Establishing Reliability and Loci of Effect for Individual Differences in Susceptibility to Proactive Interference

A Thesis
Submitted to the Faculty of Graduate Studies in Partial Fulfilment of the Requirements for the Degree of Master of Arts
by
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April, 1994

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ESTABLISHING RELIABILITY AND LOCI OF EFFECT FOR
INDIVIDUAL DIFFERENCES IN SUSCEPTIBILITY TO
PROACTIVE INTERFERENCE

BY

ROCK HAU

A Thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements for the degree of

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Abstract

This study had two primary aims. The first was to obtain temporal reliability in measures of individual differences in susceptibility to proactive interference (PI). The second aim, was to examine the relationships between the measures of susceptibility to PI and measures of frontal lobe functioning, and to assess the underlying mechanism which might account for the loci of PI. In Phase 1, 91 subjects were presented with eight blocks of three 12-word lists on two separate days and were tested for recall. The relationships between the measures of PI susceptibility, \((\text{Trial 1 - Trial 3}) / \text{Trial 1}\), and measures of frontal lobe functioning, the Wisconsin Card Sorting Test (WCST) and verbal fluency, were examined. Temporal reliability was established and PI measures did correlate with verbal fluency but not with the WCST. In Phase 2, loci of PI were examined from breadth of activation and time of activation perspectives. Seventy subjects were presented with five blocks of four 15 word lists on three separate days. Time of activation was examined by presenting word lists from the same category separated by 0, 1, or 2 word lists from other categories. Breadth of activation was performed by shifting to a different category or subcategory on
Trial 4. Expected differences between high and low susceptibility groups, based on the susceptibility measures obtained in Phase 1, were not found for the time of activation hypothesis. For the breadth of activation hypothesis marginal results were obtained.
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In 1959, Peterson and Peterson illustrated that material which is briefly presented to individuals is quickly forgotten when rehearsal is prevented. They presented subjects with syllables made up of three consonants and measured recall performance at different intervals, namely 3, 6, 9, 12, 15, and 18 seconds. During these intervals subjects counted backwards by threes or fours from a given number. At the end of the interval, they were asked to recall the three consonant syllable. The results indicated that recall performance decreased significantly as a function of time. That is, subjects' recall performance, on average, was significantly better at the 3-second interval than at the 18-second interval.

Proactive interference. Keppel and Underwood (1962) explained that the rapid loss of items from memory in the Peterson and Peterson (1959) paradigm was due largely to massive amounts of proactive interference (PI). PI is said to occur when previously presented material interferes or impedes recall of more recently presented material. Keppel and Underwood demonstrated that recall performance drops off rapidly
across a series of trials when the retention interval is held constant. Their analysis of the Peterson and Peterson results drew heavily from an influential analysis of interference effects by Underwood (1957).

To establish PI, the following procedure is normally performed. Subjects are shown a few words, normally three or four, from the same semantic category and are instructed to commit them to memory. Next, a distractor task, usually counting backwards by threes, is imposed to prevent rehearsal. Following this retention interval, subjects are asked to recall the words. Although their memory is good in the first trial, performance declines rapidly as new words from the same category are presented on subsequent trials.

In an important study, Wickens, Born, and Allen (1963) demonstrated that the build-up of PI is class specific, because shifting class to some different semantic category results in significant increases in recall performance. For example, switching from the semantic category "types of trees" for the PI build-up trials to "types of dwellings" as the release trial produces an increase in performance. This increase in performance with a semantic category shift is known as release from PI. Based on this, Wickens and his students used the Keppel and Underwood (1962) findings
to develop a procedure for investigating encoding categories or encoding dimensions. They demonstrated that the build-up of PI and subsequent release from PI can occur when the shift from the PI build-up trials to the release trial is made to an opposite end of the class, such as in semantic differential categories, or when the shift is made to a new class, that is, from one concept to another. Wickens et al.'s. main argument was that the build-up of PI was a reflection of fundamental attributes of encoding.

Initially, this PI paradigm was studied using word triads (Peterson & Peterson, 1959; Wickens, 1970). However, it was shown by Craik and Birtwistle (1971) that PI builds up and releases similarly in a series of trials with longer lists of words drawn from the same conceptual category. In their study, Craik and Birtwistle used lists of 15 words. Subjects were asked to recall the last four words first followed by all of the remaining words in any order. The same pattern of PI build-up and release occurred with this paradigm, which did not include a formal retention interval task.

It should be noted that, until the Craik and Birtwistle (1971) study, it was accepted by most researchers that the Peterson and Peterson (1959) paradigm was a short-term memory task. However, the
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results of the study performed by Craik and Birtwistle suggested that the Peterson and Peterson paradigm reflected long-term memory differences since the amount of time used to present the 15 word lists, approximately 40 seconds, is much longer than the 10 to 15 seconds normally associated with short-term memory.

More recently, researchers have obtained measures of PI with broader idea units using brief prose passages (Blumenthal & Robbins, 1977) and television news items (Gunter, 1979; Gunter, Berry, & Clifford, 1981; Gunter, Clifford, & Berry, 1980). In the Gunter et al. studies (1979, 1981) the authors reported that subjects were presented triads of television news items, for example world news, and tested for recall of items following an interpolated distractor task. Build-up of PI occurred over trials. When the type of news item was shifted on a critical trial to, for example, sports, release from PI resulted. While Wickens (1970) focused on the build-up of and release from PI with individual items of small sets, these studies revealed that the build-up and release of PI also occur with broader idea units.

**Individual differences.** Dempster (1985) questioned if PI could be demonstrated when conditions of topic similarity were varied and more carefully
controlled using materials that would simulate connected discourse. He also wanted to discover if susceptibility to PI was an individual difference variable. The first aim of his study was to determine if learning in the classroom setting could be influenced by PI. The second aim was to examine the relationship between individual differences in susceptibility to PI and measures of achievement on the American College Test (ACT) entrance exams.

Dempster (1985) presented his subjects with six blocks of four 19-word sentences. The first three sentences in each block were related to the same topic and began with the same word. The fourth sentence began with a different word and dealt with a different topic. For example, in the first block, subjects were presented three sentences beginning with the word "anxiety" and the fourth sentence began with the word "clans." Averaging performance across the six blocks for all subjects yielded the typical pattern of PI build-up and release. That is, retention decreased from approximately seven words on Trial 1, to five and four words on Trial 2 and Trial 3 respectively, and performance jumped to eight words on Trial 4, the release trial.
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Collapsing the data across the six blocks, Dempster (1985) established measures of individual differences in susceptibility to PI in the following manner: \( \text{Sus}_2 = (\text{Trial 1} - \text{Trial 2}) / \text{Trial 1} \), thus expressing individual differences in susceptibility to PI as a proportional drop in performance across trials on the same topic. Dempster could have used \( \text{Sus}_3 = (\text{Trial 1} - \text{Trial 3}) / \text{Trial 1} \) to establish measures of individual differences in susceptibility to PI. However, he argued the former was more appropriate because most of the decrease in recall performance occurred between Trial 1 and Trial 2. Dempster found that this measure of individual differences in susceptibility to PI correlated significantly with various subtests of the ACT, namely, Mathematics Usage (\( r = -0.51 \)), Social Science Reading (\( r = -0.57 \)), and Natural Science Reading (\( r = -0.50 \)). That is, subjects who showed the highest levels of susceptibility to PI had lower scores on the ACT. It should also be noted that the correlation between the susceptibility measure and Trial 1 performance was quite weak (\( r = -0.16 \)). In addition, Trial 1 recall correlated weakly with ACT scores (\( r = 0.15 \) to \( r = 0.32 \)). Dempster concluded that correlations between the ACT and the susceptibility measures were not due to general memory ability or IQ.
but to the effects of PI.

Dempster (1985) proposed that his findings were important for several reasons. First, they suggested PI may be a common cause of everyday learning problems and were a first step in identifying the kinds of material that are most sensitive to PI. Second, because of the impressive correlations between the individual differences in susceptibility to PI measures and ACT scores, individual differences in susceptibility to PI may be an important source of differences in scholastic achievement since they do not appear attributable to general memory ability. Such a link between general intellectual performance and susceptibility to interference has theoretical and educational implications. Finally, Dempster suggested that possible loci of PI may be found in the priming and activation processes or in the time course of priming and activation processes.

Dempster's (1985) use of the term "activated" refers to a concept from spreading activation models of memory. This type of model views semantic memory as a network of units of information, each associated with many other units of information (Anderson, 1983). When one unit is primed, for example, by being retrieved, it activates associated units, bringing them into working
memory and increasing their likelihood of being retrieved. However, if too many units of information are activated, they compete for retrieval and inhibit retrieval of the target item (Postman & Keppel, 1977).

To follow up on Dempster’s (1985) findings and suggestions, several studies have recently been completed in McIntyre’s laboratory (J. S. McIntyre, personal communication, March 24, 1993) with mixed results. Five of these studies will now be discussed in some detail.

The purpose of the first experiment (Reisdorf & McIntyre, 1987) was to identify the underlying basic processing strategies that lead to consistent individual differences in susceptibility to PI. It was surmised that there were two possible reasons some individuals might be more vulnerable to PI effects. The first was that, once activated, conceptual categories may stay highly activated for a longer period in individuals more susceptible to PI. Evidence exists that PI dissipates in Wickens-type paradigms solely as a function of time. In fact, a rest interval of two minutes between Trials 3 and 4 is usually sufficient to produce release from PI (Loess & Waugh, 1967) in the same way as changing conceptual categories. Therefore, it was hypothesized that highly
susceptible individuals hold concepts longer in the memory system yielding overall greater interference from recently experienced events.

The second possibility was that highly susceptible individuals may have boundaries between categories and concepts that are not as clearly defined as in low susceptible individuals. This hypothesis stipulated that, when a broadly defined concept is activated by highly susceptible individuals, it is more likely to overlap with subsequently presented materials than would be the case for low susceptible individuals.

To examine both hypotheses, it was decided that the categorized list presentations of Craik and Birtwistle (1971) would be more appropriate than the sentence materials of Dempster (1985). This is primarily because it is much easier to manipulate word lists than sentences and allows for more precise control over the construction of the lists. Subjects received five blocks of four trials of 20-word lists in a PI build-up and release sequence on each of three days. The first block of each day became the base for measuring individual differences in susceptibility to PI, while the remaining four blocks allowed for tests of the time versus breadth of activation hypotheses.
To test the time of activation hypothesis, categorized lists of words on Trial 1 of a block were first presented and then, the number of intervening trials were varied with lists from other categories before a second list drawn from the Trial 1 category was presented. The number of intervening lists varied from 0 to 1 to 2. If high susceptible individuals have concepts activated for a longer period, then there should be a susceptibility group by number of intervening lists interaction in performance. To test the breadth of activation hypothesis, lists within a block were constructed so that a subtle shift within a category would occur between Trial 3 and Trial 4 in the first block of each day. For example, the shift might be from wild to domestic animals.

Individual differences in susceptibility to PI were calculated by the measure Sus, averaged across the first block of each day. Based on this measure, groups of high and low PI susceptibles were formed on a median split basis. The groups were then compared in terms of their performance across trials on the remaining test blocks. The results did not support either hypothesis.

Assuming there was insufficient stability in the measure of PI susceptibility, the second experiment (Reisdorf & McIntyre, 1988) was similar to the first
except that the number of blocks was increased from three to six. Again, no significant comparisons were obtained between the low and high susceptible groups.

