothesis stated that learning directions would have a significant influence on a learner's processing activities such that direction-relevant information from the second passage interferes with corresponding information from the first, whereas incidental information

from the second passage does not have an interfering effect.

This hypothesis was not supported by the data. Subjects with positive directions with the interfering passage experienced no differential learning loss. Subjects with negative directions with the interfering passage had greater incidental, rather than relevant, learning loss after interference.

Hypothesis Five

This hypothesis predicted that positively stated learning directions would be significantly more effective than negatively stated directions (when given in conjunction with the first passage) in counteracting the effects of interference.

Hypothesis five was not supported by the data. Positively stated learning directions were not significantly more effective than negatively stated directions in counteracting the effects of retroactive interference regardless of the position of the directions.

Hypothesis Six

This hypothesis predicted that retention would not decrease over a one-day period. This hypothesis was confirmed. Subjects who received a multiple-choice test rather than a cued recall test as their test three had significantly higher relevant and incidental scores, most likely due to the test effect. The processes involved in recall and recognition are not the same, and therefore the test results do not indicate changes in retention over one day.

Hypothesis Seven

This hypothesis predicted that intrusion errors would increase over time due to response competition for all interference groups.

Intrusion errors did increase for one group on cued recall tests, and for most groups when test three was multiple-choice. Since each multiple-choice item contained an interfering response as an alternative, response competition was stimulated. This increase in intrusions was due to differences in test performance rather than a memory change.

In summary, although the basic assumptions underlying this study were confirmed (hypotheses one and two), the interactions predicted between learning directions and retroactive interference (hypotheses three and four) did not occur. The implications of the results will be discussed by considering the outcome of each hypothesis.

Theoretical Implications of Results

The present study touches upon some major issues in the fields of prose learning and information processing. The question of what happens to a piece of written material between the time the learner is presented with it and the time the learner answers questions based on the material is not fully answered by theoreticians or researchers at the moment. Thus the question of how to optimize memory, or understanding, of written materials is not fully answered either. Research on optimizing memory has focused on the behaviors learners engage in when they are confronted by text. Studies on these learner behaviors led Frase (1975) to develop a model of prose processing which attempts to describe the processing mechanisms involved when a student tries to learn text material.

According to this model, some aspects of the text will be processed more fully than others, depending on the orienting directions given, and the motivation and prerequisite knowledge of the learner. In the present study, directions were given which focused the learner's attention to relevant text sentences; other directions focused the learner's attention away from incidental information. In the case of positive directions, according to the model, the directions had a selective effect in that more relevant than incidental information was selected for encoding. Once encoded, this relevant material was rehearsed, sequentially. That is, a sentence was encoded and then held in short-term memory where it was rehearsed; as sentence one was being held and rehearsed, sentence two was being encoded. After rehearsal, if enough overlearning occurred, ideas in long-term memory would be retrieved and compared to the newly acquired information, and this would aid memory. The two key elements are encoding and rehearsal, because this is where the selective effect of the learning directions has its greatest impact. The directions determined what will be encoded and therefore, what will be rehearsed. Of course, rehearsal determines what will be remembered. Thus, when a learner's attention is directed through the use of a cue to certain parts of a text and not to others, the relevant aspects of the text will undergo a process which the incidental aspects of the text will not. This model helps to clarify, therefore, the outcome of hypothesis one-- that relevant learning was higher than incidental learning for subjects who received learning directions with passage one.

However, the present study had an unanticipated outcome with respect to learning directions. Subjects with learning directions had

lower posttest scores than subjects in the control condition. Thus instead of having a mathemagenic positive effect, the learning directions had a mathemagenic negative effect. Other investigators have recently found that adjunct questions can have a negative effect on learning (Shavelson et al., 1974). The materials used by Shavelson et al. (1974) included a 104-page textbook on precision teaching and applied concepts of operant conditioning to classroom teaching. The book was required reading for the subjects in their educational psychology courses. Shavelson et al. (1974) found that control group scores (no adjunct aid) were higher than treatment group scores (adjunct aids were given). The investigators discuss several possible explanations for this negative effect of adjunct questions: 1) subjects may possess effective strategies for prose processing which were interfered with when adjunct questions were given, and 2) control group subjects may have had to work harder than other groups without the support of adjunct questions. No final conclusion was drawn as to why a negative effect was found.

There are various possible explanations for the negative effect of learning directions found in the present study. First, the population used in this study was somewhat younger (high school students as opposed to college students) than many subject populations in this area of research. Perhaps learning directions are not as effective for younger subjects. A second reason is that the brevity of the reading passages used may have made the addition of learning directions unnecessary, or even interfering. As in the Shavelson et al. (1974) study, it may be that learners possess adequate processing strategies, especially with simple material, and that instead of enhancing learning, learning

directions inhibit natural learning strategies and result in depressed performance. In other words, the adjunct aid may limit encoding and rehearsal activities rather than enhance them. In terms of Frase's (1975) model, lower level activities (e.g., searching for information in a text) may contribute little to memory. A third reason for the negative effect is that specific transfer between learning directions and posttest items was not possible. Past studies (Rothkopf & Kaplan, 1972) allowed for transfer between objectives and posttest questions in that similar wording was used to elicit both the use of the adjunct aid and the answering of posttest items. In the present study, the learning directions did not map on to the posttest items in an obvious manner.

Another interpretation concerning the negative effect of the learning directions is that they interfered with the potential meaningfulness of the learning passage by forcing the learner to focus on sentences which were not logically connected. This interpretation supports the relation component of Frase's (1975) model. The learning directions may have interfered with the processes which would normally facilitate the transfer of new information to long-term memory. A related possibility is that portions of text may be mutually supportive for recall. Limiting text inputs could reduce this conceptual base.

Hypothesis two dealt with the phenomenon of retroactive interference. Interference effects were found in the present study. The mechanisms underlying interference are not agreed upon, but several models for short-term memory have been proposed to explain how interference works. Bjork (in Norman, 1970) summarizes these models which describe how items are represented in memory and how interfering items

affect recall of original items. In model one, as a result of presentation, a memory trace is established to a momentary maximum strength sufficient to result in perfect immediate recall. During interference, trace strength decreases with time. Each subsequent presentation both reinstates the trace to the maximum momentary strength and increases the resistance of the trace to interference. In model two, the first presentation of an item results in a copy of the item being stored in memory. With each subsequent presentation of the item, there is some probability that an additional item is stored in memory. During each unit of interfering time, any one copy in memory is, independent of other copies, lost from memory with some probability. If one or more copies of the item are in memory at the time of recall, the item is recalled; if no copies are in memory, there is no recall. According to model three, an item is at any point in time in exactly one of three states: not in memory, in short-term memory, or in long-term memory. If it is not in memory, it is not recalled. If it is in either short- or long-term memory, it is recalled. Items in long-term memory are safe from interference. Items in short-term memory are lost in an all-or-none fashion with some probability during each unit of interfering time. The third model described by Bjork (1970) is similar to the model described by Frase (1975).

Thus the model of memory representation used to describe the fate of text material will determine how the mechanism of rehearsal is interpreted. According to model one, rehearsal increases the strength of a single memory trace; according to model two, rehearsal increases the number of traces of an item; according to model three, rehearsal facilitates a change from short-term memory to long-term memory in the state of

the item. A further question is whether rehearsal of the item in short-term memory (model three and the Frase model) has the same effect as repetition of the stimulus. Both of these processes somehow increase the memory of an item; rehearsal increases memory of an item the longer it is rehearsed and repetition increases memory through the number of presentations of the item. In terms of interference, the greater the rehearsal or repetition of an item, the greater its resistance to interference. This is why the present study hypothesized that items reinforced in passage one (through the use of learning directions) would resist interference and that items reinforced in passage two (through the use of learning directions) would cause interference. These were the third and fourth hypotheses of the study. These hypotheses, however, were not supported by the data.

It has already been stated that although the learning directions did distinguish between relevant and incidental information, they did not facilitate relevant performance as expected. Without this facilitation, the learning directions did not have reinforcing power; they had selective power only. Therefore, relevant information was no more resistant to interference than incidental information. In terms of information processing, more relevant than incidental information was selected for encoding, but rehearsal strategies did not favor relevant over incidental information. When learning directions were given with passage two, they did not reinforce the relevant information in that passage to the extent necessary for causing forgetting of related information in passage one. In fact, the subjects who received negative directions with an interfering passage experienced more incidental than relevant loss. In other

words, the information in the second passage which subjects were told not to learn seems to have caused the interference. Unfortunately, the learning of the second passage was not tested. A test of this kind would have revealed which information from the passage was learned and which was not learned. This would have provided a clearer picture of which information in passage two caused the interference of incidental information in passage one.

The fifth hypothesis stated that positive learning directions would be more effective than negative learning directions in counteracting interference, but this was not the case in the present study. In the past (Frase & Kreitzberg, 1975) negative learning directions have resulted in suppressed incidental recall, and positive learning directions have resulted in high relevant recall. Therefore, the present study predicted that positive directions would be more powerful than negative directions in reinforcing text information to the extent necessary to counteract interference. Due to the unanticipated outcome regarding the negative effect of learning directions, positive directions did not work differently from negative directions in counteracting interference. A question which should be investigated in future studies concerning the use of negative learning directions is whether they work because of an attentional mechanism or a memory mechanism. That is, is material not to be learned ignored, forgotten, suppressed, or unavailable for retrieval? According to Bjork (1970), learners segregate to-be-remembered items from to-be-forgotten items and can intentionally forget items that would have caused interference had they been remembered. In prose learning, however, the stimulus situation is more complex than it is in list learning tasks.

Instead of storing items with a to-be-forgotten tag, items may be screened out long before they are stored. Items not to be learned may never be encoded; they may be encoded but not rehearsed; they may be inadequately encoded; they may be inadequately rehearsed. In order to investigate the effect of negative directions, the wording and placement in the text of these directions will be important.

