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The Effect of Subliminal Learning: Using a Direct Manipulation Computer Interface

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THE EFFECT OF SUBLIMINAL LEARNING:

USING A DIRECT MANIPULATION COMPUTER INTERFACE

by

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A thesis submitted to the
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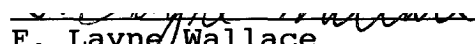DEPARTMENT OF COMPUTER AND INFORMATION SCIENCES

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ABSTRACT

Research to determine what subliminal presentation accomplishes and its effects upon the learning process is very limited. The possibility of presenting subliminal information in a passive manner to reinforce the learning process and the possibility that this presentation can aid in the absorption of the information needed to learn is examined. A previous study examined this possibility using a text editor as the test instrument. In this thesis, a direct manipulation interface using a spreadsheet which visually presents tasks is examined to determine if this environment might be more effective with a learning medium using subliminal perception, then was the case of a text editor. This approach is based on the idea that, in contrast to a text editor, with direct manipulation the user would be completely focused on the computer screen where the subliminal message is presented increasing the chances for feedback. The results of this study show no significant difference between subjects who were getting subliminal help screen presentations and those who were getting either subliminal garbage screen presentations or blank screen presentations. This is in conflict with previous research.

Chapter 1

INTRODUCTION

Subliminal perception is the presentation of stimuli to a
subject in a form that the subject is not consciously aware
of the information presented and no act of attention will
bring the information to his/her conscious awareness
[Groeger84]. There are several aspects of study involving
subliminal perception in the academic environment. These
approaches try to explain subliminal perception and how it
works. In this thesis, the task is to determine if
subliminal perception can assist in the learning process
within a computer environment.

According to Ben Shneiderman, one of the world's leading
authorities on User Interface Design, additional computer
applications have increasingly placed a heavy demand on
ergonomics, to include screen layouts, color choices,
wording of messages, icon designs, etc. [Shneiderman88].
Human factors and human computer interaction are presently
of much concern and interest to researchers. Interaction
styles such as menu selection, form fill-in, command
language, natural language and direct manipulation all have
their place in today's technology. Subliminal Information
transfer has been tested in a line-oriented text editor and

should also be tested in the rest of these environments to
determine its effect on user performance.

Can passive subliminal information aid the user in learning
the commands of a software package? Unconscious thoughts
aid in learning and remembering, helping to develop human
actions and functions on a daily basis [Lewicki89, Reber89].
Manipulation of subconscious thoughts could be incorporated
into the computer environment. Perhaps the ergonomics
specialists could employ such techniques in developing a
method to increase the ease of learning to use the computer.
One study tested this theory by presenting microcomputer-
based subliminal information passively to reinforce the
learning of an on-line HELP screen in a line-oriented text
editor [Wallace91]. This same concept can be tested in a
direct manipulation environment.

Shneiderman is of the opinion that more attention be focused
toward direct manipulation. Direct manipulation is a visual
representation of data in its natural form. It visually
presents tasks. Direct manipulation encourages exploration
and has high subjective satisfaction [Shneiderman88].

This thesis examines subliminal presentation in a direct
manipulation environment to determine if subliminal
presentation is effective in the context of a task driven
spreadsheet. During the experiment referenced above using a

line-oriented text editor, the subjects were not focused

entirely on the computer monitor, concentrating primarily on

the document. It is the purpose of this study to determine

if in a direct manipulation environment, where the subject

is completely focused on the computer screen and where the

subliminal message is presented, what effect the use of

subliminal perception has on learning to use the interface.

Chapter 2

SUBLIMINAL LEARNING

Jacoby and Whitehouse show an illusion of memory can be produced by unconscious perception [Jacoby89]. In their study, a context word was presented subliminally, temporarily activating memory by unconscious perception. This invoked a feeling of familiarity when the same word was presented in a test of recognition. The unconsciously perceived word resulted in a head start in the memory activation of the test word resulting in more fluent processing. In the same respect, Jacoby and Whitehouse showed that a subliminally perceived context word that did not match a test word would lead to confusion and slow down processing of the test word, making the test word seem less familiar than it would have if nothing was subliminally presented. A comparison of subjects that were aware and unaware of the context words resulted in conclusions that were opposite for each situation, eliminating the possibility that the unaware subjects consciously perceived the context words. The conclusions of the Jacoby and Whitehouse experiment were that the effects of unconscious perception can create an illusion of memory and familiarity and therefore influence memory processing.