Subsequently, Jongsma and McIntyre (1992) attempted to find out whether reliable individual differences in measures of susceptibility to PI could be established across time or testing circumstances. Both the Craik and Birtwistle (1971) and Dempster (1985) paradigms were used. Subjects received five blocks of four sentences, taken from Dempster’s study, followed by four blocks of four lists of the Craik and Birtwistle type on each of two days. This procedure allowed for the development of four independent measures of susceptibility, one for each task and day combination. Additionally, the PI susceptibility scores for each task for the two days were combined yielding six PI susceptibility scores. None of the important correlations in this study approached significance suggesting that the measure of PI susceptibility has neither the desired temporal nor across-task stability to warrant it being called a true individual difference variable.

Frontal lobe functioning. The next experiment (Hau, 1993) obtained its impetus from a Dempster (1992) review paper in which he outlined a general
relationship between frontal lobe functioning and interference phenomena. Dempster proposed that resistance to interference is a major factor in cognitive development and aging, and that it is associated with the operation of the frontal cortex of the brain.

Dempster (1992) based his proposal on three facts; (a) that recent advances in neuroscience have suggested that the frontal lobes play an important role in the ability to control interference from both external and internal sources, (b) that the frontal cortex is slow to develop and is one of the first brain regions to show signs of deterioration later in life, and (c) that the number and variety of interference-sensitive tasks that require the suppression of irrelevant stimuli or responses for effective performance are much greater than is commonly believed.

Support for Dempster's proposition comes from Hasher and Zacks (1988) who suggested that one reason older adults may show greater sensitivity to interference sensitive tasks is due to lowered inhibition. That is, one reason for which older adults may display inferior performance on memory tasks is because of a decline in their ability to control interference effects.
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Additional support comes from Craik, Morris, Morris, and Loewen (1990) who examined the relationship between normal aging, source amnesia, and frontal lobe functioning within a group of normal adults. Using the Wisconsin Card Sorting Test (WCST) and measures of verbal fluency, they found that source amnesia was correlated with both the WCST ($r = .53$) and verbal fluency ($r = -.38$). The WCST has been found especially sensitive to frontal lobe disorders. It has also been shown that older adults show significantly impaired performance on the WCST when compared to younger adults (Dempster, 1992).

It is important to note that the substantial amounts of source amnesia Craik et al. (1990) found in the elderly do not simply reflect some general cognitive impairment. This is because mean IQ scores did not correlate reliably with source amnesia. Craik et al. concluded that the normal aging process is associated with a reduction in the efficiency of frontal lobe functioning and that this impaired functioning is manifested as an increased liability to make source amnesic errors.

It can be seen then, that Dempster’s (1992) proposition allowed for a clear prediction that individual differences in susceptibility to P1 should
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be correlated with measures of frontal lobe functioning. Therefore, Hau (1993) presented 65 subjects with Dempster’s (1985) paradigm, Craik and Birtwistle’s (1971) paradigm, and two established measures of frontal lobe functioning, the WCST and verbal fluency. Since the WCST and measures of verbal fluency are indicators of mental flexibility and cognitive functioning that reflect sensitivity to interference, performance on these tasks should be correlated with measures of susceptibility to PI.

Measures of individual differences in susceptibility to PI for both memory tasks were obtained using both Sus₂ and Sus₁. Given that reliability had been previously difficult to establish it was believed that using both measures might alleviate this problem. These measures were then correlated with the perseverative responses of the WCST and the measures of verbal fluency. Some support (one out of four r’s) for the reliability of PI susceptibility measures across tasks was obtained representing the first clear indication of reliability of PI susceptibility measures. A significant correlation was obtained between the Sus₁ measures for the Dempster and the Craik and Birtwistle paradigms (r = .30). Additionally, significant correlations were
found between the word list PI susceptibility measures and the perseverative responses on the WCST (r = .37 and r = .25). These correlations support, in part, Dempster’s (1992) suggestion that measures of frontal lobe functioning do relate to other interference sensitive tasks. However, none of the PI susceptibility measures correlated with verbal fluency performance.

Encouraged by the supportive results of this study, in the most recent experiment, Hau and McIntyre (1993) attempted to obtain temporal reliability in measures of individual differences in susceptibility to PI using the Craik and Birtwistle (1971) paradigm. Subjects were presented with five blocks of three 12-word lists on three separate days. Additionally, on each of the three days, subjects were given a four-alternative forced choice vocabulary test on 25 items drawn from the Reader’s Digest and a measure of verbal fluency was obtained by having subjects iterate words to five letters for 30 seconds. Finally, on each day, subjects were presented two lists of words in a part list cuing retrieval blocking paradigm (See Roediger & Neely, 1982 for a full description of the paradigm and related research). A total of 70 subjects participated in the study; however, data for only those 42 subjects
who were native English speaking were analyzed.

Individual differences to PI were calculated for each of the three days using both Sus 2 and Sus 3. This allowed for the calculation of six susceptibility measures. Additionally, the data were collapsed across the three days and overall susceptibility measures were calculated, yielding a total of eight susceptibility measures. Inter-correlations of these susceptibility measures resulted in 10 of 15 significant correlations for the susceptibility measures (these significant r’s ranged form .65 to .27). Thus, meaningful support was established for reliability of PI susceptibility measures across days on the same task. Additionally, day to day measures of vocabulary and verbal fluency were highly correlated (r ranging from .85 to .60) suggesting high reliability within these measures. A PI susceptibility measure was also calculated for the part-set cuing paradigm. While there was little stability in this measure across days, the overall susceptibility measures for the two paradigms were correlated (r = .29).

The general outcomes of the studies completed in McIntyre’s laboratory suggest that susceptibility to PI may be an individual difference phenomenon as was proposed by Dempster (1985). However, finding both
temporal and cross task stability has been elusive and the relationships obtained to date, while significant, have not been overwhelming in comparison to normal expectations of reliability. That is, the correlations just achieved significance and explained only 8% to 12% of the variance.

There are several possible explanations why reliability has been difficult to achieve consistently. First, it would appear that a basement effect in some subjects may be detrimentally affecting the susceptibility measures. That is, if mean performance for Trial 1 across blocks is too low, then performance on subsequent trials will not be significantly different from Trial 1 and thus, measures of susceptibility to PI would be meaningless. Additionally, it becomes impossible to compare these individuals with those who perform strongly on Trial 1.

To evaluate the negative impact of poor Trial 1 performance on the correlational relationships expected, subjects who in Hau and McIntyre (1993) achieved a recall performance at least equal to the mean recall performance of all subjects were selected for a second analysis. This resulted in the selection of 25 subjects for this analysis and yielded more significant correlations and the correlations in
themselves were stronger, explaining close to 40% of the variance. Additionally, using shorter lists of words appears to increase overall recall performance on Trial 1. It seems that a reasonable level of Trial 1 performance is necessary to meaningfully pursue differences in PI susceptibility.

A second important factor resides with the background characteristics of subjects. In all of the experiments conducted in McIntyre’s laboratory, except the most recent one, there were no restrictions imposed for the selection of subjects from introductory psychology courses. Lack of homogeneity in subjects may affect the relationship between susceptibility measures and other variables. As was demonstrated in the Hau and McIntyre (1993) study, when mother tongue was controlled for, the significant relationships were more numerous. Variations in Trial 1 performance caused by differential familiarity with the language and concepts involved clearly needs to be controlled. Finally, it should be noted that Dempster’s (1985) high correlations were obtained with only 16 subjects. Statistically, the correlations would have had to be high to achieve standard levels of significance. Thus, Dempster’s results should be viewed with this in mind.
To properly examine PI susceptibility as an individual difference variable, homogeneity of subjects in terms of language must first be ensured. Secondly, only those subjects who perform adequately on average, on Trial 1, should be selected for further study. Once these factors have been controlled, it might be possible to determine whether the build-up of PI is based on the priming and activation processes or in the time course of priming and activation processes as was suggested by Dempster (1985) and investigated in the Reisdorf and McIntyre (1987, 1988) studies. The poor results of the Reisdorf and McIntyre studies may be attributed to the problems discussed above. Therefore, a new study to reevaluate their hypotheses and control for these factors was deemed appropriate.

Considering the factors discussed in the preceding paragraphs, this study had three aims. The first aim was to obtain better temporal reliability measures of individual differences in PI susceptibility than had been found in previous studies. To accomplish this, subjects were presented with eight blocks of three lists on two separate days. Given the results of Hau and McIntyre (1993), there was reason to believe that reliability would be achieved by using 12 item word lists of the Craik and Birtwistle (1971) type, and by
selecting subjects who spoke English as a mother tongue. The second aim was to provide a better test of the time and breadth-of-activation hypotheses first investigated by Reisdorf and McIntyre (1987) by controlling for those factors discussed above. The third aim was, based on the rationale developed by Dempster (1992), to explore again the relationships between individual differences in susceptibility to PI and performance on the WCST and verbal fluency.

To test the time of activation hypothesis, two lists from the same category were separated by 0, 1 or 2 lists from other categories. If the temporal hypothesis is correct, then subjects with low susceptibility to PI should show as much PI as subjects with high susceptibility to PI when the paired lists are close together, but PI should be weaker for those less susceptible as the pairs were presented farther apart. Thus, a susceptibility group by separation interaction was predicted.

Release from PI was also used to evaluate support for the breadth of activation hypothesis. After PI had built up over several lists from the same category, a list from a different category was presented to facilitate release. The release list was either from a totally different category or from a closely related
subcategory. If the discrimination hypothesis is correct, individuals with high susceptibility to PI would not discriminate between the build-up category and the release category resulting in little or no release from PI. Individuals with low susceptibility to PI were expected to display significant levels of release from PI.

In Phase 1, it was expected that measures of individual differences in susceptibility to PI would be significantly correlated across occasions. For the second phase, it was believed that either or both the priming and activation processes or the time course of priming and activation processes would be correlated to measures of individual differences in susceptibility to PI. It was also anticipated that measures of perseverative responses on the WCST would be positively correlated to the measures of individual differences in susceptibility to PI and that measures of verbal fluency would be negatively correlated with PI susceptibility.

Method

This study was conducted in two phases. In Phase 1, subjects were presented with eight blocks of three 12-word lists on two separate days. At the end of the first day, a general memory questionnaire, and
Establishing Reliability

an overall recall memory test were also administered.
In Phase 2, subjects were presented with five blocks of
four 15-word lists and a test of verbal fluency on each
of three separate days. Lastly, they were administered
the WCST on a separate occasion.

Phase 1

Subjects

Ninety-one introductory psychology students, 52
females (mean age of 19.52 years) and 39 males (mean
age of 19.77), at the University of Manitoba who
learned English as their first language were recruited
and earned course credit for their participation. No
gender restrictions were in effect. However, age was
restricted to 18-30 (actual range 17 - 28) years as
there is evidence (Dempster, 1992) of increasing
susceptibility to PI with age.

Tasks and Materials

Subjects were presented with eight blocks of three
12 word lists of the Craik and Birtwistle (1971) type
on two separate days. The eight blocks of three trials
of 12 words were drawn from the Battig and Montague
(1969) norms. For each category, words were randomly
selected from the top 80 words of the norms but
excluded the first five. Given that the first five
words are easily generated, it is possible that
subjects might recall these words by chance alone and not because they actually remember them. The word lists were recorded on audio cassette tape by the experimenter. The categories used were as follows; a) trees, b) vehicles, c) dwellings, d) furniture, e) reading materials, f) animals, g) weapons, h) spices, i) crimes, j) geographical formations, k) birds, l) kitchen utensils, m) world cities, n) occupations, o) sports, and p) fish. (For complete word lists, see Appendix A.)