The sixth and seventh hypotheses of the present study were confirmed, although tests of these hypotheses have a weaker experimental status than other hypotheses. Hypothesis six accepts the null hypothesis as evidence, and hypothesis seven is consistent mainly with data that are complicated by test item differences (cued versus multiple-choice tests). Retention did not decrease over a one-day period whether the test given the next day was cued recall or recognition. Intrusion errors due to response competition were high when the test given was multiple-choice. It has been found (VanMondrans et al, 1973) that whether response competition or response unavailability (unlearning) is operative in an interference situation depends on the type of test used. Multiple-choice tests, when one alternative for each question is the competing response, bring out response competition; cued recall tests result in response unavailability. Performance in the present study depended on the type of test given. This is because these two types of tests place different demands upon the learners' processing. According to Kintsch (in Norman, 1970) there are major differences in the processes of recall and recognition and in the variations in stimulus material which affect these processes. First, intention to learn improves recall considerably, but is irrelevant for recognition. Recognition is a fairly

automatic process, but efficient recall presupposes an active, intentional process. Secondly, interitem relationships play an important role in recall, but for recognition, each item may be considered separately. Thus, interference has more serious consequences for recall than for recognition. Third, the difference between recall and recognition is a function of how well integrated the stimulus material is. The better the integration, the less the superiority of recognition over recall. Because of partial recognition, one can recognize an item by recognizing only a small, characteristic part of it; recall of only a part of an item is usually insufficient to reconstruct the whole item. Thus, there is more guessing on a recognition test. In terms of interference, if only a small part of an item is necessary for recognition, the competing response will be selected over a neutral (incorrect) response because it is recognized as familiar. A fourth difference between recall and recognition is that recall involves a search process and recognition does not. In recognition, items are sensorily present and can be judged for their newness. In recall, items must be retrieved from memory, interitem relationships are important, and words to be recalled are embedded in various associations.

In terms of the present study, these differences in recall and recognition processes affected performance and the interpretation of interference. In a recall task, the posttest item is encoded, and the learner must then retrieve the required answer. In a recognition task, the posttest item is also encoded. However, only a small portion of the needed response need be retrieved. This portion can be compared to each alternative encoded from the test list. An alternative is accepted or

rejected on the basis of the comparison between the alternative and the portion of the response which was retrieved from memory. Two alternatives are thus recognized--the correct one, and the competing one. Which alternative is chosen depends on which is more strongly linked to the stem of the item due to factors such as repetition of pairings and degree of interference. That response competition was found to be operative in a recognition test is consistent with Kintsch's (1970) interpretation of the recognition process.

Summary

The outcome of each hypothesis of the present study has implications for theory and research in prose learning and information processing. The question of selecting an appropriate model for the phenomenon of interference or for prose learning in general is still open. The model offered by Frase (1975) and those summarized by Bjork (in Norman, 1970) need further testing and clarification. Some major research questions which require more probing as a result of this and similar studies are: When do learning directions have a mathemagenically negative effect? What learner variables (for instance, age of subjects) are critical for the effective use of such aids? What circumstances and what kinds of adjunct aids can be used to modify interference? How do learning directions affect recall and recognition processes differentially?

Practical Implications of Results

Aside from theoretical value, research on the mathemagenic concept and on retroactive interference has implications for education. Mathemagenic behaviors can be manipulated by the designer of instructional

materials on various levels. Input processes can be controlled through the appearance of the material, its layout, type style, color, and organization. These, in turn, affect encoding. Encoding of materials is also affected by the questions or learning directions accompanying the text material. Encoding, in turn, affects rehearsal and memory transfer. Barry (1974) believes that more efficient text material can be created if adjunct aids are appropriately used. He also sees applications of this research to programmed instruction and to remedial reading. Adjunct aids might benefit poor readers by remedial techniques utilizing mathemagenic positive behaviors. The possibility of mathemagenic negative behaviors suggests cautions in the practical use of such aids.

In the present study, it was believed that adjunct aids could be used to counteract retroactive interference. The practical value of this is to inhibit forgetting of previously learned information. In school settings, memory is an important element of achievement. Thus, finding ways to improve memory and overcome the causes of forgetting will facilitate achievement. The present study revealed a source of interference, presumably due to lower level search. When extensive search is stimulated by learning directions, the efficiency of learning may be disrupted.

More research must be undertaken to further pinpoint the processes involved in encoding of memory for text. Only then will the relationship between adjunct aids and interference be clarified. Such investigations can contribute to advancing the theories underlying memory and processing and will bring us closer to applying findings in this area to school learning situations.

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APPENDIX A

Experimental Materials

The materials used in the main investigation are included in this appendix. They are in the following order:

Instructions

Learning directions

Reading passages (interference and neutral)

Cued tests

Multiple-choice tests

Biographical information sheet

Test attitude survey.

The experimental groups who received the various types of directions are indicated on the bottom line of the directions in abbreviated form. For example, P1 = positive directions with passage 1.

NAME: _____

INSTRUCTIONS

On the last page of this handout you will find a short reading passage. You are to learn some of the information in the reading passage. To find which information we want you to learn look at the list on the next page. The list tells you which sentences in the reading passage you should learn. The list will direct you to learn approximately half of the sentences in the reading passage. Since the list is in the same order as the information in the reading passage (except some sentences are skipped) you won't have to waste time looking for the sentences we want you to learn.

Be sure that you study all of the information in the sentences that are on the list. Some of the sentences contain several facts.

You may look at the list along with the reading passage. If you find it helpful, pull the pages apart and look at the list and the reading passage side by side.

It is important that you underline the information in the passage which the list refers to. This will be helpful to you.

You will have 6 minutes to study the passage. If you finish before the 6 minutes are up, go back to the beginning and study the passage again (according to the instructions stated above).

Do not waste any of the 6 minutes. It is very important that you really learn the information which you are asked to learn.

NAME: _____

INSTRUCTIONS

On the last page of this handout you will find a short reading passage. You are to learn some of the information in the reading passage. To find which information we want you to learn look at the list on the next page. The list tells you which sentences in the reading passage you should learn. The list will direct you to learn approximately half of the sentences in the reading passage. Since the list is in the same order as the information in the reading passage (except some sentences are skipped) you won't have to waste time looking for the sentences we want you to learn.

Be sure that you study all of the information in the sentences that are on the list. Some of the sentences contain several facts.

You may look at the list along with the reading passage. If you find it helpful, pull the pages apart and look at the list and the reading passage side by side.

It is important that you underline the information in the passage which the list refers to. This will be helpful to you.

You will have 6 minutes to study the passage. If you finish before the 6 minutes are up, go back to the beginning and study the passage again (according to the instructions stated above). If you still have time left, go back for a third time.

Do not waste any of the 6 minutes. It is very important that you really learn the information that you are asked to learn.

NAME: _____

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INSTRUCTIONS

On the last page of this handout you will find a short reading passage. You are to learn some of the information in the reading passage. To find which information you don't have to learn, look at the list on the next page. The list tells you which sentences in the reading passage not to learn. The list will direct you to learn approximately half of the sentences in the reading passage. Since the list is in the same order as the information in the reading passage (except some sentences are skipped) you won't have to waste time looking for the sentences we want you to learn.

Be sure that you study all of the information in the sentences that you have to learn. Some of the sentences contain several facts.

You may look at the list along with the reading passage. If you find it helpful, pull the pages apart and look at the list and the reading passage side by side.

It is important that you underline the information in the passage which the list refers to. This will be helpful to you.

You will have 6 minutes to study the passage. If you finish before the 6 minutes are up, go back to the beginning and study the passage again (according to the instructions stated above).

Do not waste any of the 6 minutes. It is very important that you really learn the information which you are asked to learn.

NAME: _____

INSTRUCTIONS

On the last page of this handout you will find a short reading passage. You are to learn some of the information in the reading passage. To find which information you don't have to learn, look at the list on the next page. The list tells you which sentences in the reading passage not to learn. The list will direct you to learn approximately half of the sentences in the reading passage. Since the list is in the same order as the information in the reading passage (except some sentences are skipped) you won't have to waste time looking for the sentences we want you to learn.

Be sure that you study all of the information in the sentences that you have to learn. Some of the sentences contain several facts.

You may look at the list along with the reading passage. If you find it helpful, pull the pages apart and look at the list and the reading passage side by side.

It is important that you underline the information in the passage which the list refers to. This will be helpful to you.

You will have 6 minutes to study the passage. If you finish before the 6 minutes are up, go back to the beginning and study the passage again (according to the instructions stated above). If you still have time left, go back for a third time.

Do not waste any of the 6 minutes. It is very important that you really learn the information that you are asked to learn.

NAME: _____

INSTRUCTIONS

On the next page of this handout you will find a short reading passage.

You are to learn all of the information in the reading passage.

You will have 6 minutes to study the passage. If you finish before the 6 minutes are up, go back to the beginning and study the passage again.

Do not waste any of the 6 minutes. It is very important that you learn the passage well.

NAME: _____

INSTRUCTIONS

On the next page of this handout you will find a short reading passage. You are to learn all of the information in the reading passage.

You will have 6 minutes to study the passage. If you finish before the 6 minutes are up, go back to the beginning and study the passage again. If you still have time left, go back to the beginning and study the passage for a third time.

Do not waste any of the 6 minutes. It is very important that you learn the passage well.

NAME: _____

Learn the information in all of the sentences which begin as follows:

1. John Payton was...
2. His father was...
3. When Payton was...
4. Meanwhile, he...
5. In the Spring...
6. After much...

NAME: _____

Learn the information in all of the sentences which begin as follows:

1. Payton was...
2. After the...
3. After four years...
4. However, his...
5. Ten years later...
6. Soon after this...

NAME: _____

Learn the information in all of the sentences except those which begin as follows:

1. Payton was...
2. After the...
3. After four years...
4. However, his...
5. Ten years later...
6. Soon after this...

NAME: _____

Learn the information in all of the sentences except those which begin as follows:

1. John Payton was...
2. His father was...
3. When Payton was...
4. Meanwhile, he...
5. In the Spring...
6. After much...