Bernstein and Welch challenge the "Jacoby-Whitehouse effect" stating that the results do not require "subliminal" assumptions [Bernstein91]. They agreed that the results of the Jacoby and Whitehouse experiment, (briefly exposed material increased the tendency of awareness of old material and longer durations had the reverse effect) were correct conclusions. However, their experiment duplicated Jacoby and Whitehouse's with the exception of not presenting subliminal context words. The argument is that the exposure does not have to be subliminal in nature to produce the results of the experiment. The terms "subtle" and "incidental" are used by these authors to describe a brief exposure time that is not subliminal, concluding that "everyday life provides examples of how the subtle may contrast with the blatant; that which is blatant more clearly evokes resistance (inhibition) than the subtle." [Bernstein91]

Lewicki and Hill believe that if humans did not have the skills to nonconsciously acquire and use knowledge, they would function not as humans but as science fiction robots, explaining that outside forces which exert influence on skill and knowledge processes unconsciously cause normal biases [Lewicki89]. There are several reasons why unconscious learning is different from consciously controlled acquisition of information:

1. Processing of complex knowledge structures
   occurs that could not possibly be comprehended
   on a conscious level.
2. Not necessarily maintaining consistency with
   consciously controlled knowledge can be an
   effect of unconscious learning.
3. Not having control over the influence of how a
   processes works can also be an effect of
   unconscious learning.

Reber claims that implicit learning is an unconscious
process that yields abstract knowledge [Reber89]. It is
acquired in the absence of consciousness and reflects
learning strategies. His research demonstrates that
knowledge acquired from implicit learning is ahead of the
capability to process the information. His conclusions show
that implicit learning takes place independently of
consciousness and operates outside of awareness.

Brody disputes Reber's claims that the knowledge acquired is
unconscious, citing discrepancies between the subjects
behavior and reports [Brody89]. He argues the distinction
between "what a subject is aware of and the subject's
awareness of being aware." Additional questions to the
subjects may indicate that subjects acquire more knowledge
than the subject is aware of having. He tested different
intervals of presentation times providing accurate

judgements 75% of the time. At a 30-40ms presentation time, subjects were unable to make accurate judgements of content. At 10ms, subjects were aware only of a flash of light. At 2 and 3ms, 75% judgment accuracies were obtained when a chance performance would have yielded 50%. Brody assumed that the stimuli permitted accurate judgements even though the subjects were unaware of their awareness, although he discounts the possibility that the knowledge was unconscious. He cites claims that challenge this idea, suggesting that information that cannot be differentiated with greater than 50% accuracy can influence judgements of other information. He concludes that there is evidence that a difference exists from stimuli out of awareness and the same stimuli in awareness.

Groeger defines a subliminal message as a case where the subject is unaware of stimuli which no act of attention will bring to his awareness [Groeger84]. He compares this to unattended messages (the subject is not aware due to lack of attention) and subrecognition messages (the subject is aware but the stimuli cannot be recognized). He tested conscious versus unconscious stimuli and found subjects tended to select a word to complete a sentence that was semantically similar to a subliminal word presented and structurally similar when the preceding word was not subliminally presented. Groeger's research supports the foundation of the existence of subliminal perception. His

findings conclude that unconscious semantic processing does
actually occur. Similar findings were established by Marcel
in 1978 [cf. Brody89].

Dixon defines subliminal presentation as information which
is not consciously noticed by the subject [cf. Groeger84].
He describes three criteria to ensure that the information
received is beyond awareness:
1. The information should be presented below the
   lowest level of awareness.
2. The subject should indicate that he did not see
   or hear anything related to the information.
3. The effects should be different then when the
   information is within the subject's awareness
   level.

Jacoby and Kelley believe the only way to escape the effects
of unconscious memory is to consciously remember the
experience, understand its influence and alter reasoning to
exchange the criteria for behavior [Jacoby87]. Effects that
reveal unconscious influences of the past on performance are
very easy to uncover and are very common. This research
reflects the theory that unconscious use of memories will
have a greater effect when there is a match between details
of the unconscious memory and the current situation. It
follows that memory might have a greater effect on

performance when it is working at an unconscious level and the source is not specified.

Wallace, Flanery & Knezek conducted a study presenting microcomputer-based subliminal information passively to reinforce the learning of an on-line HELP screen in a line-oriented text editor [Wallace91]. They examined the variance of response using three subliminally presented screens, a traditional HELP screen, a "garbage" screen in the same form, and an empty screen. Results from this experiment showed significant differences between the group unconsciously receiving HELP screens and the group receiving garbage screens. The research showed that the group receiving garbage through the subliminal presentation required help sooner, requesting help after less commands than the group that received the correct HELP screens.