Following the last block of trials, subjects were given two minutes to complete a general memory questionnaire (see Appendix B). Next, they were asked for a final free recall for all words presented in the last block, that is, the last three lists. When subjects had finished, they were asked to examine the lists they had written and identify which words had been presented in List 1, List 2 and List 3. The purpose of this final free recall was to evaluate if the pattern of PI across these lists would be reflected in this final free recall when sufficient time to dissipate the PI effect had been granted to subjects. (Watkins & Watkins, 1975; Loftus & Patterson, 1975).
Establishing Reliability

Procedure

To complete Phase 1 subjects were required to attend two separate sessions each lasting approximately 45 minutes. In each session they were presented with eight blocks of three 12 word lists. Subjects participated in groups of 20 to 25 in a quiet room. Upon entering the room subjects were given information about the task. It was emphasized that their task was to try to remember words and to perform arithmetic problems accurately. They were instructed to recall as many words as possible. After presentation of these instructions the following procedure was described.

Each trial began with the word "ready," followed by a two-second interval and then the list of 12 words, with words presented at a two-second rate. Presentation of the last word was followed by a 15-second interval in which subjects were presented with a simple arithmetic problem, for example, $16 \times 2 - 4 + 10$, for which only their final answer was required. At the conclusion of this 15-second interval, subjects heard the word "recall," which was followed by a 20-second recall interval. During this period the subjects wrote down, in any order, as many words as they could remember. When it followed the first two trials in a block, "ready," signalled the end.
of the recall interval and the beginning of the next trial. The end of the third and final trial of each block was signalled by the word "stop." Each block was separated by a two minute rest period during which the subjects were engaged in casual conversation with the experimenter. Loess and Waugh (1967) showed that two minutes is sufficient time to release accumulated PI.

**Phase 2**

**Subjects**

All subjects who participated in Phase 1 of the experiment were called and invited to participate in Phase 2. Of those, 28 males (mean age of 19.57 years) and 42 females (mean age of 19.76 years), completed all aspects of Phase 2 and only their data were included in the Phase 2 analysis. The age range for all subjects was 17 to 28 years. (See p. 47-48 for the breakdown of subjects into high and low susceptibility groups).

All subjects earned additional course credit for their participation in this phase.

**Design and Materials**

In Phase 2, subjects were given five blocks of build-up trials on each of the three days. Three of these blocks were used to evaluate the time of activation hypothesis and the other two had either full or subtle release conditions as the fourth trial in
each block. Lists used in the 0, 1, and 2 lag conditions were counterbalanced across three subgroups to ensure there would be no confound between specific categories and lag condition. This counterbalancing group effect, along with susceptibility condition, became between-subject variables in subsequent data analyses.

**Word list recall.** Five blocks of four 15-item lists of words were constructed for the Craik and Birtwistle (1971) procedure and were presented on three separate occasions. The word lists were drawn from the Battig and Montague (1969) norms. For each category, words were selected from the top 80 words of the norms but excluded the first five. (For a complete list see Appendix C).

For one of the five blocks, the first three lists contained words from the same semantic category to maximize PI build-up. The fourth list contained words from a completely different semantic category. Another block was constructed in the same fashion, for example clothing; however, the fourth list was drawn from a different but closely related category to facilitate release from PI, for example, accessories.

The other three blocks were similarly constructed. In these blocks, however, a categorized list of words
was presented on Trial 1 of a block. Then the number of intervening trials was varied with items from other categories before a second list was drawn from the Trial 1 category. The number of intervening lists varied from 0 to 1 to 2. Therefore, in each block there were two lists drawn from the same category, while the other two lists were drawn from separate categories. Thus, every block within a session had three unique categories. Further, the separation of the critical trial was different for each of the three sub-groups. For example, if the category was men’s names, one group was presented with the second list immediately after the presentation of the first list. The second and third group were presented with the second list of men’s names on list 3 and list 4, respectively.

All word lists were recorded by the experimenter and presented via an audio cassette. Additionally, the presentation of the five blocks was randomized for each day. Several characteristics of the design should be noted. For the blocks dealing with the breadth of activation (Blocks 1 & 4), the order of the lists was the same for each of the three groups. Only the order of the presentation of the blocks was randomized across each day. Similarly, the order of the presentation of
the blocks concerning the time course of activation (Blocks 2, 3 & 5) was also randomized across days.

Wisconsin Card Sorting Test. The computerized version of the WCST (Grant & Berg, 1948) was used in this study. The WCST uses four stimulus cards and 128 response cards that display figures of varying forms (crosses, circles, stars, or triangles), colours (red, blue, yellow, or green), and numbers (one, two, three, or four). The four stimulus cards are placed at the top of the computer terminal and the response card is placed at the bottom of the terminal. Subjects are then asked to match each of the response cards, via the keyboard, to the stimulus card they believe it matches. Once subjects have selected the appropriate key on the keyboard, the computer places the card under the selected match. For each response subjects are informed, by the computer terminal, whether that response is right or wrong, and are not told the correct sorting principle. Once subjects have made a specified number of correct (10) responses, the criterion principle is changed to a new category without warning. When a subject has successfully completed six criterion principles, the computer ends the test and thanks them for their participation.
Establishing Reliability

The scoring of the WCST is performed by the computer. A perseverative response occurs when a subject continues to sort according to a sorting principle after being informed that the response is wrong. Measures of total perseverative responses are calculated in accordance with Heaton's (1981) suggestions: that is, (a) a response that would have been correct in the immediately preceding category; (b) repetitions of the first unambiguous response in stage one (before the first category is completed); and (c) repetitions of any response following three successive unambiguous matches involving that response. The scoring of the WCST has been shown to be reliable (Axelrod et al., [1992] cited in Heaton et al., 1993). Intrascorer and interscorer agreement was found to be excellent with interclass correlations of $r_{icc} = .93$ and $r_{icc} = .96$, respectively. Similarly, the WCST has been shown to be a valid measure of executive function in adults (Shute & Huertas, [1990], cited in Heaton et al., 1993).

Verbal fluency. Verbal fluency measures are normally obtained by asking subjects to generate as many words as possible to a given letter within a specified period, normally one minute (Spreen & Benton, 1969). This procedure is repeated for several letters.
Overall performance is obtained by counting the number of valid words given. In this experiment subjects were asked to generate and write down as many words as possible for each of the following letters: f, g, m, c, and p on the first day; h, l, v, d, and n on the second day; and b, r, s, t, and j on the third day. Each letter was presented individually and subjects had one minute in which to write down as many words as possible. The total number of words provided by the subjects was used to establish the measure of verbal fluency.

Procedure

To complete the memory recall and verbal fluency tasks, subjects attended three sessions of approximately 45 minutes. In each session, they completed the verbal fluency task first and the word list recall task second. To complete the WCST each subject attended a fourth session of approximately 30 minutes. Each of the three sessions for the Craik and Birtwistle (1971) and verbal fluency tasks occurred four days apart. The WCST was administered individually throughout the course of Phase 2 of the study.

Verbal fluency. To complete the verbal fluency task, the experimenter read each letter aloud to the
subjects and held up a card on which the letter had been written. At the end of one minute the next letter was read followed by the cue card. After the end of this task, subjects were given a short break and were told to prepare for the word lists.

**Word list recall.** The procedure for this task was very similar to the one used in Phase 1 of the experiment. The subjects were presented with five blocks of four 15-word lists. Subjects participated in groups of six to 10 in a quiet room. Upon entering the room subjects were provided information about the task. It was emphasized that their task was to try to remember words and to perform arithmetic problems accurately. They were instructed to recall as many words as possible. After presentation of these instructions, the procedure followed was similar to that of Phase 1. Each Trial began with the word "ready," followed by a two-second interval and then the list of 15 words presented at a two-second rate. Presentation of the last word was followed by a 15-second interval in which subjects were presented with a simple arithmetic problem to be solved mentally. Subjects then heard the word "recall," which was followed by a 25-second interval. During this period subjects wrote down in any order as many words as they
could remember. At the end of the 25-second interval subjects heard the word "ready." This word signalled the end of the recall period and the beginning of the next trial. The end of fourth and final trial of each block was signalled by the word "stop." Each block was separated by a two minute rest period during which the subjects engaged in casual conversation with the experimenter.

**Wisconsin Card Sorting Test.** The computerized version of WCST was administered to each subject. Upon entering the room the subject was read the instructions regarding the WCST by the experimenter. Once this had been completed, subjects sorted the cards. The test was normally completed in under 15 minutes and subjects were then debriefed by the experimenter as to the nature and purpose of the WCST. If asked, subjects were told they had performed well on the test.

**Results**

All analyses for this study were completed with the SPSS/PC version 3.1 computer software program. The level of significance was set at the $p < .05$ level for all individual tests. Given that this study was exploratory in nature, no overall experiment-wide error rate was established. For both Phase 1 and 2, recall performance was calculated by counting the number of
correct words written down for each individual list of words. Incorrect words or words written more than once in any given list were ignored.

**Phase 1**

Ninety-one subjects, 39 males and 52 females, completed Phase 1. No differences due to age or sex were found in this study. To ensure that PI was occurring across Trials, a repeated measures ANOVA, with Day, Block, and Trial as within subject independent variables and word list recall as the dependent variable, was performed. Table 1 shows the cell means of this analysis. For all 16 blocks, except two, performance decreased substantially from Trial 1 to Trial 2 and somewhat less from Trial 2 to Trial 3. These results are reflected in a main effect of Trials (see Table 2 for the ANOVA results). For both of the exceptions, performance decreased substantially from Trial 1 to Trial 2; however, there was a slight increase from Trial 2 to Trial 3. While the pattern of decrease in performance varied somewhat from Block to Block, it can be seen that in each case performance declined as a function of Trial and demonstrates a
Table 1

Trial Means for Each Block and for Each Day

<table>
<thead>
<tr>
<th></th>
<th>Day 1</th>
<th></th>
<th>Day 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T1</td>
<td>T2</td>
<td>T3</td>
<td>T1</td>
</tr>
<tr>
<td>Block 1</td>
<td>5.86</td>
<td>3.69</td>
<td>3.05</td>
<td>5.15</td>
</tr>
<tr>
<td>Block 2</td>
<td>5.15</td>
<td>3.52</td>
<td>2.97</td>
<td>5.74</td>
</tr>
<tr>
<td>Block 3</td>
<td>5.87</td>
<td>4.48</td>
<td>3.42</td>
<td>5.90</td>
</tr>
<tr>
<td>Block 4</td>
<td>4.47</td>
<td>3.18</td>
<td>3.09</td>
<td>5.52</td>
</tr>
<tr>
<td>Block 5</td>
<td>5.54</td>
<td>3.65</td>
<td>3.45</td>
<td>5.53</td>
</tr>
<tr>
<td>Block 6</td>
<td>6.01</td>
<td>3.55</td>
<td>2.80</td>
<td>5.84</td>
</tr>
<tr>
<td>Block 7</td>
<td>6.26</td>
<td>3.75</td>
<td>3.32</td>
<td>6.13</td>
</tr>
<tr>
<td>Block 8</td>
<td>5.00</td>
<td>3.54</td>
<td>2.92</td>
<td>5.35</td>
</tr>
<tr>
<td>Means</td>
<td>5.52</td>
<td>3.67</td>
<td>3.13</td>
<td>5.64</td>
</tr>
</tbody>
</table>
### Establishing Reliability