NAME: _____

Learn the information in all of the sentences which begin as follows:

1. Robert Fowler was...
2. His father was...
3. When Fowler was...
4. Meanwhile, he...
5. In the Spring...
6. After much...

NAME: _____

Learn the information in all of the sentences which begin as follows:

1. Fowler was...
2. After the...
3. After four years...
4. However, his...
5. Two years later...
6. Soon after this...

NAME: _____

Learn the information in all of the sentences except those which begin as follows:

1. Fowler was...
2. After the...
3. After four years...
4. However, his...
5. Two years later...
6. Soon after this...

NAME: _____

Learn the information in all of the sentences except those which begin as follows:

1. Robert Fowler was...
2. His father was...
3. When Fowler was...
4. Meanwhile, he...
5. In the Spring...
6. After much...

NAME: _____

JOHN PAYTON

John Payton was one of the finest poets England has ever known. Payton was born in Northshire at the end of October, 1810. His father was a servant who worked in the nearby town of Blackrock. When Payton was only five years old, his father and mother died of pneumonia. After the death of his parents, Payton was left as the eldest of six orphans, and he was looked after by his uncle. Meanwhile, he was attending a small school at Greenmount where he met Steven Warren who later became a close friend. After four years of apprenticeship, Payton entered Gate's Hospital, Brentford, as a medical student.

However, his ambitions now turned to writing poetry. In the Spring of 1832 he wrote his long poem, Ode To Jupiter. Ten years later, in 1842, his brother Mathew left England and emigrated to Norway. Soon after this, Payton began to suffer from cancer of the lungs and was cared for by his sister Charlotte. After much misery, he died in Geneva on April 12, 1859.

NAME: _____

ROBERT FOWLER

Robert Fowler was one of the finest poets England has ever known. Fowler was born in Hampstead at the end of October, 1795. His father was a blacksmith who worked in the nearby town of Newland. When Fowler was only eight years old, his father and mother died of tuberculosis. After the death of his parents, Fowler was left as the eldest of four orphans, and he was looked after by his grandmother. Meanwhile, he was attending a small school at Enfield where he met James Brock who later became a close friend. After four years of apprenticeship, Fowler entered Thomas's Hospital, Coleridge, as a medical student.

However, his ambitions now turned to writing poetry. In the Spring of 1818 he wrote his long poem, Youth And Love. Two years later, in 1820, his brother George left England and emigrated to France. Soon after this, Fowler began to suffer from heart disease and was cared for by his aunt Grace. After much misery, he died in Rome on February 23, 1823.

NAME: _____

KARISOON

Karisoon is an island off the coast of Brazil. Tuna is the most popular food fish caught in the offshore waters. In addition, fertilizer is manufactured from Menhaden, a nonedible fish. Karisoon has many lakes and rivers in the mountainous northern region. Lake Cadorus, with an area of one hundred square miles, is the largest lake. Good hunting for rabbit is found along these lakes and streams, but in the more remote regions of the island, deer abound. There is a hunting season of four weeks on most game.

Climate variations enable Karisoon to produce a diversity of crops. Tobacco is grown throughout most of the central region of Karisoon. Brahma cattle are raised on the prairie lands west of the capital of Leetown. Karisoon ranks third in the world in the production of phosphate rock. Commercially important clays, like Kaolin, are also found in abundance. Many islanders also work in the clothing factory which was built in 1958.

NAME: _____

CLASS NUMBER: _____ 125

JOHN PAYTON

Instructions: Try to answer every question.

1. What was the name of the friend whom Payton met at school? _____
2. After Payton's parents died he was the eldest of how many orphans? _____
3. What was the name of Payton's long poem? _____
4. How old was Payton at the time of his parents' death? _____
5. Payton served an apprenticeship at a small school in what city in England? _____
6. How did Payton's father earn a living? _____
7. In what city was the hospital in which Payton was a medical student? _____
8. What was the name of Payton's brother who emigrated? _____
9. In what city did Payton die? _____
10. What disease did Payton suffer from? _____
11. Of what did Payton's parents die? _____
12. To what country did Payton's brother emigrate? _____
13. In what year was Payton born? _____
14. After Payton's apprenticeship he entered what hospital as a medical student? _____
15. In what year did Payton die? _____
16. Who took care of Payton before he died? _____
17. In what city was Payton born? _____
18. After Payton's parents died, who looked after him? _____
19. In what year did Payton write a long poem? _____
20. In what town did Payton's father work? _____

NAME: _____ CLASS NUMBER: _____

JOHN PAYTON

Instructions: Try to answer every question.

1. In what city was Payton born? _____
2. How did Payton's father earn a living? _____
3. In what city was the hospital in which Payton was a medical student? _____
4. Of what did Payton's parents die? _____
5. What was the name of the friend whom Payton met at school? _____
6. In what year did Payton die? _____
7. After Payton's parents died, he was the eldest of how many orphans? _____
8. Payton served an apprenticeship at a small school in what city in England? _____
9. What was the name of Payton's brother who emigrated? _____
10. How old was Payton at the time of his parents' death? _____
11. After Payton's apprenticeship he entered what hospital as a medical student? _____
12. What was the name of Payton's long poem? _____
13. In what year did Payton write a long poem? _____
14. After Payton's parents died, who looked after him? _____
15. What disease did Payton suffer from? _____
16. To what country did Payton's brother emigrate? _____
17. In what town did Payton's father work? _____
18. In what city did Payton die? _____
19. In what year was Payton born? _____
20. Who took care of Payton before he died? _____

NAME: _____

JOHN PAYTON

Instructions: Circle the correct answer to each question. Please answer every question. There are 20 questions.

<p>1. To what country did Payton's brother emigrate?</p> <p>A. Spain D. Norway B. France E. None of these C. Holland</p>	<p>6. What was the name of Payton's brother who emigrated?</p> <p>A. George D. Mathew B. Arthur E. None of these C. David</p>
<p>2. In what year did Payton write a long poem?</p> <p>A. 1832 D. 1793 B. 1818 E. None of these C. 1840</p>	<p>7. Payton served an apprenticeship at a small school in what city in England?</p> <p>A. Enfield D. Lennox B. Brooksville E. None of these C. Greenmount</p>
<p>3. In what city was Payton born?</p> <p>A. Ridgewood D. Hampstead B. Northshire E. None of these C. Linnedale</p>	<p>8. How old was Payton at the time of his parents' death?</p> <p>A. two D. eight B. eleven E. None of these C. five</p>
<p>4. How did Payton's father earn a living?</p> <p>A. farmer D. butler B. servant E. None of these C. blacksmith</p>	<p>9. In what year was Payton born?</p> <p>A. 1795 D. 1810 B. 1780 E. None of these C. 1843</p>
<p>5. In what year did Payton die?</p> <p>A. 1806 D. 1859 B. 1750 E. None of these C. 1823</p>	<p>10. In what city did Payton die?</p> <p>A. Rome D. Copenhagen B. Geneva E. None of these C. Lisbon</p>

JOHN PAYTON (continued)

- | | |
|--|---|
| <p>11. After Payton's parents died, who looked after him?</p> <p>A. uncle D. cousin</p> <p>B. grandmother E. None of these</p> <p>C. nurse</p> | <p>16. After Payton's parents died, he was the eldest of how many orphans?</p> <p>A. six D. four</p> <p>B. nine E. None of these</p> <p>C. seven</p> |
| <p>12. What was the name of Payton's long poem?</p> <p>A. <u>Joy Of Spring</u> D. <u>Youth And Love</u></p> <p>B. <u>Hope And Innocence</u></p> <p>C. <u>Ode To Jupiter</u> E. None of these</p> | <p>17. After Payton's apprenticeship he entered what hospital as a medical student?</p> <p>A. Lord's Hospital D. Gate's Hospital</p> <p>B. King's Hospital E. None of these</p> <p>C. Thomas's Hospital</p> |
| <p>13. In what town did Payton's father work?</p> <p>A. Blackrock D. Wingate</p> <p>B. Medeland E. None of these</p> <p>C. Newland</p> | <p>18. Of what did Payton's parents die?</p> <p>A. cholera D. cancer</p> <p>B. pneumonia E. None of these</p> <p>C. tuberculosis</p> |
| <p>14. Who took care of Payton before he died?</p> <p>A. his brother, John</p> <p>B. his sister, Charlotte</p> <p>C. his cousin, Margaret</p> <p>D. his aunt, Grace</p> <p>E. None of these</p> | <p>19. What disease did Payton suffer from?</p> <p>A. heart disease D. malaria</p> <p>B. brain lesion E. None of these</p> <p>C. cancer of the lungs</p> |
| <p>15. In what city was the hospital in which Payton was a medical student?</p> <p>A. Thayerville D. Coleridge</p> <p>B. Southwyke E. None of these</p> <p>C. Brentford</p> | <p>20. What was the name of the friend whom Payton met at school?</p> <p>A. James Brock D. Gregory Foster</p> <p>B. Steven Warren E. None of these</p> <p>C. Elery Grant</p> |

NAME: _____ CLASS NUMBER: _____

ROBERT FOWLER

Instructions: Try to answer every question.

1. What was the name of the friend whom Fowler met at school? _____
2. After Fowler's parents died he was the eldest of how many orphans? _____
3. What was the name of Fowler's long poem? _____
4. How old was Fowler at the time of his parents' death? _____
5. Fowler served an apprenticeship at a small school in what city in England? _____
6. How did Fowler's father earn a living? _____
7. In what city was the hospital in which Fowler was a medical student? _____
8. What was the name of Fowler's brother who emigrated? _____
9. In what city did Fowler die? _____
10. What disease did Fowler suffer from? _____
11. Of what did Fowler's parents die? _____
12. To what country did Fowler's brother emigrate? _____
13. In what year was Fowler born? _____
14. After Fowler's apprenticeship he entered what hospital as a medical student? _____
15. In what year did Fowler die? _____
16. Who took care of Fowler before he died? _____
17. In what city was Fowler born? _____
18. After Fowler's parents died, who looked after him? _____
19. In what year did Fowler write a long poem? _____
20. In what town did Fowler's father work? _____

NAME: _____ CLASS NUMBER: _____

ROBERT FOWLER

Instructions: Try to answer every question.