In the Wallace study, the subliminal message is written to the graphics screen without actually being displayed. At the appropriate time to display the subliminal screen, the text screen is turned off and the subliminal message is presented. The subliminal screen is scanned one time during the Vertical retrace which lasts 1.04 milliseconds after the vertical trace. From beginning of one trace to the next is 16.63 milliseconds. Due to the decay time of the P22 phosphors, it is assumed that the phosphor is no longer visible before the next Vertical Trace begins, therefore the

subliminal message is no longer visible. It was noted during preliminary tests that when used with a blank screen, the presence of the subliminal message could be seen if a concentrated effort to find it was made. When the text screen was full of text, the presence of the subliminal message was hard to observe even by the researchers.

Two methods were utilized to present the subliminal message to the subjects. The first was Fixed Ratio: all input was monitored and after a predefined number of keystrokes were made, the subliminal screen would be evoked. The second is Fixed Interval: in this method, the subliminal screen was presented at fixed time intervals of 15 seconds.

A text line editor was developed for this experiment, utilizing nine commands which were presented in a HELP screen. The subjects involved in the experiment were familiar with line editors but did not know anything about the particular application used in the experiment. The commands on the HELP screen were summarized in a few words but gave enough information for the subjects to accomplish the goals required. The two goals designed for this editor's HELP screen included:

    1. A small number of commands used to display the
      HELP screen easily.
    2. The commands should not be too easy to learn.

The editor would require some complexity in order to study the learning response of the subjects during the experiment.

The data analyzed in this study was collected from the commands invoked by the subjects and the times at which they were called. This information was written to disk along with the final form of the edited document. Demographic data was also requested from each subject for further analysis. The task requested of the subjects was to edit the document on the computer screen to match the document that they were given. In the final analysis of the experiment, the researchers felt that the subjects spent more time reviewing the printed document than looking at the computer screen. This may have prevented them from obtaining the full impact of the subliminal information. Although for this reason the study did not find large differences, the authors were able to conclude that there is some evidence that computers can provide learning support in a passive manner through subliminal information [Wallace91].

Chapter 3

DIRECT MANIPULATION

Direct manipulation is a human-computer interaction
technique that provides direct action between the user and
the control of system activities [Teeni89]. Te'eni reports
on experiments which determine that feedback resulting from
direct manipulation is as effective and more efficient than
feedback unrelated to the user's action. These results
support the concept that direct manipulation enhances
cognitive control. Thus, direct manipulation has the
potential to provide a source of feedback for increasing the
user's control. The concept of direct manipulation in human
computer interaction refers to a broad range of ideas and
techniques, especially those techniques that give users a
sense of direct control of visibly represented objects.

Shneiderman [Shneiderman88] cites as benefits of direct
manipulation:

* control/display compatibility

* less syntax reduces error rates

* faster learning and higher retention

* encouragement of exploration

Direct manipulation interfaces:

    * create a visual representation of the

      "world of action"

    * rapid, incremental and reversible actions

    * replace typing with pointing/selecting

    * make results of actions immediately visible

Roy Pea explains that computers are believed to change how
effectively traditional tasks are accomplished, amplifying
or extending capabilities, with the assumption that these
tasks stay fundamentally the same [Pea85]. He concludes
that the primary role for computers is changing the tasks we
do by reorganizing our mental functioning, not only by
amplifying it. The electronic spreadsheet is an example of
a direct manipulation tool that can reorganize mental
functioning. Many lines of thought can be simultaneously
activated and their outcomes compared easily by the
manipulation of a few cells in this direct manipulation
environment. In this case, computer technology provides a
cognitive tool that improves the process of organizing
thoughts into actions in such a way that it has become
indispensable for many application environments.

Chapter 4

EXPERIMENTAL DESIGN

The primary purpose of the current study is to repeat the
efforts of Wallace, Flanery and Knezek for an application
environment better suited to presentation of subliminal
information. Using a direct manipulation environment, it is
likely that the subject will be more focused on the screen
where the information is presented then the text editing
environment of [Wallace91]. Consequently, this approach is
used. The subliminal information is presented in a passive
manner to reinforce the learning process of the HELP screen
in the same manner as in [Wallace91].

In conducting the study, subjects were tested in groups from
two to ten subjects at a time, randomly assigning them to
three independent groups according to screen type as noted
below. In all, thirty-five subjects completed the task,
approximately eleven per group.

One of three subliminal screen types was presented to each
group to include:
    *   the original HELP screen in the same format the
        user viewed when asking for help (Appendix A)

* a "garbage screen" that had the same data as the HELP screen (Appendix B), but in an unreadable (scrambled) form
* a blank screen with no information presented (Appendix C).