#### Table 2

**Summary Table for ANOVA for Day, Block and Trial**

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day (A)</td>
<td>6.23</td>
<td>1</td>
<td>2.65</td>
<td>2.35</td>
<td>.128</td>
</tr>
<tr>
<td>Block (B)</td>
<td>340.78</td>
<td>7</td>
<td>1.72</td>
<td>28.27</td>
<td>.000</td>
</tr>
<tr>
<td>Trial (C)</td>
<td>4753.13</td>
<td>2</td>
<td>2.01</td>
<td>1181.33</td>
<td>.000</td>
</tr>
<tr>
<td>A x B</td>
<td>176.47</td>
<td>7</td>
<td>1.67</td>
<td>15.09</td>
<td>.000</td>
</tr>
<tr>
<td>A x C</td>
<td>1.64</td>
<td>2</td>
<td>1.66</td>
<td>.49</td>
<td>.612</td>
</tr>
<tr>
<td>B x C</td>
<td>179.62</td>
<td>14</td>
<td>1.47</td>
<td>8.73</td>
<td>.000</td>
</tr>
<tr>
<td>A x B x C</td>
<td>151.39</td>
<td>14</td>
<td>1.48</td>
<td>7.32</td>
<td>.000</td>
</tr>
</tbody>
</table>
pattern of results normally obtained with PI paradigms. The significant interactions and overall Block effect resulted because of the slightly different patterns seen across blocks. The overall mean scores of Trials 1, 2, and 3 for Day 1 were: 5.52 (SD 0.84), 3.67 (SD 0.86), and 3.13 (SD 0.79). Similarly, mean scores of Trials 1, 2, and 3 for Day 2 were 5.64 (SD 0.88), 3.74 (SD 0.89), and 3.16 (SD 0.84). These data are reflected in a failure to find a main effect of Days or a Days x Trials interaction. The significant Block, Block by Trial, and Day by Block by Trial effects suggest variation in ease of remembering these categories and in the total amount of PI accumulating across Trials. However, the basic pattern of PI is evident throughout all blocks.

 Particularly interesting was the fact that for each subject, except eight, results reflected the typical PI pattern. The eight exceptions also demonstrated PI in that their performance decreased from Trial 1 to Trial 2, but showed a slight increase from Trial 2 to Trial 3.

 In addition, the results of the total free recall of the last block on Day 1 revealed that subjects recalled a mean of 4.70 (SD 1.92), 3.05 (SD 1.64), and 2.93 (SD 1.88) words on Lists 1, 2, and 3,
respectively. The typical pattern of PI was also found with this procedure. When subjects were asked to identify which of the words they had written down belonged to which list, the pattern of results was also quite similar (List 1, 3.21 [SD 1.97], List 2, 1.88[SD 1.42], List 3, 1.60[SD 1.58]).

**Susceptibility measures.** Measures of individual differences in susceptibility to PI for each subject were estimated using the $\text{Sus}_1$ and $\text{Sus}_2$ formulas in which the drop between Trials 1 and 2 and Trials 1 and 3 are expressed as a proportion of Trial 1 performance. These measures were calculated for each day. Additional susceptibility measures were calculated for the two days combined. Thus, a total of six separate susceptibility measures were generated although the two overall measures were expected to be highly intercorrelated.

The analyses of the correlations of the susceptibility measures are shown in Table 3 and revealed that all of the susceptibility measures were significantly intercorrelated. Important were the inter-correlations of the two $\text{Sus}_1$ measures and the two $\text{Sus}_2$ measures; these were $r = .21$ and $r = .38$ respectively.
Establishing Reliability

In an attempt to provide further support for the temporal reliability of PI susceptibility measures, a different analysis was performed. Measures of susceptibility to PI were calculated for each subject and block using the $\text{Sus}_1$ formula and then these measures were averaged for each day. This resulted in a correlation of $r = .37$ for these susceptibility measures. Cronbach's alpha coefficient was .536 and the Spearman-Brown correction was .54.

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Insert Table 3 about here

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Based on these significant, but small, correlations for the daily susceptibility measures, it was decided to examine whether overall recall performance was stable across days. Thus, a correlational analysis using mean day trial results was performed. The outcome of this analysis revealed a Day 1-Trial 1 with Day 2-Trial 1 correlation of $r = .64$. Similarly Day 1-Trial 2 and Day 2-Trial 2 and Day 1-Trial 3 and Day 2-Trial 3 correlated $r = .60$ and $r = .74$, respectively. These suggest that subjects' recall performance was stable over days. It should be noted, however, that these correlations explain 36 to 55 percent of the variance. While these are quite
Table 3
Intercorrelations Among Susceptibility Measures

<table>
<thead>
<tr>
<th></th>
<th>D1S2</th>
<th>D1S3</th>
<th>D2S2</th>
<th>D2S3</th>
<th>S2</th>
<th>S3</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1S2</td>
<td>--</td>
<td>.55*</td>
<td>.21**</td>
<td>.34*</td>
<td>.77*</td>
<td>.53*</td>
</tr>
<tr>
<td>D1S3</td>
<td>--</td>
<td>.31*</td>
<td>.38*</td>
<td>.55*</td>
<td>.82*</td>
<td></td>
</tr>
<tr>
<td>D2S2</td>
<td>--</td>
<td>.52*</td>
<td>.78*</td>
<td>.51*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2S3</td>
<td>--</td>
<td>.57*</td>
<td>.83*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td>.67*</td>
<td></td>
</tr>
<tr>
<td>S3</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p < .01,  ** p < .05

Legend

D1S2     (Trial 1 - Trial 2) / Trial 1, Day 1
D1S3     (Trial 1 - Trial 3) / Trial 1, Day 1
D2S2     (Trial 1 - Trial 2) / Trial 1, Day 2
D2S3     (Trial 1 - Trial 3) / Trial 1, Day 2
S2       refers to (Trial 1 - Trial 2) / Trial 1
          both days added together
S3       refers to (Trial 1 - Trial 3) / Trial 1
          both days added together
acceptable, it is not surprising that the correlations of the susceptibility measures were not higher. Given the unexplained variance of daily recall performance, it becomes logical that the susceptibility correlations, based on those trial data, are smaller.

Phase 2

To determine subject participation for this Phase, it had been intended to select only those subjects who performed at or above the 35th percentile on overall Trial 1 Phase 1 results. However, based on the stable pattern of Phase 1 results, it did not appear necessary to proceed as originally planned for the following reasons. First, a correlational analysis of the susceptibility measures was performed selecting those subjects who scored an average of 5.00 or higher on Trial 1. The resulting correlations on these subjects differed little from those in the original analysis with all 91 subjects. In fact, the correlations, while still significant, were not as strong as had been obtained with the complete set of subjects. Secondly, on the assumption that a considerable loss of subjects would occur throughout Phase 2, it was concluded that inviting all subjects to participate in Phase 2 was warranted. Thus, all 91 subjects were invited to participate in Phase 2 and a total of 70 subjects, 28
males and 42 females, completed all aspects of Phase 2. Eight subjects declined participation and the remainder missed either Day 2 or Day 3 of the study and therefore their data was removed from any analysis.

**High and low susceptibility groups.** Subjects in Phase 2 were assigned to either high or low susceptibility groups based on a median split analysis of the overall Sus, of Phase 1. The mean age of high and low susceptibility groups were not different (\( \bar{x} = 19.9 \) and 19.4, respectively). The proportion of females in the two groups was 29% for the high and 31% for the low. Similarly the proportion of males in the two groups was 21% and 19% respectively. A chisquare analysis of susceptibility group and gender revealed no significant differences (\( \chi^2 [1, N = 70] = .24, p = .63 \)) between cells. All Phase 2 analyses thus involved a two independent group design. To ensure that the groups were different in Phase 1 performance, an ANOVA on Phase 1 overall Trial performance was completed. Here, Group (high versus low, [Hilo]) is a between subject factor and Trial is a within subject factor. The results of this analysis revealed a main effect of Group \( F(1, 68) = 18.21, \ MS_e = 1.33 \), a main Trial effect \( F(2, 136) = 1212.11, \ MS_e = .10 \), and a Group x Trial interaction \( F(2, 136) = 22.53, \ MS_e = .10 \). The cell
means of the high and low susceptibility groups are depicted in Figure 1. Posthoc analysis of the Group by Trial interaction (Tukey, HSD p < .05, Q_{tv} = 2.85, df = 68) indicates that both groups recalled words equally on Trial 1 (Q = 1.48), with performance differences on Trial 2 (Q = 3.94) and Trial 3 (Q = 5.02) favouring the low susceptibility group.

To demonstrate the reliability of this Phase 1 difference between susceptibility groups, a parallel analysis was done on those blocks in Phase 2 in which the first 3 trials allowed for a build up of PI (blocks involving the first three trials of the full and subtle category shifts). The results were parallel to the Phase 1 analysis with significant Group F(1, 68) = 7.16, MS_e = 3.28, Trial F(2, 136) = 205.15, MS_e = .42 and Group x Trial effects F(2, 136) = 7.63, MS_e = .42. The cell means are shown in Figure 2. Post hoc analysis (Tukey, HSD p < .05, Q_{tv} = 2.85, df = 68) showed no group differences on Trial 1 (Q = .591) and an increase in group differences on Trial 2 (Q = 3.21). Group differences decreased slightly on Trial 3 (Q = 2.75); however the result approached significance.

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Insert Figure 1 & 2 about here

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Figure 1. Comparison of high and low susceptibility groups on Phase 1 mean Trial performance.
Figure 2. Comparison of high and low susceptibility groups on Phase 2 mean Trial performance of Full and Subtle release blocks.
In addition to these analyses, the results of the final free recall completed in Phase 1 were also examined in terms of the high and low susceptible groups. Thus, an analysis of variance with susceptibility Group as a between subject factor and Trial as a within subject factor was performed. The results of this analysis, which are depicted graphically in Figure 3, revealed a significant Group effect $F = 4.75 (1, 89) \text{ MS}_g = 4.81$, and a significant Trial effect $F = 36.37 (2, 178) \text{ MS}_t = 2.45$. The Group x Trials interaction, $F = 1.10 (2, 178) \text{ MS}_{gt} = 2.45$, was not significant. Simple effects analyses revealed that the groups did not differ on Trial 1 or Trial 2, $F = 1.18 (1, 89) \text{ MS}_g = 3.89$, $F = .90 (1, 89) \text{ MS}_t = 2.68$, but did differ on Trial 3, $F = 6.42 (1, 89) \text{ MS}_t = 3.35$.

Having thus established that the high and low susceptibility groups were being differentially affected by PI it was now possible to determine whether the time course of activation or breadth of activation hypotheses could be confirmed.
Figure 3. Comparison of high and low susceptible groups on free recall.
Breadth of activation. To test the breadth of activation hypothesis I first performed an ANOVA on the difference score (Trial 4 - Trial 3) calculated for each of the full and subtle release category blocks. Thus susceptibility Group (Hilo) and Order (counterbalancing sub-group) were between subject factors and Release Type (full vs. subtle shift) was a within subject factor in a 2 x 3 x 2 mixed ANOVA. As can be seen from the ANOVA summary table (Table 4),

Insert Table 4 about here

there was only a main effect of Release Type with the full shift condition involving a greater release than the subtle shift condition (see Figure 4 for the comparison of group means). Performance is very similar for the two susceptibility groups, which both show big differences between the full and subtle shift conditions.