1. In what city was Fowler born? _____
2. How did Fowler's father earn a living? _____
3. In what city was the hospital in which Fowler was a medical student? _____
4. Of what did Fowler's parents die? _____
5. What was the name of the friend whom Fowler met at school? _____
6. In what year did Fowler die? _____
7. After Fowler's parents died, he was the eldest of how many orphans? _____
8. Fowler served an apprenticeship at a small school in what city in England? _____
9. What was the name of Fowler's brother who emigrated? _____
10. How old was Fowler at the time of his parents' death? _____
11. After Fowler's apprenticeship he entered what hospital as a medical student? _____
12. What was the name of Fowler's long poem? _____
13. In what year did Fowler write a long poem? _____
14. After Fowler's parents died, who looked after him? _____
15. What disease did Fowler suffer from? _____
16. To what country did Fowler's brother emigrate? _____
17. In what town did Fowler's father work? _____
18. In what city did Fowler die? _____
19. In what year was Fowler born? _____
20. Who took care of Fowler before he died? _____

NAME: _____

ROBERT FOWLER

Instructions: Circle the correct answer to each question. Please answer every question. There are 20 questions.

<p>1. To what country did Fowler's brother emigrate?</p> <p>A. Spain D. Norway B. France E. None of these C. Holland</p>	<p>6. What was the name of Fowler's brother who emigrated?</p> <p>A. George D. Mathew B. Arthur E. None of these C. David</p>
<p>2. In what year did Fowler write a long poem?</p> <p>A. 1832 D. 1793 B. 1818 E. None of these C. 1840</p>	<p>7. Fowler served an apprenticeship at a small school in what city in England?</p> <p>A. Enfield D. Lennox B. Brooksville E. None of these C. Greenmount</p>
<p>3. In what city was Fowler born?</p> <p>A. Ridgewood D. Hampstead B. Northshire E. None of these C. Linnedale</p>	<p>8. How old was Fowler at the time of his parents' death?</p> <p>A. two D. eight B. eleven E. None of these C. five</p>
<p>4. How did Fowler's father earn a living?</p> <p>A. farmer D. butler B. servant E. None of these C. blacksmith</p>	<p>9. In what year was Fowler born?</p> <p>A. 1795 D. 1810 B. 1780 E. None of these C. 1843</p>
<p>5. In what year did Fowler die?</p> <p>A. 1806 D. 1859 B. 1750 E. None of these C. 1823</p>	<p>10. In what city did Fowler die?</p> <p>A. Rome D. Copenhagen B. Geneva E. None of these C. Lisbon</p>

NAME: _____

CLASS NUMBER: _____

- AGE: 1. under 16 4. 20 - 25
 2. 16 - 17 5. over 25
 3. 18 - 19

- SEX: 1. male
 2. female

- EDUCATIONAL LEVEL: 1. 9th grade
 2. 10th grade
 3. 11th grade
 4. 12th grade
 5. attending college
 6. college graduate

- ETHNIC BACKGROUND: 1. Black
 2. Hispanic
 3. Oriental
 4. American Indian
 5. other: _____
-

NAME: _____

CLASS NUMBER: _____

TEST ATTITUDE SURVEY (TAS)

Instructions: Answer each of the following questions TRUE or FALSE.
Do not spend too much time on any one question.
Your first reactions are the best.

- _____ 1. If I knew I was going to take an intelligence test, I would feel confident and relaxed, beforehand.
- _____ 2. I sometimes feel my heart beating very fast during important tests.
- _____ 3. I have an uneasy, upset feeling before taking a final examination.
- _____ 4. During exams I sometimes wonder if I'll ever get through school.
- _____ 5. I wish examinations did not bother me so much.
- _____ 6. I really don't see why some people get so upset about tests.
- _____ 7. I don't study any harder for final exams than for the rest of my course work.
- _____ 8. Even when I'm well prepared for a test, I feel very anxious about it.
- _____ 9. Before an important examination I find my hands or arms trembling.
- _____ 10. I seldom feel the need for "cramming" before an exam.

APPENDIX B

Raw Data

The raw data of the main investigation are listed in this appendix. The first four numbers of each row indicate each subject's label. The second four refer to biographical information. Then there are fifteen numbers which are the raw data in the following order:

1. relevant learning--test 1
2. incidental learning learning--test 1
3. total learning learning--test 1
4. number of blanks--test 1
5. relevant learning--test 2
6. incidental learning--test 2
7. total learning--test 2
8. number of blanks--test 2
9. total intrusions--test 2
10. relevant learning--test 3
11. incidental learning--test 3
12. total learning--test 3
13. number of blanks--test 3
14. total intrusions--test 3
15. "none of these" responses--test 3 (multiple choice Ss only)

The scores indicated are based on the number of responses out of a total test of 20 questions. The number "99" indicates missing data.

0101 2122	7.	0.	7.	5.	7.	0.	7.	12.	0.	6.	0.	6.	2.	5.	0.
0105 1221	4.	2.	6.	12.	3.	5.	8.	9.	1.	3.	4.	7.	7.	4.	0.
0106 1222	3.	1.	4.	10.	7.	1.	8.	6.	0.	4.	0.	4.	1.	4.	0.
0108 2232	5.	4.	9.	4.	5.	3.	8.	5.	0.	4.	3.	7.	5.	2.	0.
0109 2235	6.	3.	9.	10.	6.	3.	9.	9.	0.	6.	3.	9.	9.	0.	0.
0110 2231	4.	1.	5.	12.	2.	0.	2.	9.	7.	7.	0.	3.	7.	7.	0.
0111 2231	4.	0.	4.	16.	4.	0.	4.	16.	0.	4.	0.	4.	16.	0.	0.
0112 2231	4.	1.	5.	11.	3.	1.	4.	10.	2.	99.	99.	99.	99.	99.	99.
0113 1232	6.	4.	10.	5.	7.	2.	9.	6.	1.	8.	4.	12.	5.	1.	0.
0116 3123	6.	3.	9.	6.	8.	7.	15.	5.	0.	7.	6.	13.	4.	1.	0.
0118 2132	3.	3.	6.	4.	1.	2.	3.	7.	1.	1.	3.	4.	6.	2.	0.
0119 2232	4.	1.	5.	13.	4.	1.	5.	12.	0.	3.	1.	4.	9.	4.	0.

Total subjects in group was 12.

0201	2221	3.	0.	3.	10.	4.	1.	5.	10.	0.	3.	0.	3.	0.	14.	2.
0202	1222	6.	2.	8.	6.	4.	1.	5.	7.	0.	8.	7.	15.	0.	4.	1.
0203	1221	8.	2.	10.	6.	8.	2.	10.	5.	2.	9.	4.	13.	0.	4.	1.
0204	1232	5.	7.	12.	8.	4.	5.	9.	9.	2.	99.	99.	99.	99.	99.	99.
0205	1221	4.	4.	8.	9.	0.	0.	0.	0.	15.	5.	5.	10.	0.	2.	1.
0207	2233	6.	5.	11.	4.	5.	5.	10.	0.	3.	9.	10.	19.	0.	0.	1
0208	2121	6.	6.	12.	6.	6.	6.	12.	6.	0.	99.	99.	99.	99.	99.	99.
0209	2231	5.	0.	5.	13.	3.	0.	3.	3.	6.	99.	99.	99.	99.	99.	99.
0210	2135	2.	3.	5.	13.	3.	3.	6.	7.	2.	5.	6.	11.	0.	4.	2.
0211	2131	6.	3.	9.	3.	5.	4.	9.	5.	0.	6.	5.	11.	0.	6.	3.
0212	2231	3.	0.	3.	13.	2.	0.	2.	2.	7.	4.	0.	4.	0.	7.	1.
0202	2233	4.	2.	6.	8.	2.	1.	3.	15.	0.	4.	3.	7.	0.	8.	3.
0214	1222	6.	6.	12.	8.	8.	6.	14.	6.	0.	99.	99.	99.	99.	99.	99.
0215	2222	3.	3.	6.	5.	2.	3.	5.	0.	6.	4.	4.	8.	0.	7.	1.
0218	2132	6.	8.	14.	3.	7.	8.	15.	1.	1.	8.	8.	16.	0.	2.	2.
0220	1231	3.	0.	3.	15.	1.	0.	1.	2.	15.	2.	0.	2.	0.	18.	0.

Total subjects in group was 16.

0301	1222	6.	7.	13.	5.	6.	7.	13.	5.	0.	7.	6.	13.	5.	0.	0.
0302	1221	8.	8.	16.	2.	8.	8.	16.	0.	0.	9.	8.	17.	1.	0.	0.
0303	1222	8.	5.	13.	4.	8.	5.	13.	5.	0.	6.	7.	13.	4.	0.	0.
0304	2231	10.	9.	19.	0.	9.	9.	18.	2.	0.	1.	0.	1.	9.	7.	0.
0306	1221	6.	6.	12.	4.	3.	6.	9.	5.	5.	4.	5.	9.	1.	9.	0.
0307	1232	6.	7.	13.	4.	6.	6.	12.	5.	0.	6.	5.	11.	8.	0.	0.
0308	1231	3.	4.	7.	6.	2.	4.	6.	2.	3.	6.	6.	12.	7.	0.	0.
0309	2232	7.	8.	15.	1.	7.	8.	15.	2.	0.	8.	8.	16.	2.	0.	0.
0310	2231	6.	6.	12.	6.	5.	5.	10.	6.	1.	6.	5.	11.	8.	0.	0.
0311	2231	6.	5.	11.	7.	5.	4.	9.	7.	0.	6.	5.	11.	7.	0.	0.
0312	2232	2.	5.	7.	10.	2.	5.	7.	10.	0.	3.	5.	8.	10.	0.	0.
0314	1221	8.	7.	15.	2.	8.	6.	14.	3.	0.	0.	1.	1.	11.	3.	0.
0315	1222	9.	9.	18.	1.	9.	9.	18.	1.	0.	9.	9.	18.	0.	0.	0.
0316	1221	1.	0.	1.	17.	3.	1.	4.	14.	0.	4.	1.	5.	13.	0.	0.
0318	2231	4.	4.	8.	8.	4.	8.	12.	5.	0.	99.	99.	99.	99.	99.	99.
0319	2232	3.	7.	10.	7.	3.	7.	10.	7.	0.	3.	7.	10.	8.	0.	0.
0320	2232	10.	9.	19.	1.	10.	9.	19.	1.	0.	10.	10.	20.	0.	0.	0.