The primary research design had one independent measure (subliminal screen content) and three dependent measures (accuracy, speed, and number of requests for HELP). Only syntactic errors were evaluated. Speed was determined as the time for task completion calculated by the entrance into the test instrument and exit. The independent variable had three groups; HELP screen, Garbage screen, and Blank screen. A one way ANOVA was used for each of the dependent variables.

The subjects were briefed on the purpose of the task and the method that would be required to complete the task before performing the computerized portion of the experiment (Appendix D). The instructions for the computerized session were self-evident within the program. This aided in assuring that the subject was constantly looking at the screen and not having to refer back to a printed document, drawing attention away from the screen. Continual concentration on the on-screen document allowed subjects the maximum possible exposure to assimilate the subliminal information presented.

The data was in the form of a simple checkbook register document. The fields of data included check/deposit number, date, description of transaction, payment/debit or deposit/credit, check amount, beginning date of cash summary, ending date of cash summary, initial balance, total receipts, total payments and ending balance. A cash summary statement maintained the current values in the check register and the deposit register summarizing an ending balance based on the date of the last transaction made.

There were three separate data repositories, one for the check register data, one for the deposit register data and one for imported data that had not been sorted into the two previous categories. The data repository descriptions can be found in Appendix E.

A series of tasks was requested of the user. One hundred and two individual tasks were expected to be completed within approximately one hour. It was expected that the average time to complete the task list would be about 40 minutes. The complete list of tasks required of a subject can be found in Appendix F. The main objective was to enter and organize data for a specified period of time. Tasks involved included:

* adding data by editing cells
* manipulating columns and blocks of data to
    include sorting, querying, copying and moving

* managing files to include importing data from a
  file and saving data.

A summary of these tasks can be found in Appendix G.

Spreadsheet macros were used, activated by independent
keystrokes, the macro keystrokes listed on a HELP screen.
This HELP screen was the same screen subliminally presented
to some of the subjects (Appendix A). The HELP screen
consisted of ten commands. Each command was summarized in a
few words to keep from cluttering the HELP screen with
unnecessary information. The HELP screen took the following
format:

* two commands per line

* left justified

* double spacing between lines.

This ensured clarity and minimized screen complexity. The
number of commands corresponded to studies based on George
Miller's 1956 paper [cf. Shneiderman92] showing that the
limited capacities for absorbing information is seven plus
or minus two chunks of information in short term memory.
The commands were designed so the subject was unable to
easily memorize them within a few minutes, but
straightforward enough for the subliminal HELP screen to be
effectively tested. The HELP screen was easily accessible
at any time during the task. The requirements necessary to
complete the task also remained accessible throughout the
experiment.

The spreadsheet was protected except for the fields where data input was required. The user remained in the instruction window except when entering data via a macro. The LOTUS command key "/" was disabled along with all function keys to prevent the user from using LOTUS commands. The HELP macro displayed the HELP screen, all other macros returned the subject to the next instruction at the completion of its function. The instructions to ask for HELP were always located at the top cell of the spreadsheet. Macros could be initiated from any portion of the spreadsheet including from within the HELP menu.

Chapter 5

DATA COLLECTION

5.1 Subjects

Subjects were students selected from an introductory
computer course. The students were computing novices
familiar with the LOTUS spreadsheet environment. Although
familiar with the commands presented by LOTUS, they were
required to use commands defined in a HELP screen during the
experiment. The subjects were briefed on the purpose and
method to complete the task and were given an exit interview
after completing the experiment (Appendix H).

5.2 Procedure

A terminate and stay resident (TSR) program was installed to
present the subliminal screen, capture keystrokes from
subjects and save each session to disk. Positive effects on
subliminal presentation of HELP screens using commercial
software packages were first established through pilot work
conducted at the University of North Florida using a (TSR)
program on an IBM Personal computer. This program was
loaded into primary storage prior to loading the LOTUS 123
software package.

The software package application employed was LOTUS 123, a
commercial spreadsheet that directly manipulates data. The
task performed the management of a personal financial
register. While most spreadsheets would accomplish the
tasks required, LOTUS 123 was chosen because the test
subjects were familiar with it. The test instrument
consisted of the use of unknown functions (macros) to
manipulate the spreadsheet and these were the only commands
used by the subjects. An exit interview was given at the
completion of the exercise to gather subjects comments on
the use of the spreadsheet and the macros.

5.3 Apparatus

The experiment was conducted on MS-DOS based machines. Color
graphics were utilized. The Test Instrument was constructed
using LOTUS 123 Version 2.2. The macros designed and
utilized for the experiment can be found in Appendix I.