Insert Figure 4 about here

Because the high and low susceptibility groups would be expected to differ on Trial 3 performance, a new score was calculated which measured the
<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS&lt;sub&gt;e&lt;/sub&gt;</th>
<th>F</th>
<th>p</th>
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<tbody>
<tr>
<td>Sus Group (A)</td>
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<td>1</td>
<td>1.36</td>
<td>1.84</td>
<td>.180</td>
</tr>
<tr>
<td>Order (B)</td>
<td>5.89</td>
<td>2</td>
<td>1.36</td>
<td>2.17</td>
<td>.122</td>
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<tr>
<td>Rel Type (C)</td>
<td>172.17</td>
<td>1</td>
<td>1.17</td>
<td>147.51</td>
<td>.000</td>
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<tr>
<td>A x B</td>
<td>2.70</td>
<td>2</td>
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<td>A x C</td>
<td>.58</td>
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<td>1.17</td>
<td>.49</td>
<td>.485</td>
</tr>
<tr>
<td>B x C</td>
<td>5.79</td>
<td>2</td>
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<td>2.48</td>
<td>.092</td>
</tr>
<tr>
<td>A x B x C</td>
<td>.98</td>
<td>2</td>
<td>1.17</td>
<td>.42</td>
<td>.658</td>
</tr>
</tbody>
</table>
Figure 4. Comparison of high and low susceptibility groups on Full versus Subtle release from PI On Phase 2 using Difference Score.
proportional release from PI for each subject and condition. This was calculated for the subtle and full shift conditions using the following formula: \((\text{Trial 4} - \text{Trial 3}) / (\text{Trial 1} - \text{Trial 3})\). The ANOVA on these proportional release scores can be found in Table 5 and reveals the same significant Release Type effect found for the simple difference score. However, the ANOVA revealed a marginally significant Group x Release Type interaction \(F[1, 58] = 3.80, \text{MS}_e = .81, p = .056\).

Figure 5 provides the means for this analysis and it appears that the low susceptibility group does show a greater proportional release from PI than the high susceptibility group. Simple effects analysis reveals that for the low susceptibility group there was no significant difference in the amount of proportional release between the full and subtle measures \(F = 2.89 [1, 62] \text{MS}_e = .99\). However, for the high susceptibility group this difference was significant \(F = 16.26 [1, 62] \text{MS}_e = .99\). These relative analyses
Table 5

**ANOVA Involving Full vs Subtle Shift in Category**

**using Susceptibility Scores by Susceptibility Group**

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sus Group (A)</td>
<td>.95</td>
<td>1</td>
<td>.81</td>
<td>1.16</td>
<td>.285</td>
</tr>
<tr>
<td>Order (B)</td>
<td>1.43</td>
<td>2</td>
<td>.81</td>
<td>.88</td>
<td>.420</td>
</tr>
<tr>
<td>Rel Type (C)</td>
<td>13.36</td>
<td>1</td>
<td>1.00</td>
<td>13.40</td>
<td>.001</td>
</tr>
<tr>
<td>A x B</td>
<td>3.65</td>
<td>2</td>
<td>.81</td>
<td>2.24</td>
<td>.116</td>
</tr>
<tr>
<td>A x C</td>
<td>3.79</td>
<td>1</td>
<td>1.00</td>
<td>3.80</td>
<td>.056</td>
</tr>
<tr>
<td>B x C</td>
<td>1.25</td>
<td>2</td>
<td>1.00</td>
<td>.63</td>
<td>.539</td>
</tr>
<tr>
<td>A x B x C</td>
<td>2.38</td>
<td>2</td>
<td>1.00</td>
<td>1.20</td>
<td>.310</td>
</tr>
</tbody>
</table>
Figure 5. Comparison of high and low susceptibility groups on Full versus Subtle release from PI with proportional release scores.
support the original hypothesis concerning breadth of activation.

**Time of activation.** To examine the time of activation hypothesis several ANOVAs were performed. First, a mixed effect 2 x 3 x 3 ANOVA was performed on Trial 1 - Trial 2 difference scores, in which Trial 2 is the critical Trial for those blocks in which categories were separated by 0, 1, or 2 other categories. Again susceptibility Group (Hilo) and Order were the between subject factors and Lag was the within subject variable. The results of this analysis can be found in Table 6 and reveal no significant effects except for an Order x Lag interaction. The Group x Lag interaction was not significant and thus does not support the time of activation hypothesis. These results are depicted graphically in Figure 6 and indicate that, for Lag 0 and Lag 1, both high and low susceptibility groups experienced equal amounts of release from PI. However, for Lag 2, this difference
### Table 6

**ANOVA Involving Difference in the Lag Condition by Susceptibility Group**

<table>
<thead>
<tr>
<th>Source</th>
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</thead>
<tbody>
<tr>
<td>Sus Group (A)</td>
<td>3.05</td>
<td>1</td>
<td>1.43</td>
<td>2.14</td>
<td>.149</td>
</tr>
<tr>
<td>Order (B)</td>
<td>.90</td>
<td>2</td>
<td>1.43</td>
<td>.31</td>
<td>.732</td>
</tr>
<tr>
<td>Lag (C)</td>
<td>4.85</td>
<td>2</td>
<td>1.19</td>
<td>2.03</td>
<td>.136</td>
</tr>
<tr>
<td>A x B</td>
<td>.97</td>
<td>2</td>
<td>1.43</td>
<td>.34</td>
<td>.714</td>
</tr>
<tr>
<td>A x C</td>
<td>3.06</td>
<td>2</td>
<td>1.19</td>
<td>1.28</td>
<td>.136</td>
</tr>
<tr>
<td>B x C</td>
<td>19.79</td>
<td>4</td>
<td>1.19</td>
<td>4.14</td>
<td>.003</td>
</tr>
<tr>
<td>A x B x C</td>
<td>3.78</td>
<td>4</td>
<td>1.19</td>
<td>.79</td>
<td>.534</td>
</tr>
</tbody>
</table>
Figure 6. Comparison of high and low susceptibility groups on Time Lag with Difference Scores.
disappears and is somewhat puzzling. A second ANOVA was performed using susceptibility Group (Hilo) and Order as between subject factors and Lag (0, 1, 2) and Trials as within subject factors in a 2 x 3 x 3 x 2 mixed ANOVA. These results can be seen in Table 7 and reveal significant results for Trials, Group, and Order x Lag x Trial effects. However, the expected interactions for Group x Trials and Group x Lag did not appear. These results are depicted graphically in Figure 7. Based on the lack of significance for these analyses, several other analyses with varying modifications were attempted. For example, the analyses were re-calculated using three levels of susceptibility to PI and included only the top and bottom third of the cases. It was believed this might lead to significant differences between the two groups. The analyses were not statistically significant.
Table 7

ANOVA Involving Lag Condition and Delay Condition by Susceptibility Group

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS_e</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group (A)</td>
<td>54.60</td>
<td>1</td>
<td>7.88</td>
<td>6.93</td>
<td>.011</td>
</tr>
<tr>
<td>Treatment (B)</td>
<td>3.86</td>
<td>2</td>
<td>7.88</td>
<td>.25</td>
<td>.783</td>
</tr>
<tr>
<td>A x B</td>
<td>8.52</td>
<td>2</td>
<td>7.88</td>
<td>.54</td>
<td>.585</td>
</tr>
<tr>
<td>Lag (C)</td>
<td>.09</td>
<td>2</td>
<td>.85</td>
<td>.05</td>
<td>.948</td>
</tr>
<tr>
<td>A x C</td>
<td>.23</td>
<td>2</td>
<td>.85</td>
<td>.14</td>
<td>.872</td>
</tr>
<tr>
<td>B x C</td>
<td>3.49</td>
<td>4</td>
<td>.85</td>
<td>1.03</td>
<td>.393</td>
</tr>
<tr>
<td>A x B x C</td>
<td>3.73</td>
<td>4</td>
<td>.85</td>
<td>1.10</td>
<td>.358</td>
</tr>
<tr>
<td>Trials (D)</td>
<td>313.57</td>
<td>1</td>
<td>.71</td>
<td>438.60</td>
<td>.000</td>
</tr>
<tr>
<td>A x D</td>
<td>1.53</td>
<td>1</td>
<td>.71</td>
<td>2.14</td>
<td>.149</td>
</tr>
<tr>
<td>B x D</td>
<td>.45</td>
<td>2</td>
<td>.71</td>
<td>.31</td>
<td>.732</td>
</tr>
<tr>
<td>A x B x D</td>
<td>.48</td>
<td>2</td>
<td>.71</td>
<td>.34</td>
<td>.714</td>
</tr>
<tr>
<td>C x D</td>
<td>2.42</td>
<td>2</td>
<td>.60</td>
<td>2.03</td>
<td>.136</td>
</tr>
<tr>
<td>A x C x D</td>
<td>1.53</td>
<td>2</td>
<td>.60</td>
<td>1.28</td>
<td>.281</td>
</tr>
<tr>
<td>B x C x D</td>
<td>9.89</td>
<td>4</td>
<td>.60</td>
<td>4.14</td>
<td>.003</td>
</tr>
<tr>
<td>A x B x C x D</td>
<td>1.89</td>
<td>4</td>
<td>.60</td>
<td>.79</td>
<td>.534</td>
</tr>
</tbody>
</table>
Figure 7. Comparison of high and low susceptibility groups on Time Lag with Susceptibility Scores.
Establishing Reliability

An additional analysis was performed to determine whether the Sus, obtained in Phase 1 would correlate with the susceptibility measures calculated for the subtle and full release conditions as well as each of the Lag susceptibility measures. A correlation of $r = -0.24$ was obtained between the Sus, and the subtle susceptibility measure. The correlation between the Sus, and the full release susceptibility measure was not significant ($r = 0.16$). The correlations between the 0, 1, and 2, Lag susceptibility measures and Sus, were, $r = 0.33$, $r = 0.24$, and $r = -0.05$.

**Frontal lobe measures.** Measures of verbal fluency were scored for each day and an overall fluency score was also calculated. The mean scores were, respectively, 72.23 (SD 16.59), 69.84 (SD 13.60), 79.46 (SD 15.25). The overall mean score was 73.84 (SD 14.05). Intercorrelations of the daily verbal fluency measures revealed the following correlations $r = 0.76$, $r = 0.80$ and $r = 0.81$. This clearly suggests that subjects performance was stable across days and that these measures are reliable.

Several measures are normally obtained with the WCST. However, all measures are highly intercorrelated and the measure of perseverative responses is the one that is considered most appropriate (Heaton, 1981).
The mean score for the perseverative responses was 11.83 (SD 7.62). This measure was used for all correlational analyses.

Based on Dempster's suggestions (1992) it was expected that the measures of frontal lobe functioning would correlate with the susceptibility measures. Thus, the verbal fluency score and the WCST were correlated with the six susceptibility measures in obtained in Phase 1. These correlations can be found Table 8. In summary, verbal fluency correlated significantly with five of the six susceptibility measures while the WCST correlated with only one of the susceptibility measures. Verbal fluency did not correlate with perseverative responses, although the observed correlation was in the predicted direction.