Total subjects in group was 17.

0401	1221	4.	4.	8.	7.	3.	5.	8.	2.	0.	99.	99.	99.	99.	99.	99.
0402	1225	7.	5.	12.	4.	6.	5.	11.	5.	0.	9.	6.	15.	0.	1.	2.
0403	1221	8.	6.	14.	3.	8.	5.	13.	4.	0.	9.	6.	15.	0.	0.	4.
0404	2231	6.	5.	11.	3.	6.	6.	12.	1.	1.	7.	8.	15.	0.	1.	3.
0405	2221	6.	7.	13.	2.	5.	7.	12.	3.	0.	4.	8.	12.	0.	0.	8.
0406	1222	5.	6.	11.	5.	5.	6.	11.	6.	0.	9.	8.	17.	0.	0.	3.
0407	2235	8.	10.	18.	1.	9.	10.	19.	1.	0.	9.	9.	18.	0.	1.	1.
0408	2231	6.	4.	10.	6.	6.	3.	9.	7.	0.	6.	7.	13.	1.	1.	4.
0409	1121	5.	8.	13.	4.	5.	7.	12.	4.	0.	10.	9.	19.	0.	0.	0.
0410	2231	8.	10.	18.	1.	8.	9.	17.	3.	0.	8.	10.	18.	0.	0.	2.
0411	2231	7.	5.	12.	5.	6.	6.	12.	6.	0.	8.	6.	14.	0.	2.	3.
0412	2231	1.	1.	2.	8.	1.	2.	3.	11.	2.	2.	4.	6.	1.	7.	2.
0413	2231	5.	6.	11.	9.	6.	6.	12.	6.	1.	6.	7.	13.	0.	6.	0.
0404	1122	6.	8.	14.	4.	5.	7.	12.	7.	0.	99.	99.	99.	99.	99.	99.
0415	1223	8.	6.	14.	0.	6.	6.	12.	0.	0.	8.	7.	15.	0.	0.	5.
0416	1221	6.	9.	15.	5.	5.	9.	14.	5.	1.	5.	10.	15.	0.	4.	1.
0418	2132	6.	7.	13.	4.	7.	7.	14.	2.	1.	9.	7.	16.	0.	3.	0.
0419	2231	7.	7.	14.	5.	5.	7.	12.	1.	1.	8.	10.	18.	0.	1.	0.
0420	2231	4.	4.	8.	7.	4.	5.	9.	7.	0.	5.	6.	11.	0.	5.	4.

Total subjects in group was 19.

0501	1222	1.	0.	1.	16.	0.	0.	0.	18.	0.	1.	0.	1.	19.	0.	0.
0502	2221	2.	3.	5.	15.	1.	3.	4.	13.	1.	1.	0.	1.	7.	10.	0.
0503	1222	5.	2.	7.	6.	4.	3.	7.	8.	1.	5.	1.	6.	7.	1.	0.
0504	2231	7.	8.	15.	0.	6.	7.	13.	0.	2.	6.	7.	13.	1.	1.	0.
0505	1221	7.	2.	9.	9.	4.	3.	7.	10.	0.	5.	2.	7.	8.	0.	0.
0506	1222	2.	0.	2.	16.	1.	0.	1.	11.	7.	0.	0.	0.	14.	6.	0.
0507	2231	9.	3.	12.	5.	9.	3.	12.	6.	0.	9.	3.	12.	6.	0.	0.
0508	2235	6.	8.	11.	4.	7.	5.	12.	3.	0.	7.	5.	12.	5.	0.	0.
0509	1221	7.	0.	7.	7.	6.	0.	6.	5.	2.	4.	1.	5.	14.	11.	0.
0510	2131	4.	4.	8.	7.	3.	5.	8.	11.	0.	3.	4.	7.	8.	2.	0.
0511	2221	2.	4.	6.	9.	1.	3.	4.	1.	13.	3.	5.	8.	2.	8.	0.
0512	2232	2.	0.	2.	4.	1.	0.	1.	16.	1.	1.	0.	1.	9.	8.	0.
0513	2231	6.	7.	13.	6.	6.	5.	11.	6.	0.	5.	6.	11.	4.	0.	0.
0514	1223	7.	5.	12.	4.	7.	4.	11.	4.	1.	6.	7.	13.	3.	0.	0.
0515	1222	7.	7.	14.	5.	6.	6.	12.	7.	0.	8.	8.	16.	4.	0.	0.
0516	1221	4.	3.	7.	11.	5.	2.	7.	10.	0.	2.	4.	6.	10.	2.	0.
0517	1121	2.	3.	5.	5.	2.	3.	5.	13.	0.	3.	3.	6.	12.	0.	0.
0518	2231	0.	2.	2.	14.	0.	0.	0.	9.	11.	1.	1.	2.	12.	2.	0.
0519	2231	3.	4.	7.	7.	3.	4.	7.	5.	0.	2.	6.	8.	6.	0.	0.
0520	2231	2.	2.	4.	11.	3.	2.	5.	12.	0.	3.	1.	4.	7.	3.	0.

Total subjects in group was 20.

0601 1221	4.	0.	6.	11.	4.	2.	6.	9.	1.	6.	5.	11.	0.	3.	3.
0602 1223	6.	4.	10.	5.	6.	4.	10.	4.	0.	9.	7.	16.	0.	1.	2.
0603 1222	6.	3.	9.	6.	0.	0.	0.	0.	20.	6.	4.	10.	0.	0.	8.
0604 2234	4.	1.	5.	11.	5.	2.	7.	8.	0.	5.	6.	11.	0.	4.	1.
0605 1222	4.	1.	5.	15.	3.	1.	4.	8.	7.	3.	2.	5.	3.	11.	0.
0606 1221	1.	2.	3.	10.	11.	11.	2.	11.	1.	3.	7.	10.	0.	4.	2.
0607 2231	0.	3.	3.	13.	1.	3.	4.	8.	2.	3.	5.	8.	0.	8.	1.
0608 2231	4.	3.	7.	9.	3.	4.	7.	8.	0.	3.	4.	7.	2.	6.	3.
0609 1222	0.	5.	5.	13.	4.	4.	8.	10.	0.	4.	8.	12.	1.	2.	4.
0610 2221	6.	4.	10.	6.	7.	3.	10.	8.	0.	8.	5.	13.	0.	1.	6.
0613 2121	3.	0.	3.	17.	3.	0.	3.	17.	0.	3.	0.	3.	10.	2.	5.
0614 1221	5.	3.	8.	8.	4.	3.	7.	9.	1.	6.	7.	13.	0.	5.	1.
0615 1222	8.	7.	15.	0.	8.	5.	13.	0.	2.	8.	9.	17.	0.	0.	3.
0617 1221	3.	7.	10.	8.	4.	7.	11.	5.	0.	4.	7.	11.	0.	5.	2.
0619 1231	5.	2.	7.	13.	5.	2.	7.	13.	0.	8.	4.	12.	0.	7.	0.
0620 2231	6.	0.	6.	12.	6.	0.	6.	12.	1.	6.	3.	9.	0.	6.	4.

Total subjects in group was 16.

0701	1221	7.	8.	15.	1.	7.	9.	16.	1.	0.	8.	8.	16.	4.	0.	0.
0702	1221	10.	9.	19.	0.	9.	8.	17.	1.	0.	8.	7.	15.	0.	0.	0.
0703	1122	6.	6.	12.	2.	5.	6.	11.	6.	0.	4.	8.	12.	5.	2.	0.
0704	1225	4.	1.	5.	12.	3.	2.	5.	12.	0.	3.	1.	4.	12.	0.	0.
0705	1221	4.	3.	7.	11.	4.	3.	7.	11.	0.	4.	1.	5.	11.	0.	0.
0706	1221	7.	6.	13.	6.	7.	5.	12.	7.	0.	6.	6.	12.	7.	0.	0.
0707	2231	4.	7.	11.	8.	8.	6.	14.	5.	0.	6.	7.	13.	5.	0.	0.
0708	2231	5.	7.	12.	4.	5.	5.	10.	6.	0.	4.	7.	11.	5.	0.	0.
0709	2232	5.	5.	10.	7.	4.	5.	9.	9.	0.	3.	5.	8.	9.	0.	0.
0710	2231	6.	2.	8.	11.	8.	5.	13.	3.	0.	6.	6.	12.	3.	1.	0.
0711	2232	7.	5.	10.	5.	7.	5.	12.	3.	0.	8.	7.	15.	2.	0.	0.
0712	2232	6.	6.	12.	1.	5.	6.	11.	0.	0.	4.	8.	12.	0.	0.	0.
0713	2231	1.	1.	2.	13.	1.	2.	3.	12.	0.	2.	1.	3.	10.	2.	0.
0714	2231	7.	7.	15.	5.	7.	8.	15.	4.	0.	7.	8.	15.	5.	0.	0.
0715	1225	10.	8.	18.	0.	10.	8.	18.	1.	0.	9.	8.	17.	0.	0.	0.
0717	1221	9.	8.	17.	2.	8.	6.	14.	4.	0.	7.	5.	12.	3.	1.	0.
0719	2231	8.	8.	16.	3.	8.	7.	15.	1.	0.	8.	7.	15.	0.	0.	0.
0720	2231	9.	7.	16.	0.	7.	8.	15.	0.	0.	7.	6.	13.	0.	1.	0.