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Insert Table 8 about here
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Discussion

The results of this study are both encouraging and discouraging. The results of Phase 1, were consistent with those normally obtained with PI studies using the Craik and Birtwistle (1971) paradigm; PI increased over trials when the semantic category is held constant. It was also found that most of the PI build-up occurred
Establishing Reliability

Table 8

Correlations Between Verbal Fluency, WCST and Susceptibility Measures

<table>
<thead>
<tr>
<th></th>
<th>Fluency</th>
<th>WCST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suscep2</td>
<td>-.28*</td>
<td>.24*</td>
</tr>
<tr>
<td>Suscep3</td>
<td>-.31*</td>
<td>.17</td>
</tr>
<tr>
<td>Fluency</td>
<td>--</td>
<td>-.19</td>
</tr>
</tbody>
</table>

* p < .05
from Trial 1 to Trial 2. It is particularly interesting to note that the pattern of PI build-up was found in each of the 16 blocks. Even more interesting was the fact that the typical pattern of PI build-up was found for the majority of the subjects and that the few exceptions have Trial 3 performance slightly higher than Trial 2. Even for these subjects, PI was evident. Overall, the results were quite consistent with the typical pattern of PI results.

The primary purpose of Phase 1 was to establish temporal reliability of measures of individual differences in susceptibility to PI. Support was provided in that both the Sus, and Sus, susceptibility measures of Day 1 were significantly correlated with those of Day 2 as was hypothesized. In fact, all measures of susceptibility intercorrelated significantly. Some caution is warranted, however, since the correlations obtained explained only 4% to 14% of the variation. The success obtained in this study over previous ones (Hau, 1993; Hau & McIntyre, 1993) in regards to the measures of reliability is due to several possible factors. First, it seems that the use of more blocks of trials appears beneficial. That is, better stability in the measures was obtained. Secondly, constructing slightly shorter lists than
normally used with the Craik and Birtwistle (1971) paradigm, also seems worthwhile. This was done on the assumption that subjects overall recall performance would be better on Trial 1. Finally, using lists of equal recallability appears to have helped. It would seem then, that this study has found a variable with temporal stability. However, the reliability is not as strong as was found with verbal fluency, for example, and is not in the .70 or above range that would have been preferred. In summary, the primary goal of Phase 1 was achieved.

A particularly interesting finding of Phase 1 data was that, for the free recall test, the resulting performance reflected the typical pattern of PI and was directly parallel to the overall list recall. This suggests that PI is not just a temporary retrieval phenomenon. It indicates that PI reflects a fundamental problem of encoding. Further, this data suggests that individuals with high PI susceptibility experience more problems with encoding and retrieval processes when materials are more semantically related. Therefore, these data add empirical support for Dempster’s (1985) suggestion that individuals with higher levels of susceptibility to PI may be affected in the typical academic environment.
In previous studies (Loftus & Patterson, 1975; Watkins & Watkins, 1975), this pattern of PI build-up was not found in tests of free recall. In both these studies the Brown-Peterson paradigm was used, where only a few items are presented in any given trial. One possible explanation for the difference of results in this study is that the Craik and Birtwistle paradigm was used. It is possible that the PI retrieval deficit manifested in previous studies was due to a possible artifact. Since subjects are normally presented numerous trials in the Brown-Peterson paradigm, it is possible that the results obtained are more indicative of memory strategies rather than PI.

Phase 2 had several purposes. One was to establish support for Dempster’s (1992) suggestion that frontal lobe functioning should be sensitive to interference effects. Dempster has argued that all of the Brown-Peterson tasks (here represented by the Craik & Birtwistle [1971] procedure), WCST and verbal fluency are interference susceptible tasks relying on the frontal lobes. As expected, the overall verbal fluency score was negatively correlated with the susceptibility measures. That is, subjects who displayed higher levels of susceptibility generated fewer words in comparison to those subjects who displayed less
susceptibility. The fact that the verbal fluency score was significantly correlated with the susceptibility measures provides substantial support for Dempster's proposition. However, the WCST correlated with only one of the susceptibility measures providing only weak support for Dempster's (1992) suggestion.

The correlations obtained in this study are in contrast to those obtained by Hau (1993) and need to be clarified. In Hau's (1993) study, the verbal fluency score was not correlated with the susceptibility measures. The only difference between that study and the current study is the amount of time given to generate words, being 30 seconds in Hau (1993) and 60 seconds in this study. While this difference might account for some of the difference in the results obtained, the selection of subjects is probably the more critical factor. It should be remembered that in this study all subjects were selected on the basis that their mother tongue was English. In Hau's (1993) study this factor was not controlled. It is quite probable that those who do not learn English as a first language do not generate English words as quickly as those who do. If so, this would weaken correlational data. Similarly, in Hau and McIntyre (1993) the correlations between verbal fluency and the susceptibility measures,
while not significant, were in the appropriate
direction. That is, individuals who generated more
words had lower susceptibility scores.

The results of the WCST are somewhat more
difficult to explain. The results of this study in
combination with our previous attempt (Hau, 1993) which
found that only one susceptibility measure correlated
with the WCST, provide only weak support for a
relationship between susceptibility measures and the
WCST. Several important differences in the
administration of the WCST should be noted. In this
study the WCST was administered with the computer
version of the WCST while Hau (1993) administered the
card version of the WCST. First, the computer version
requires that subjects achieve 10 correct responses to
a given sorting principle before that principle is
changed to a new one. This cannot be altered. Using
the manual version, Hau set the level at seven correct
responses. A second difference is that the computer
version ends the test once six categories have been
successfully achieved. With the manual version the
test can be continued until all of the 128 cards have
been sorted which is what Hau had done. Both these
factors would somewhat limit the variance of the
results that can be obtained with the computer version.
A third difference is that the scoring is done automatically with the computer version, and thus the probability of scoring error is eliminated. It is probable then, that these factors contributed to the differences in the results obtained in both studies.

The correlation between the two frontal lobe measures, the WCST and verbal fluency, was not significant and is somewhat surprising. While Dempster (1992) argued that both measured mental flexibility and should be highly correlated, these results suggest that, while both the WCST and verbal fluency may reflect frontal lobe functioning, apparently they reflect different processing operations where one (verbal fluency) relates to production tasks and the other (WCST) relates to inhibition. Thus, the fact that verbal fluency did correlate with the susceptibility measures and that the WCST did not, is not as problematic as one might expect.

What is somewhat more puzzling, is that verbal fluency measures did correlate with the susceptibility measures in this study and did not correlate with the susceptibility measures in two previous studies (Hau 1993; Hau & McIntyre, 1993). What should also be noted however, is that, Hau and McIntyre (1993) did obtain a significant correlation between verbal fluency and a
susceptibility measure calculated for the part-set cuing paradigm \( r = -.27 \). This suggests that the part-set cuing paradigm reflects a generation effect similar to that of verbal fluency. This is because subjects are cued according to categories and must generate the appropriate words for each of the categories. In summary, given the results of this study and the two previous studies (Hau, 1993; Hau & McIntyre, 1993) completed in McIntyre's laboratory, measures of frontal lobe functioning, that is, the WCST, verbal fluency and PI susceptibility, do not consistently relate to each as strongly as Dempster (1992) proposed.

The primary purpose of Phase 2 was to identify the underlying basic processing strategies that lead to consistent differences in susceptibility to PI. The time course of activation hypothesis was clearly not supported. However, it is probable that using only a total of 45 words for this condition was insufficient to establish definitely reliable measures. Using several blocks for each of the 0, 1, 2 lag conditions might allow for a better test of this hypothesis.

The results of the breadth of activation hypothesis, however, did receive support suggesting that this process may be an underlying mechanism that
might explain individual differences in susceptibility to PI. There are several possible theoretical alternatives that might explain the results for the breadth of activation hypothesis. An initial possibility that might account for the differences between the high and low susceptibility groups is the amount of memory resource and organizational ability required to encode and retrieve the information presented. It has been shown (Rabinowitz, Craik, & Ackerman, 1982) that older adults display less memory in comparison to younger adults when retrieval cues are varied. That is, older adults displayed equal memory in comparison to younger adults when the retrieval cues for any given category were more general. However, when retrieval cues were more specific, older adults recalled fewer items than younger adults. The authors argued that the reason for the difference in recall performance was that, when the older adults were initially presented with the material, they were only able to encode in a more general fashion because their limited pool of resources did not allow encoding at the more specific, and resource demanding, level that young adults are capable of. Thus, for older adults, retrieval of the items under specific encoding and retrieval cues is more difficult, resulting in
decreased recall performance.

In parallel, it might be argued that individuals with low susceptibility to PI possess more cognitive resources in comparison to individuals with high susceptibility to PI. Thus, they are able to encode and retrieve material more easily. That is, it is possible that low susceptible individuals are able to utilize their cognitive resources in a manner which allows for richer encoding of materials presented. This in turn would allow for easier retrieval of the required items, and thus reduce their vulnerability to PI effects. Alternatively, it is possible that individuals with low susceptibility to PI are simply more efficient in their utilization of available memory resources. If this is so, less cognitive effort would be required to encode the material which in turn implies that they are able to devote more of their cognitive resources to processing strategies.

A second and parallel alternative to explain the breadth of activation results is that low susceptible individuals have more refined encoding strategies in comparison to high susceptible individuals. What may be occurring here is that high susceptible individuals encode items in a more general fashion in comparison to low susceptible individuals. That is, low susceptible
individuals develop more refined category boundaries which allows for more efficient and effortless encoding and retrieval of individual items. Thus, for low susceptible individuals the number of possible items for any given category would be substantially less in comparison to high susceptible individuals who would automatically have a much higher number of items for any given category. This would enable low susceptible individuals to encode materials more appropriately and efficiently into categories and sub-categories. In contrast, high susceptible individuals can only activate broader categories. Thus, when an item is presented and a category initiated, high susceptible individuals would activate a general category while low susceptibles would activate a subcategory. It would appear logical to conclude that activation of the more general category and thus greater number of total instances, would generate higher levels of interference. A manner in which to further test breadth of activation would be to construct a series of trials in which each subsequent trial is a sub-category of the first trial. Clearly, what should occur is that low susceptible individuals would develop little if any PI, whereas the high susceptible individuals should demonstrate progressively higher levels of PI.
Another possible explanation in understanding how differences occur between high and low susceptible individuals is that low susceptible individuals are better able to inhibit the effects of interference. Hasher and Zacks (1988) have argued that the reason why older adults display more forgetting is because of their inability to inhibit interference effects. What is suggested here is that the difference between the high and low susceptible groups is not because of the former has fewer cognitive resources or more broadly defined categories, but that it is not as capable in inhibiting the effects of interference as the latter group can. Thus, both groups experience the same level of interference, however one group is better at countering the effects of the interference. It is quite apparent that the breadth of activation hypothesis clearly warrants further investigation.

Dempster (1985) was interested in determining if connected meaningful material was susceptible to PI and how individual differences in susceptibility to PI might affect individuals within a classroom setting. The significant correlations that he obtained between the susceptibility measures and the ACT were obtained with what he called the related topic condition. In this condition, Dempster began each of the sentences he
used with words that were related, for example, inhibition, anxiety, hostility and hysteria. He argued that this activated several different but related concepts and primed other neighbouring concepts, which in turn, leads to differences in susceptibility to PI. It would seem logical then to assume that high susceptible individuals should show more PI, in comparison to low susceptible individuals, with closely related topics than when the lists are all of the same topic.

Both Dempster’s (1985) study and this study suggest that PI may have a detrimental effect on achievement within the academic environment. For example, when individuals are presented with highly abstract and difficult material, several related concepts would normally be activated and compete for attention. Individuals with low PI susceptibility would more readily discern nuances between concepts and facilitate their understanding of the material which is being presented. In contrast, individuals with high susceptibility would not as readily differentiate between the related concepts and would require more concentrated effort to understand the material presented. Because of the interference generated, it is probable that concepts may overlap somewhat and make
it difficult for high susceptible individuals to fully comprehend the material in the manner intended. Later when they are tested, concepts originally presented would be remembered in the manner which they had understood. Similarly, the same process might be occurring when one is reading a difficult text. Often, difficult passages have to be read several times before their intended meaning becomes clearly understood. Could it be that PI is being manifested?

It has been suggested that Dempster’s (1985) findings might reflect differences in verbal ability (Greene, 1992). The verbal fluency measures appear to support this; low susceptible individuals had higher mean daily verbal fluency scores than did the high susceptibles. Verbal ability directly affects our comprehension capability. That is, the better our verbal ability, the more quickly we will be able to comprehend material presented visually and in text. However, what might be initially affecting verbal ability is PI. That is individuals with low susceptibility to PI would acquire words or verbal ability more quickly than high susceptible individuals. In this scenario then, the effects of PI would impact upon individuals early in life and affect their academic performance throughout their education. It
becomes important then to ensure that reading skills and comprehension be established early. Individuals experiencing comprehension difficulties may be experiencing high levels of PI. Presenting reading materials in a different manner might dissipate PI effects, increase comprehension, and ultimately academic performance.

In conclusion, the overall results of this study and those previously completed in McIntyre's laboratory do suggest that susceptibility to PI is a reliable individual difference variable. Additionally, it would appear that breadth of activation is the key component of individual differences in susceptibility to PI. It is also evident that the methodology used requires refinement before clear conclusions can be stated. The possibility that PI may be a contributing factor in academic performance should be aggressively investigated, especially if it is found to be prevalent in early childhood.
Establishing Reliability

References


Appendix A

Phase 1 Word Lists

Day 1

Block 1
List 1
Birch, Cork, Mulberry, Walnut, Bonsai, Spruce, Sequoia, Willow, Mahogany, Pear, Fig, Cedar.
List 2
Lemon, Lilac, Teak, Aspen, Cherry, Linden, Peach, Ash, Juniper, Hemlock, Elm, Beechnut.
List 3
Bamboo, Olive, Chestnut, Plum, Sycamore, Mimosa, Poplar, Rubber, Banana, Fir, Balsa, Redwood.

Block 2
List 1
Dog-sled, Rocket, Tank, Buggy, Skis, Scooter, Ferry, Glider, Canoe, Ambulance, Balloon, Sleigh.
List 2
Biplane, Trailer, Horse, Jeep, Wagon, Yacht, Blimp, Submarine, Cart, Schooner, Sedan, Cruiser.
List 3
Tractor, Camel, Tram, Oxcart, Tandem, Jet, Raft, Taxi, Truck, Motorbike, Rickshaw, Sail-boat.
Establishing Reliability

Block 3
LIST 1
Duplex, Cabin, Garage, Villa, Jail, Condo, Cavern, Chamber, Office, Shack, Cottage, Chateau.
List 2
Palace, Barracks, Bungalow, Farm, Mansion, Camper, Tepee, Hacienda, Igloo, Ranch, Habitat, Cove.
List 3
Rectory, Foxhole, Prison, Sampan, Motel, Flat, Dorm, Estate, Castle, Home, Monastery.

Block 4
List 1
Alcove, Cushion, Dinette, Vanity, Cupboard, Closet, Mantle, Hammock, Podium, Cradle, Armchair, Piano.
List 2
Cabinet, Dresser, Divan, Hutch, Freezer, Settee, Commode, Drapes, Buffet, Secretary, Bookshelf, Chaise.
List 3
Crib, Curtains, Oven, Ashtray, Painting, Stool, Pillow, Ottoman, Ricker, Organ, Chest, Mirror.
Establishing Reliability

Block 5
List 1
Cloves, Spices, Onion, Mustard, Nutmeg, Vinegar,
Butter, Lemon, Thyme, Parsley, Almond, Herbs.
List 2
Sage, Chives, Ginger, Sauce, Wine, Peppers, Chervil,
Chicory, Clover, Mint, Oregano, Paprika.
List 3
Cinnamon, Vanilla, Accent, Dill, Marjoram, Basil,
Curry, Anise, Lime, Sesame, Rosemary, Cardamom.

Block 6
List 1
Walrus, Bear, Goat, Jackal, Iguana, Fawn, Burro,
Badger, Muskrat, Gopher, Bobcat, Otter.
List 2
Gorilla, Boar, Ocelot, Frog, Cougar, Mink, Lizard,
Bison, Hyena, Opossum, Gazelle, Beaver.
List 3
Turtle, Monkey, Deer, Squirrel, Rabbit, Wolf, Moose,
Raccoon, Panther, Llama, Skunk, Coyote.
Establishing Reliability

Block 7

List 1

List 2
Scissors, Grenade, Bullet, Sabre, Wrench, Machete, Scarf, Tomahawk, Razor, Stiletto, Bolo, Javelin.

List 3
Chain, Torch, Mace, Slingshot, Pistol, Rope, Sword, Blowgun, Crowbar, Catapult, Cudgel, Crossbow.

Block 8

List 1

List 2

List 3
Day 2

Block 1
List 1
Larceny, Adultery, Killing, Battery, Felony, Speeding, Forgery, Treason, Fraud, Suicide, Perjury, Homicide.
List 2
Bigamy, Extortion, Bribery, Slander, Gambling, Espionage, Smuggling, Looting, Torture, Mugging, Libel, Molesting.
List 3
Arson, Assault, Blackmail, Rioting, Narcotics, Peddling, Subversion, Stabbing, Sodomy, Vandalism, Sabotage, Stealing.

Block 2
List 1
Lake, Canyon, Cliff, Ocean, Terrain, Hillock, Geyser, Abyss, Gorge, Crevice, Stream, Plateau.
List 2
Cave, Gully, Volcano, Desert, Island, Glacier, Ravine, Crater, Beach, Dune, Boulder, Fossil.
List 3
Mound, Iceberg, Knoll, Pond, Quarry, Reef, Ridge, Harbour, Tundra, Pebbles, Bay, Meadow.
Block 3
List 1
Canary, Hawk, Wren, Oriole, Parrot, Pigeon, Starling, Vulture, Swallow, Chicken, Dove, Thrush.
List 2
Duck, Falcon, Pheasant, Finch, Buzzard, Ostrich, Lark, Turkey, Raven, Swan, Crane, Geese.
List 3
Pelican, Stork, Warbler, Quail, Rooster, Condor, Heron, Grouse, Crow, Bluebird, Owl, Seagull.

Block 4
List 1
Bowl, Beater, Skillet, Toaster, Strainer, Ladle, Saucer, Sifter, Scraper, Colander, Tongs, Grater.
List 2
Mixer, Spatula, Plate, Blender, Broiler, Kettle, Platter, Dish-pan, Teaspoon, Canister, Steamer, Mould.
List 3
Sieve, Opener, Sponge, Roaster, Grinder, Casserole, Chopper, Brush, Dicer, Baster, Cup, Flipper.
Establishing Reliability

Block 5
List 1
Sydney, Athens, Toledo, Vienna, Aspen, Dansk, Baghdad, Dublin, Manila, Lyons, Delhi, Moscow.
List 2
List 3
Paris, Zurich, Bonn, Tulsa, Brussels, Munich, Dover, Memphis, Berlin, Prague, Brisbane, Barcelona.

Block 6
List 1
Nurse, Plumber, Clerk, Farmer, Chemist, Merchant, Banker, Physicist, Fireman, Judge, Artist, Umpire.
List 2
Baker, Barber, Druggist, Editor, Foreman, Waitress, Gardener, Butler, Draughtsman, Physician, Priest, Mechanic.
List 3
Secretary, Minister, Janitor, Grocer, Milkman, Butcher, Painter, Welder, Chef, Dean, Detective, Jeweller.
Establishing Reliability

Block 7
List 1
Fencing, Softball, Polo, Rugby, Sailing, Pool, Squash, Surfing, Archery, Fishing, Judo, Boxing.
List 2
Track, Golf, Soccer, Lacrosse, Canoeing, Hiking, Curling, Croquet, Skiing, Camping, Billiards, Bullfighting.
List 3

Block 8
List 1
Flounder, Porpoise, Carp, Piranha, Muskie, Eel, Puffer, Sucker, Goldfish, Sturgeon, Black bass.
List 2
Crappie, Tarpon, Bullhead, Swordfish, Mackerel, Salmon, Walleye, Garfish, Marlin, Sardine, Sailfish, Gourami.
List 3
Stingray, Tuna, Sunfish, Haddock, Starfish, Guppy, Pickerel, Blowfish, Barracuda, Squid, Halibut, Pike.
Appendix B

General Memory Questionnaire

Name______________________________

Brief Background Questionnaire:

Please answer each of the following questions. Your answers will help us in understanding whether the outcome of our various memory tests are related to important individual difference variables such as gender or familiarity with English.

1. Your Age _____ years
2. Sex female / male (please circle one)
3. Year in University ______
4. Major______________________________
5. Number of university courses completed to date_______
6. Are you a Canadian citizen? Yes___ No___
7. Is English your...
   a. first language
   b. second language
   c. third language
8. How would you rate your ability in English:
   a. English is my only or first language
   b. Excellent
   c. Fair
9. How would you rate your memory compared to the way it was.... (much worse = 1; much better = 7)
   a. one month ago 1 2 3 4 5 6 7
   b. one year ago 1 2 3 4 5 6 7
   c. five years ago 1 2 3 4 5 6 7
   d. ten years ago 1 2 3 4 5 6 7

10. How often do you use these techniques to remind yourself about things... (always = 1, never = 7)
    a. keep an appointment book 1 2 3 4 5 6 7
    b. write yourself reminder notes 1 2 3 4 5 6 7
    c. make lists of things to do 1 2 3 4 5 6 7
    d. make grocery lists 1 2 3 4 5 6 7
    e. have others remind you 1 2 3 4 5 6 7
    f. plan your daily schedule in advance 1 2 3 4 5 6 7
    g. mental repetition 1 2 3 4 5 6 7
    h. association with other objects 1 2 3 4 5 6 7
    i. keep objects in the identical place so you always know where to find them 1 2 3 4 5 6 7
    j. keep things you need to do in a prominent place where you will notice them 1 2 3 4 5 6 7
11. How often do these present a memory problem for you... (always = 1; never = 7)

a. names 1 2 3 4 5 6 7
b. faces 1 2 3 4 5 6 7
c. appointments 1 2 3 4 5 6 7
d. where you put things (ie Keys) 1 2 3 4 5 6 7
e. performing household chores 1 2 3 4 5 6 7
f. direction to places 1 2 3 4 5 6 7
g. phone numbers you’ve just checked 1 2 3 4 5 6 7
h. phone numbers used frequently 1 2 3 4 5 6 7
i. things people tell you 1 2 3 4 5 6 7
j. keeping up correspondence 1 2 3 4 5 6 7
k. personal dates (ie birthdays) 1 2 3 4 5 6 7
l. words 1 2 3 4 5 6 7
m. going to the store and forgetting what you came to buy 1 2 3 4 5 6 7
n. taking a test 1 2 3 4 5 6 7
o. beginning to do something and forgetting what you were going to do 1 2 3 4 5 6 7
Appendix C