Total subjects in group was 18.

0801	1222	6.	5.	11.	7.	6.	5.	11.	8.	0.	9.	7.	16.	0.	2.	2.
0802	1223	5.	1.	6.	12.	5.	1.	6.	8.	0.	8.	8.	16.	0.	1.	1.
0803	1222	6.	7.	13.	3.	5.	3.	8.	6.	0.	7.	8.	15.	0.	2.	3.
0804	1222	5.	4.	9.	8.	3.	6.	9.	7.	2.	8.	5.	13.	0.	5.	1.
0805	1221	4.	5.	9.	9.	5.	3.	8.	9.	1.	6.	7.	13.	0.	4.	2.
0806	2221	4.	4.	8.	11.	5.	2.	7.	7.	0.	8.	3.	11.	0.	2.	6.
0807	2232	8.	10.	18.	2.	7.	9.	16.	2.	0.	9.	10.	19.	0.	1.	0.
0808	2232	7.	7.	14.	5.	5.	5.	10.	4.	4.	7.	7.	14.	0.	4.	1.
0809	2232	8.	7.	15.	5.	7.	6.	13.	7.	0.	8.	10.	18.	1.	0.	1.
0810	2231	5.	5.	10.	5.	6.	5.	11.	3.	1.	6.	8.	14.	0.	2.	3.
0811	2232	5.	6.	11.	7.	1.	0.	1.	5.	7.	5.	5.	10.	0.	3.	4.
0812	3131	8.	5.	13.	4.	8.	5.	13.	5.	1.	9.	7.	16.	0.	0.	4.
0813	1121	6.	8.	14.	5.	7.	9.	16.	2.	0.	10.	9.	19.	1.	0.	0.
0814	2232	4.	4.	8.	3.	4.	3.	7.	2.	4.	6.	6.	12.	0.	2.	5.
0815	2222	7.	5.	12.	4.	6.	4.	10.	2.	0.	6.	6.	12.	1.	2.	3.
0816	1221	9.	8.	17.	0.	8.	7.	15.	1.	0.	10.	8.	18.	0.	0.	2.
0817	1221	6.	5.	11.	6.	5.	5.	10.	8.	0.	9.	6.	15.	0.	2.	3.
0819	1232	8.	9.	17.	1.	9.	8.	17.	1.	0.	10.	10.	20.	0.	0.	0.
0820	2232	6.	6.	12.	6.	7.	6.	13.	5.	0.	99.	99.	99.	99.	99.	99.

Total subjects in group was 19.

0901	2222	8.	7.	15.	2.	6.	6.	12.	4.	1.	4.	6.	10.	0.	4.	0.
0902	1225	5.	5.	10.	5.	4.	3.	7.	7.	0.	8.	9.	17.	1.	0.	0.
0903	1222	5.	4.	9.	8.	5.	2.	7.	10.	0.	4.	5.	9.	11.	0.	0.
0904	1222	5.	4.	9.	7.	5.	3.	8.	7.	0.	10.	5.	15.	1.	0.	0.
0905	1122	6.	9.	15.	3.	6.	7.	13.	3.	0.	6.	9.	15.	2.	0.	0.
0906	1221	4.	2.	6.	10.	3.	2.	5.	4.	9.	3.	2.	5.	13.	1.	0.
0907	2232	10.	9.	19.	0.	9.	9.	18.	1.	0.	9.	7.	16.	1.	0.	0.
0908	2231	8.	6.	14.	1.	5.	5.	10.	4.	1.	5.	5.	10.	8.	0.	0.
0909	2232	6.	6.	12.	3.	5.	5.	10.	4.	1.	4.	7.	11.	2.	2.	0.
0910	1121	6.	5.	11.	8.	5.	1.	6.	8.	2.	99.	99.	99.	99.	99.	0.
0911	2231	8.	8.	16.	4.	8.	5.	13.	6.	0.	7.	7.	14.	6.	0.	0.
0912	2232	4.	5.	9.	7.	4.	4.	8.	8.	0.	6.	3.	9.	11.	0.	0.
0913	1122	5.	6.	11.	0.	5.	5.	10.	0.	4.	4.	5.	9.	0.	4.	0.
0914	2231	9.	9.	18.	2.	9.	9.	18.	2.	0.	9.	8.	17.	2.	0.	0.
0915	1221	6.	4.	10.	6.	5.	4.	9.	8.	0.	6.	2.	8.	11.	0.	0.
0916	1122	6.	6.	12.	3.	7.	5.	12.	3.	1.	6.	6.	12.	5.	0.	0.
0917	1221	3.	3.	6.	10.	1.	5.	6.	9.	0.	3.	2.	5.	13.	0.	0.
0919	2221	8.	7.	15.	3.	9.	8.	17.	0.	1.	8.	7.	15.	0.	0.	0.
0920	2232	6.	8.	14.	4.	5.	6.	11.	4.	2.	5.	6.	11.	3.	4.	0.

Total subjects in group was 19.

1001	1222	5.	4.	9.	9.	5.	4.	9.	10.	0.	7.	5.	12.	0.	5.	2.
1002	1222	7.	6.	13.	6.	6.	4.	10.	7.	0.	7.	2.	12.	0.	4.	4.
1003	1122	6.	5.	11.	9.	4.	6.	10.	9.	0.	6.	7.	13.	0.	1.	6.
1004	1222	7.	8.	15.	3.	8.	7.	15.	4.	0.	9.	9.	18.	0.	0.	2.
1005	2223	4.	6.	10.	7.	5.	4.	9.	2.	0.	5.	9.	14.	1.	1.	1.
1006	1221	2.	4.	6.	10.	0.	0.	0.	8.	10.	4.	5.	9.	1.	10.	0.
1007	2232	6.	7.	13.	5.	6.	7.	13.	3.	0.	8.	9.	17.	0.	0.	3.
1008	2231	7.	9.	16.	2.	7.	7.	14.	4.	0.	10.	7.	17.	0.	2.	1.
1009	2232	4.	4.	8.	6.	3.	4.	7.	8.	0.	1.	1.	2.	0.	15.	2.
1010	1122	4.	7.	11.	6.	5.	5.	10.	5.	1.	8.	7.	15.	0.	2.	3.
1011	2231	9.	9.	18.	0.	8.	9.	17.	0.	0.	99.	99.	99.	99.	99.	99.
1012	2231	8.	8.	16.	1.	6.	6.	12.	5.	0.	7.	9.	16.	0.	1.	3.
1013	2222	6.	4.	10.	9.	3.	4.	7.	10.	0.	9.	10.	19.	0.	0.	0.
1014	3232	3.	5.	8.	8.	1.	3.	4.	7.	0.	4.	4.	8.	0.	4.	2.
1015	1122	8.	9.	17.	2.	8.	9.	17.	1.	0.	9.	6.	15.	2.	3.	0.
1017	1221	6.	7.	13.	4.	4.	6.	10.	2.	0.	8.	8.	17.	0.	1.	1.
1019	2231	4.	6.	10.	7.	5.	5.	10.	5.	0.	6.	6.	12.	0.	5.	2.
1020	2231	8.	9.	17.	0.	8.	8.	16.	0.	0.	7.	9.	16.	0.	2.	2.

Total subjects in group was 18.

1101	1221	4.	2.	6.	10.	5.	1.	6.	6.	0.	5.	1.	6.	10.	0.	0.
1102	1221	5.	3.	8.	9.	5.	3.	8.	7.	0.	5.	3.	8.	9.	0.	0.
1103	2121	4.	1.	5.	15.	4.	1.	5.	14.	0.	4.	0.	4.	13.	0.	0.
1106	1221	5.	2.	7.	8.	4.	3.	7.	7.	0.	6.	1.	7.	8.	0.	0.
1107	2231	6.	0.	6.	12.	4.	1.	5.	12.	0.	5.	0.	5.	11.	0.	0.
1108	2231	5.	2.	7.	8.	5.	2.	7.	9.	0.	5.	1.	6.	8.	0.	0.
1109	2131	2.	1.	3.	15.	4.	1.	5.	13.	0.	5.	1.	6.	7.	0.	0.
1110	1221	6.	0.	6.	4.	7.	0.	7.	5.	0.	2.	2.	4.	13.	0.	0.
1111	2232	2.	1.	3.	13.	2.	1.	3.	12.	0.	99.	99.	99.	99.	99.	99.
1112	2231	4.	2.	6.	3.	4.	2.	6.	2.	0.	4.	2.	6.	2.	0.	0.
1114	2231	6.	5.	11.	9.	6.	4.	10.	10.	0.	6.	5.	11.	8.	0.	0.
1115	1222	2.	2.	4.	10.	2.	3.	5.	8.	0.	7.	4.	11.	2.	0.	0.
1116	1221	3.	1.	4.	16.	3.	1.	4.	16.	0.	3.	1.	4.	15.	0.	0.
1117	1221	3.	0.	3.	13.	3.	1.	4.	13.	0.	1.	1.	2.	16.	0.	0.
1119	2232	7.	2.	9.	9.	5.	3.	8.	10.	0.	7.	1.	8.	10.	0.	0.
1120	2232	7.	0.	7.	11.	7.	1.	8.	7.	0.	8.	0.	8.	9.	0.	0.

Total subjects in group was 16.

1201	1221	7.	3.	10.	8.	7.	3.	10.	7.	0.	8.	5.	13.	0.	0.	4.
1202	1222	4.	1.	5.	15.	4.	1.	5.	15.	0.	6.	5.	11.	0.	0.	5.
1203	1122	5.	2.	7.	6.	5.	4.	9.	2.	0.	8.	7.	15.	0.	0.	1.
1204	1223	5.	5.	10.	7.	5.	5.	10.	6.	0.	9.	7.	16.	0.	0.	1.
1205	1121	3.	4.	7.	11.	4.	4.	8.	9.	0.	7.	7.	14.	0.	0.	4.
1206	1121	5.	6.	11.	7.	4.	8.	12.	5.	0.	7.	5.	12.	0.	0.	5.
1207	2231	5.	0.	5.	9.	5.	0.	5.	8.	0.	7.	3.	10.	0.	0.	3.
1208	2232	7.	5.	12.	7.	6.	5.	11.	5.	0.	8.	6.	14.	0.	0.	1.
1209	1232	7.	1.	8.	0.	6.	1.	7.	0.	0.	9.	5.	14.	0.	0.	3.
1210	2231	7.	4.	11.	6.	7.	4.	11.	5.	0.	7.	4.	11.	0.	0.	7.
1211	2222	4.	3.	7.	11.	4.	3.	7.	11.	0.	4.	4.	8.	0.	0.	4.
1212	2235	2.	1.	3.	15.	2.	1.	3.	16.	0.	3.	2.	5.	13.	0.	2.
1213	2222	8.	3.	11.	7.	8.	5.	13.	5.	0.	8.	7.	15.	2.	0.	3.
1214	2231	7.	5.	12.	5.	7.	5.	12.	4.	0.	9.	5.	14.	0.	0.	6.
1215	1122	4.	1.	5.	13.	4.	0.	4.	11.	0.	9.	3.	12.	0.	0.	3.
1216	1221	6.	0.	6.	14.	5.	1.	6.	14.	0.	8.	3.	11.	0.	0.	4.
1217	1225	6.	6.	12.	3.	6.	5.	11.	5.	0.	9.	8.	17.	0.	0.	2.
1219	2232	4.	3.	7.	13.	4.	4.	8.	12.	0.	7.	7.	14.	0.	0.	3.
1220	2202	6.	4.	10.	8.	7.	4.	11.	7.	0.	7.	8.	15.	0.	0.	3.
1221	2231	3.	1.	4.	5.	3.	2.	5.	1.	0.	6.	4.	10.	0.	0.	3.

Total subjects in group was 20.

1301	1221	5.	5.	11.	4.	6.	5.	11.	1.	0.	99.	99.	99.	99.	99.	99.
1302	1222	6.	4.	10.	7.	5.	4.	9.	5.	0.	7.	5.	12.	4.	0.	0.
1303	1221	6.	4.	10.	9.	6.	4.	10.	8.	0.	5.	4.	9.	9.	0.	0.
1304	1125	6.	5.	11.	4.	7.	5.	12.	2.	0.	6.	4.	10.	4.	0.	0.
1305	1221	9.	6.	15.	4.	7.	7.	14.	5.	0.	7.	5.	12.	6.	0.	0.
1306	1221	5.	5.	10.	7.	5.	6.	11.	6.	0.	5.	5.	10.	5.	0.	0.
1307	2232	4.	6.	10.	8.	6.	7.	13.	7.	0.	7.	6.	13.	7.	0.	0.
1308	1232	7.	7.	14.	3.	7.	7.	14.	4.	0.	6.	9.	15.	3.	0.	0.
1309	2222	6.	4.	10.	6.	6.	4.	10.	5.	0.	5.	5.	10.	5.	0.	0.
1310	2232	5.	5.	10.	4.	5.	5.	10.	3.	0.	5.	7.	12.	3.	0.	0.
1311	2221	7.	7.	14.	3.	7.	7.	14.	1.	0.	8.	6.	14.	3.	0.	0.
1312	2231	5.	2.	7.	9.	6.	2.	8.	5.	0.	5.	2.	7.	7.	0.	0.
1313	1221	7.	10.	17.	5.	8.	10.	18.	0.	0.	8.	10.	18.	0.	0.	0.
1314	2121	4.	6.	10.	8.	4.	4.	8.	10.	0.	4.	4.	8.	9.	0.	0.
1315	2121	2.	2.	4.	10.	2.	2.	4.	11.	0.	99.	99.	99.	99.	99.	99.
1316	1221	2.	2.	4.	14.	2.	3.	5.	13.	0.	3.	2.	5.	14.	0.	0.
1317	1122	6.	7.	13.	3.	6.	7.	13.	4.	0.	6.	7.	13.	4.	0.	0.
1319	2221	4.	2.	6.	9.	4.	2.	6.	11.	0.	4.	1.	5.	7.	0.	0.
1320	2232	6.	6.	12.	6.	6.	5.	11.	7.	0.	6.	4.	10.	6.	0.	0.

Total subjects in group was 19.

1401	1222	5.	4.	9.	8.	5.	4.	9.	8.	0.	6.	7.	13.	0.	0.	3.
1402	2121	6.	7.	13.	4.	5.	7.	12.	5.	0.	6.	8.	14.	1.	0.	2.
1403	1222	5.	4.	9.	9.	5.	4.	9.	6.	0.	6.	5.	11.	0.	0.	4.
1404	1121	8.	6.	14.	3.	8.	7.	15.	3.	0.	7.	8.	15.	1.	0.	2.
1405	1221	3.	4.	7.	9.	2.	3.	5.	10.	0.	3.	4.	7.	0.	0.	2.
1406	1222	8.	8.	16.	0.	8.	8.	16.	0.	0.	7.	8.	15.	0.	0.	3.
1407	1232	7.	9.	16.	4.	9.	10.	19.	1.	0.	9.	10.	19.	0.	0.	1.
1408	2231	9.	7.	16.	2.	9.	7.	16.	0.	0.	10.	9.	19.	0.	0.	0.
1409	2132	3.	5.	8.	8.	5.	4.	9.	8.	0.	8.	7.	15.	0.	0.	3.
1410	2232	9.	10.	19.	0.	9.	10.	19.	0.	0.	9.	10.	19.	0.	0.	1.
1411	2221	3.	5.	8.	6.	6.	4.	10.	4.	0.	7.	4.	11.	0.	0.	7.
1412	2132	4.	6.	10.	8.	5.	6.	11.	6.	0.	7.	7.	14.	0.	0.	1.
1413	1221	3.	8.	14.	4.	6.	8.	14.	4.	0.	8.	8.	16.	3.	0.	0.
1414	2231	5.	9.	14.	4.	5.	9.	14.	3.	0.	9.	9.	18.	0.	0.	1.
1415	1211	2.	3.	5.	11.	1.	3.	4.	14.	0.	4.	4.	8.	0.	0.	7.
1417	1121	5.	5.	10.	5.	5.	6.	11.	2.	0.	5.	7.	12.	1.	0.	3.
1419	2231	5.	5.	10.	7.	5.	6.	11.	7.	0.	8.	6.	14.	0.	0.	3.
1420	2235	7.	7.	14.	5.	9.	9.	18.	0.	0.	10.	10.	20.	0.	0.	0.

Total subjects in group was 18.

APPENDIX C

Analysis of Variance Tables

The one-way analysis of variance tables based on the raw data will be found in this appendix. The order of the tables is as follows:

1. Test 1 relevant learning
2. Test 1 incidental learning
3. Test 1 total learning
4. Test 1 blanks
5. Test 2 relevant learning
6. Test 2 incidental learning
7. Test 2 total learning
8. Test 2 blanks
9. Repeated Measures (RM)--Rel 1, Incid 1, Rel 2, Incid 2: PI Ss.
10. Same for Ps Ss
11. Same for N1 Ss
12. Same for N2 Ss
13. Same for No direc. with interference Ss
14. Same for P1 neutral Ss
15. Same for No direc. neutral Ss
16. Repeated Measures (RM)--Rel 1, Incid 1, Rel 2, Incid 2, Rel 3, Incid 3: PI Ss with completion test 3
17. RM (Same as above): PI Ss with multiple-choice test 3
18. Same for P2 Ss, completion
19. Same for P2 Ss, multiple-choice

20. Same for N1 Ss, completion
21. Same for N1 Ss, multiple-choice
22. Same for N2 Ss, completion
23. Same for N2 Ss, multiple-choice
24. Same for No direc., interference Ss, completion
25. Same for No direc., interference Ss, multiple-choice
26. Same for P1 neutral Ss, completion
27. Same for P1 neutral Ss, multiple-choice
28. Same for No direc. neutral Ss, completion
29. Same for No direc. neutral Ss, multiple-choice
30. Test 1 relevant--Test 2 relevant
31. Test 1 incidental--Test 2 incidental
32. Test 2 relevant intrusions
33. Test 2 incidental intrusions
34. Test 2 total intrusions
35. Test 3 relevant intrusions
36. Test 3 incidental intrusions
37. Test 3 total intrusions
38. Repeated Measures intrusions--Rel 1, Incid 1, Rel 2,

Incid 2: P1 Ss.