Phase 2 Word Lists

Day 1

Block 1
List 1
Owl, Quail, Penguin, Wren, Pigeon, Chickadee, Lark, 
Chicken, Thrush, Parakeet, Warbler, Swan, Condor, 
Buzzard, Albatross.
List 2
Peacock, Pelican, Finch, Hawk, Vulture, Crane, Dove, 
Ostrich, Kingfisher, Oriole, Goldfinch, Falcon 
Snowbird, Jay, Grouse.
List 3
Canary, Parrot, Turkey, Blackbird, Goose, Flamingo, 
Swallow, Grackle, Raven, Stork, Duck, Starling, 
Rooster, Crow, Lovebird.
List 4
Cousin, Mother, Nephew, Daughter, Husband, Sister, Son, 
Wife, Uncle, Brother, Niece, Father, Parents, Sibling, 
Godson.
Establishing Reliability

Block 2
List 1
Belgium, Chile, Egypt, Peru, Italy, Mexico, Britain, Iraq, Denmark, Laos, Israel, Norway, Japan, Sweden, Ireland.
List 2
Joan, Lynne, Nicole, Susan, Donna, Helen, Peggy, Gail, Marie, Sally, Frances, Janet, Paula, Phyllis, Alice.
List 3
Turkey, Hungary, Brazil, Poland, Vietnam, Scotland, Australia, Iran, Bolivia, China, Portugal, Panama Spain, Finland, Greece.
List 4.

Block 3
List 1
Dogfish, Flounder, Porpoise, Eel, Carp, Pickerel, Bluefish, Black bass, Jellyfish, Muskie, Piranha, Sucker, Squid, Cod, Shad.
Establishing Reliability

List 2
Sergeant, Corporal, Ensign, Officer, Yeoman, Major, Admiral, Commander, Adjutant, Seaman, Brigadier, Colonel, Boatswain, Captain, Chaplain.

List 3
Vowels, Clause, Phrases, Syllables, Modifier, Infinitive, Sentences, Participle, Subject, Comma, Consonant, Predicate, Object, Metaphor, Antonym.

List 4
Stingray, Tuna, Haddock, Starfish, Sunfish, Guppy, Puffer, Blowfish, Garfish, Sailfish, Barracuda, Halibut, Angel, Walleye, Sturgeon.

Block 4
List 1
Jacket, Trousers, Girdle, Robe, Chemise, Jeans, Nightgown, Vest, Nylons, Sandals, Pyjamas, Boots, Dress, Slacks, Jumper.

List 2
Parka, Smock, Bloomers, Tuxedo, Sweater, Suit, Bermudas, Cape, Overshoes, Blazer, Stockings, Slip Skirt, Raincoat, Undershirt.
List 3
Slippers, Panties, Swimsuit, Mittens, Corset, Gown, T-shirt, Bathrobe, Cardigan, Lingerie, Shorts, Bra, Topcoat, Vest, Briefs.

List 4
Gloves, Apron, Belt, Necklace, Ribbon, Tie, Scarf, Rings, Ascot, Bracelet, Cane, Watch, Purse, Hat, Earmuffs.

Block 5
List 1
Thomas, Stephen, Edward, Adam, Roger, Bruce, Jeff, Tony, Gordon, Duncan, Arthur, Brent, Doug, Daniel, Mark.

List 2

List 3
Plum, Mango, Coconut, Fig, Apricot, Lemon, Grape, Papaya, Kumquat, Lime, Tomato, Cantaloupe, Nectarine, Prunes, Cherry.
Establishing Reliability

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List 4
Felony, Homicide, Adultery, Perjury, Blackmail,
Treason, Fraud, Larceny, Arson, Burglary, Forgery, 
Suicide, Speeding, Sabotage, Looting.

Day 2

Block 1
List 1
Denim, Muslin, Tweed, Chiffon, Suede, Linen, Leather,
Canvas, Velvet Cashmere, Orlon, Crepe, Dacron, Lace,
Brocade.
List 2
Grey, Aqua, Magenta, Crimson, Burgundy, Beige, Pink,
Gold, Navy, White, Mauve, Lavender, Orchid, Rose,
Brown.
List 3
Butane, Kerosine, Alcohol, Octane, Naphtha, Steam,
Petrol, Charcoal, Methane, Benzene, Diesel, Propane,
Helium, Electricity, Hydrogen.
List 4
Felt, Taffeta, Polyester, Flannel, Corduroy, Satin,
Gaberdine, Chamois, Burlap, Velour, Jersey, Mohair,
Gingham, Latex, Argyll.
Establishing Reliability

Block 2
List 1
Axe, Sander, Crowbar, Ladder, Bench, Anvil, Pliers,
Leveller, File, Hacksaw, Wedge, Stapler, Ruler, Knife,
Glue.
List 2
Drill, Jigsaw, Toolbelt, Square, Punch, Sawhorse,
Chisel, Vice, Planer, Toolbox, Ratchet, Lathe, Rasp,
Pencil, Clamp.
List 3
Cognac, Tequila, Liqueur, Martini, Drambuie, Kaluah,
Screwdriver, Rum, Daiquiri, Manhattan, Gimlet, Tia
Maria, Brandy, Ale, Sake.
List 4
Ravine, Crevice, Volcano, Pond, Boulder, Cove, Meadow,
Quarry, Island, Swamp, Beach, Creek, Canyon, Cavern,
Glacier.

Block 3
List 1
Steps, Closet, Cellar, Lobby, Bedroom, Hallway,
Kitchen, Porch, Attic, Chimney, Fireplace, Nursery,
Ceiling, Banister, Awning.
Establishing Reliability

List 2
Rainbow, Twister, Drought, Fog, Cyclone, Thunder, Blizzard, Gale, Monsoon, Frost, Drizzle, Hailstorm, Sleet, Wind, Tempest.

List 3
Hall, Windowsill, Bathroom, Foundation, Wing, Workshop, Stairway, Den, Entrance, Rafters, Facade, Balcony, Beams, Shutters, Frame.

List 4
Archery, Fencing, Judo, Rugby, Boxing, Wrestling, Squash, Lacrosse, Polo, Cricket, Surfing, Bowling, Handball, Canoeing, Golf.

Block 4
LIST 1
Whip, Arrow, Hatchet, Lance, Dagger, Torpedo, Harpoon, Catapult, Bolo, Blowgun, Revolver, Wrench, Blackjack, Sword, Stick.

List 2
Establishing Reliability

List 3
Mace, Pistol, Tomahawk, Rope, Javelin, Nightstick, Crowbar, Shotgun, Machete, Scissors, Razor, Scarf, Tank, Stone, Pitchfork.

List 4
Shrine, Pagoda, Monastery, Abbey, Mission, Sanctuary, Rectory, Catacomb, Basilica, Mosque, Convent, Parish, Chapel, Tabernacle, Altar.

Block 5
List 1
Psychologist, Nurse, Banker, Clerk, Manager, Sailor, Thief, Typist, Designer, Scholar, Athlete, Journalist, Scientist, Pharmacist, Architect.

List 2
Actor, Janitor, Critic, Judge, Pianist, Optician, Butler, Florist, Analyst, Chemist, Counsellor, Biologist, Politician, Economist, Physician.

List 3
List 4
Apprentice, Barber, Welder, Plumber, Electrician, Mechanic, Blacksmith, Machinist, Cook, Butcher, Carpenter, Mason, Miner, Milkman, Painter.

Day 3
Block 1
List 1
Finger, Arms, Torso, Knuckles, Ribs, Face, Mouth, Wrist, Calves, Knee, Limbs, Back, Nose, Abdomen, Chest.
List 2
List 3
Thorax, Cheek, Head, Thighs, Scalp, Hair, Ear, Forehead, Ankle, Thumb, Tooth, Moustache, Nail, Breast, Eye.
List 4
Establishing Reliability

Block 2
List 1
Rabbit, Puma, Lizard, Camel, Giraffe, Beaver, Frog, Snake, Muskrat, Badger, Sheep, Moose, Sloth, Jackal, Iguana.
List 2
Bear, Hamster, Monkey, Skunk, Turtle, Lynx, Zebra, Fox, Antelope, Racoon, Bison, Cobra, Gopher, Weasel, Salamander.
List 3
Wolf, Panther, Alligator, Otter, Walrus, Squirrel, Coyote, Deer, Goat, Llama, Porcupine, Gorilla, Ocelot, Mink, Opossum.
List 4
Bookcase, Mirror, Bench, Piano, Stool, Cabinet, Hassock, Crib, Ottoman, Armchair, Dresser, Hutch, Rocker, Vanity, Curtains.

Block 3
List 1
Bugle, Piccolo, Fiddle, Chimes, Banjo, Guitar, Organ, Accordion, Bells, Saxophone, Mandolin, Cello, Tuba, Bass, Cymbals.
Establishing Reliability

List 2
Oboe, Harmonica, Ukulele, Bongos, Flute, Triangle,
Viola, Horn, Xylophone, Harp, Tambourine, Trombone,
Bassoon, Kazoo, Clarinet.

List 3
Turnip, Eggplant, Cabbage, Beets, Radishes, Rhubarb,
Pickle, Onions, Cucumber, Celery, Tomato, Broccoli,
Spinach, Lettuce, Parsnips.

List 4
Sulphur, Radium, Nickel, Neon, Zinc, Copper, Argon,
Carbon, Chlorine, Cobalt, Fluorine, Mercury, Helium,
Lithium, Platinum.

Block 4
List 1
Cleaver, Baster, Sifter, Toaster, Ladle, Colander,
Skillet, Spatula, Beater, Blender, Glass, Broiler,
Oven, Cup, Sink.

List 2
Wasp, Tick, Worm, Locust, Flea, Tarantula, Termite,
Moth, Lice, Ladybug, Hornet, Centipede, Beetle,
Horsefly, Grasshopper.
List 3
Opener, Stove, Scraper, Corkscrew, Chopper, Mixer, Tongs, Sieve, Kettle, Platter, Roaster, Canister, Dicer, Saucer, Brush.

List 4
Spruce, Poplar, Magnolia, Aspen, Bamboo, Linden, Walnut, Cherry, Willow, Sycamore, Chestnut, Teak, Hickory, Cedar, Dogwood.

Block 5
List 1
Bungalow, Palace, Cottage, Cabin, Igloo, Hacienda, Trailer, Rambler, Villa, Tepee, Farm, Castle, Hotel, Lean-to, Abode.
List 2
Parsley, Mint, Anise, Vinegar, Chives, Cloves, Nutmeg, Curry, Lime, Sesame, Ginger, Oregano, Paprika, Allspice, Thyme.
List 3
Clogs, Oxfords, Thongs, Skis, Loafers, Galoshes, Pumps, Moccasins, Rubbers, Skates, Flippers, Sneakers, Cleats, Heels, Flats.