39. Same for Ps Ss
40. Same for N1 Ss
41. Same for N2 Ss
42. Same for No direc., interference Ss
43. RM intrusions: Test 2 Rel--Test 3 Rel vs. Test 2 incid--

Test 3 Incid: P1 Ss

44. Same for P2 Ss
45. Same for N1 Ss
46. Same for N2 Ss
47. Same for No direc., interference Ss.

Analysis of Variance--1

Source	Sum of Squares	df	Mean Square	F Ratio
Between groups	131.4630	6	21.9105	5.6045
Within groups	938.2681	240	3.9094	
Total	1069.7310	246		$p < .01$

Analysis of Variance--2

Source	Sum of Squares	df	Mean Square	F Ratio
Between groups	667.5017	6	111.2503	23.8090
Within groups	1121.4265	240	4.6726	
Total	1788.9282	246		$p < .01$

Analysis of Variance--3

Source	Sum of Squares	df	Mean Square	F Ratio
Between groups	1315.6428	6	219.2738	16.6890
Within groups	3153.3083	240	13.1388	
Total	4468.9492	246		$p < .01$

Analysis of Variance--4

Source	Sum of Squares	df	Mean Square	F Ratio
Between groups	871.9490	6	145.3248	10.8228
Within groups	3222.6506	240	13.4277	
Total	4094.5996	246		$p < .01$

Analysis of Variance--5

Source	Sum of Squares	df	Mean Square	F Ratio
Between groups	133.5383	6	22.2564	4.9469
Within groups	1079.7798	240	4.4991	
Total	1213.3181	246		$p < .01$

Analysis of Variance--6

Source	Sum of Squares	df	Mean Square	F Ratio
Between groups	556.7317	6	92.7886	19.8058
Within groups	1124.3835	240	4.6849	
Total	1681.1152	246		$p < .01$

Analysis of Variance--7

Source	Sum of Squares	df	Mean Square	F Ratio
Between groups	595.9812	6	99.3302	6.8648
Within groups	3472.6775	240	14.4695	
Total	4068.6587	246		$p < .01$

Analysis of Variance--8

Source	Sum of Squares	df	Mean Square	F Ratio
Between groups	1169.4880	6	194.9147	13.2297
Within groups	3535.9539	240	14.7331	
Total	4705.4414	246		$p < .01$

Analysis of Variance--9

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	314.02	26		
Within people	242.75	81		
Treatment	86.10	3	28.70	14.29
Residual	156.65	78	2.01	
Total	556.77	107		$p < .01$

Analysis of Variance--10

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	534.58	35		
Within people	134.25	108		
Treatment	7.85	3	2.62	2.17
Residual	126.40	105	1.20	
Total	668.83	143		$p < .10$

Analysis of Variance--11

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	499.39	35		
Within people	306.50	108		
Treatment	46.28	3	15.43	6.22
Residual	260.22	105	2.48	
Total	805.89	143		$p < .01$

Analysis of Variance--12

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	524.23	36		
Within people	164.50	111		
Treatment	18.68	3	6.23	4.61
Residual	145.82	108	1.35	
Total	688.73	147		$p < .01$

Analysis of Variance--13

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	517.70	36		
Within people	132.00	111		
Treatment	27.32	3	9.11	9.40
Residual	104.68	108	0.97	
Total	649.70	147		$p < .01$

Analysis of Variance--14

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	270.22	35		
Within people	367.00	108		
Treatment	212.06	3	70.69	47.90
Residual	154.94	105	1.48	
Total	637.22	143		$p < .01$

Analysis of Variance--15

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	506.77	36		
Within people	124.50	111		
Treatment	2.84	3	0.95	0.84
Residual	121.66	108	1.13	
Total	631.27	147		n.s.

Analysis of Variance--16

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	123.08	9		
Within people	149.50	50		
Treatment	71.48	5	14.30	8.25
Residual	78.02	45	1.73	
Total	272.58	59		$p < .01$

Analysis of Variance--17

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	275.67	11		
Within people	214.33	60		
Treatment	89.17	5	17.83	7.84
Residual	125.17	55	2.28	
Total	490.00	71		$p < .01$

Analysis of Variance--18

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	371.96	15		
Within people	255.67	80		
Treatment	11.25	5	2.25	0.69
Residual	244.42	75	3.26	
Total	627.63	95		n.s.

Analysis of Variance--19

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	254.33	16		
Within people	159.17	85		
Treatment	40.68	5	8.14	5.49
Residual	118.49	80	1.48	
Total	413.50	101		$p < .01$

Analysis of Variance--20

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	546.20	19		
Within people	211.67	100		
Treatment	23.07	5	4.61	2.32
Residual	188.60	95	1.99	
Total	757.87	119		$p < .05$

Analysis of Variance--21

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	215.16	15		
Within people	321.83	80		
Treatment	105.80	5	21.16	7.35
Residual	216.03	75	2.88	
Total	536.99	95		$p < .01$

Analysis of Variance--22

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	433.49	17		
Within people	115.50	90		
Treatment	6.60	5	1.32	1.03
Residual	108.90	85	1.28	
Total	548.99	107		n.s.

Analysis of Variance--23

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	264.75	17		
Within people	241.50	90		
Treatment	110.53	5	22.11	14.35
Residual	130.97	85	1.54	
Total	506.25	107		$p < .01$

Analysis of Variance--24

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	315.41	17		
Within people	150.33	90		
Treatment	12.63	5	2.53	1.56
Residual	137.70	85	1.62	
Total	465.74	107		n.s.

Analysis of Variance--25

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	311.35	16		
Within people	201.17	85		
Treatment	51.93	5	10.39	5.57
Residual	149.24	80	1.87	
Total	512.52	101		$p < .01$

Analysis of Variance--26

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	77.62	14		
Within people	321.50	75		
Treatment	210.19	5	42.04	26.44
Residual	111.31	70	1.59	
Total	399.12	89		$p < .01$

Analysis of Variance--27

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	208.97	19		
Within people	412.33	100		
Treatment	255.50	5	51.10	30.95
Residual	156.83	95	1.65	
Total	621.30	119		$p < .01$

Analysis of Variance--28

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	251.04	16		
Within people	91.67	85		
Treatment	7.06	5	1.41	1.33
Residual	84.61	80	1.06	
Total	342.71	101		n.s.

Analysis of Variance--29

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	377.05	17		
Within people	140.83	90		
Treatment	47.16	5	9.43	8.56
Residual	93.68	85	1.10	
Total	517.88	107		$p < .01$

Analysis of Variance--30

Source	Sum of Squares	df	Mean Square	F Ratio	Probability of Larger F	Contribution to R. Sq.
Total	6.1809	246				
Mean	0.2441	1	0.2441	10.3437	0.0015	
G	0.3076	6	0.0513	2.1721	0.0464	0.0517
Error	5.6407	239	0.0236			
R Square = 0.0517						

Analysis of Variance--31

Source	Sum of Squares	df	Mean Square	F Ratio	Probability of Larger F	Contribution to R. Sq.
Total	6.9939	246				
Mean	0.1788	1	0.1788	7.0132	0.0086	
G	0.7161	6	0.1193	4.6815	0.0002	0.1052
Error	6.0929	239	0.0255			
R Square = 0.1052						

Analysis of Variance--32

Source	Sum of Squares	df	Mean Square	F Ratio	Probability of Larger F	Contribution to R. Sq.
Total	406.0000	174				
Mean	68.3362	1	68.3362	35.7986	0.0000	
G	21.2337	4	5.3084	2.7809	0.0285	0.0618
Error	322.6054	169	1.9089			

R Square = 0.0618

Analysis of Variance--33

Source	Sum of Squares	df	Mean Square	F Ratio	Probability of Larger F	Contribution to R. Sq.
Total	370.0000	174				
Mean	55.1862	1	55.1862	31.8662	0.0000	
G	28.6801	4	7.1700	4.1402	0.0032	0.0892
Error	292.6762	169	1.7318			

R Square = 0.0892

Analysis of Variance--34

Source	Sum of Squares	df	Mean Square	F Ratio	Probability of Larger F	Contribution to R. Sq.
Total	1454.0000	174				
Mean	246.4047	1	246.4047	36.7033	0.0000	
G	98.6509	4	24.6627	3.6736	0.0068	0.0800
Error	1134.5675	169	6.7134			
R Square = 0.0800						

Analysis of Variance--35

Source	Sum of Squares	df	Mean Square	F Ratio	Probability of Larger F	Contribution to R. Sq.
Total	783.0000	163				
Mean	256.6032	1	256.6032	91.5118	0.0000	
G	101.1654	9	11.2406	4.0087	0.0001	0.1908
Error	429.0187	153	2.8040			
R Square = 0.1908						

Analysis of Variance--36

Source	Sum of Squares	df	Mean Square	F Ratio	Probability of Larger F	Contribution to R. Sq.
Total	817.0000	163				
Mean	282.2733	1	282.2733	106.8566	0.0000	
G	174.7417	9	19.4157	7.3500	0.0000	0.3018
Error	404.1663	153	2.6416			

R Square = 0.3018

Analysis of Variance--37

Source	Sum of Squares	df	Mean Square	F Ratio	Probability of Larger F	Contribution to R. Sq.
Total	2849.0000	163				
Mean	1072.2958	1	1072.2958	118.1869	0.0000	
G	484.1561	9	53.7951	5.9292	0.0000	0.2586
Error	1388.1506	153	9.0729			

R Square = 0.2586

Analysis of Variance--38

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	35.91	10		
Within people	46.00	33		
Treatment	16.27	3	5.42	5.47
Residual	29.73	30	0.99	
Total	81.91	43		$p < .01$

Analysis of Variance--39

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	53.75	15		
Within people	24.00	48		
Treatment	1.63	3	0.54	1.09
Residual	22.38	45	0.50	
Total	77.75	63		n.s.

Analysis of Variance--40

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	169.14	19		
Within people	81.75	60		
Treatment	0.74	3	0.25	0.17
Residual	81.01	57	1.42	
Total	250.89	89		n.s.

Analysis of Variance--41

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	2.07	17		
Within people	8.25	54		
Treatment	0.71	3	0.24	1.60
Residual	7.54	51	0.15	
Total	10.32	71		n.s.

Analysis of Variance--42

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	42.24	17		
Within people	39.75	54		
Treatment	4.38	3	1.46	2.10
Residual	35.38	51	0.69	
Total	81.99	71		n.s.

Analysis of Variance--43

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	4.80	11		
Within people	0.78	12		
Treatment	0.37	1	0.37	9.88
Residual	0.41	11	0.04	
Total	5.58	23		$p < .01$

Analysis of Variance--44

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	1.50	15		
Within people	0.10	16		
Treatment	0.00	1	0.00	0.21
Residual	0.10	15	0.01	
Total	1.60	31		n.s.

Analysis of Variance--45

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	2.51	19		
Within people	0.50	20		
Treatment	0.02	1	0.02	0.70
Residual	0.49	19	0.03	
Total	3.01	39		n.s.

Analysis of Variance--46

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	0.98	17		
Within people	1.22	18		
Treatment	0.03	1	0.03	0.39
Residual	1.19	17	0.07	
Total	2.20	35		n.s.

Analysis of Variance--47

Source	Sum of Squares	df	Mean Square	F Ratio
Between people	1.09	17		
Within people	0.35	18		
Treatment	0.00	1	0.00	0.00
Residual	0.35	17	0.02	
Total	1.44	35		n.s.