5.4 Demographics

Demographic data was collected on each subject participating
in the research study. Demographic data included age,
gender, computer experience, Lotus software experience,
educational level, handedness, eyesight, typing experience,
and approximate number of hours using computers per day.

Summary statistics were calculated for demographic data. A one way Analysis of Variance (ANOVA) was used to test group independence with respect to each demographic characteristic. To ensure groups were not significantly different, a complete cross-correlation matrix was computed.

Chapter 6

DATA ANALYSIS

The data analysis was accomplished using the Statistical Analysis System (SAS) package. The first section will demonstrate the relationships of the demographic data within and between the three groups. The next three sections discuss the three dependent measures (accuracy, speed, and number of requests for HELP). The statistics will be viewed based on the independent measure: subliminal screen content (help screen, garbage screen and blank screen). Significant correlations are defined as having a correlation coefficient greater than or equal to 0.3 and a probability > |R| under Ho: Rho = 0 / N = 35 that is less than 0.05.

6.1 Demographics

The following demographic data was collected on each subject completing the research study: years of computer experience, months using spreadsheets, use of computers per day in hours, age, vision, handedness, educational level, vision, gender, and typing ability.

Some significant correlations were found among the demographic data, however there was no significance found with groups (screen types). Several significant correlations were found with respect to computer experience. As expected, there was a positive significance between computer experience and use of computers per day, showing that the more experienced subjects used the computer longer on a daily basis. Again computer experience and Lotus experience had a positive correlation, the more experienced subjects had worked with spreadsheets for longer timeframes than the less experienced users. As one might expect, computer experience and age also showed significant positive correlations, the older the subject the more computer experience he/she possessed.

Gender and age and gender and time also showed significant correlations. Male subjects tended to be older and slower than their female counterparts in the overall testing group.

Demographic data such as computer experience, typing experience, age and gender all significantly corrrelated with the time to complete the exercise. The more experienced subjects, the younger subjects, and the female subjects on a whole completed the spreadsheet task faster.

Age was the only demographic data that significantly correlated with the number of requests for help. The older subjects requested help more often.

6.2 Accuracy

The average, minimum and maximum error rates are listed in Table 1 for each screen type. The blank screen participants achieved the lowest average error rates followed by the help screen participants with the garbage screen participants having the most errors. The subjects using the blank screen also had the lowest maximum errors.

The average error rates for all subjects in the experiment was 5, with a minimum of 0 and a maximum of 35. There was not any demographic data that significantly correlated with Error rates.

Screen Type	Mean	Minimum	Maximum
Help Screen	5.69	0	19
Blank Screen	3.18	0	6
Garbage Screen	6.00	0	35

Table 1: Error Rates by Screen Type

An Analysis of Variance was performed on the model based on the dependent variable of errors. Table 2 gives a summary of the ANOVA.

Source	DF	Sum of Squares	Mean Square	F	p
Model	2	53.59	26.80	0.59	0.5600
Error	32	1452.41	45.39		

Table 2: Analysis of Variance: Errors

The probability of the model was 0.5600. The above analysis indicates no significant differences between the error rates by screen type.

6.3 Completion Times (speed)

The average, minimum and maximum completion times are listed in Table 3 for each screen type. The help screen participants achieved the lowest average completion times. The subjects using the help screen also had the lowest minimum and maximum completion times. The average completion time for all subjects in the experiment was 39.12 minutes, with a minimum of 22.37 minutes and a maximum of 63.36 minutes.

Screen Type	Mean (min)	Minimum (min)	Maximum (min)
Help Screen	36.52	22.37	48.04
Blank Screen	41.16	24.07	63.36
Garbage Screen	40.17	24.86	52.97

Table 3: Completion Times by Screen Type

Demographic data, including computer experience, typing experience, age and gender related to the time to complete the exercise, although there was no significant difference across screen types in demographic data. The more experienced subjects, the younger subjects, and the female subjects on a whole completed the spreadsheet task faster.

An Analysis of Variance was performed on the model based on the dependent variable of time. Table 4 gives a summary of the ANOVA.

Source	DF	Sum of Squares	Mean Square	F	p
Model	2	145.79	72.89	0.80	0.4577
Error	32	2912.46	91.01		

Table 4: Analysis of Variance: Time/Completion in Minutes

The probability of the model was 0.4577. The above analysis indicates no significant differences between the completion times between groups.

6.4 Requests for Help

The average, minimum and maximum requests for help are listed in Table 5 for each screen type. The blank screen participants achieved the lowest average requests for help followed by the garbage screen participants with the help screen participants having the most requests for help. The subjects using the blank screen and help screen also had the lowest minimum requests for help and the blank screen had the lowest maximum requests for help, with the help screen having the maximum requests for help.

The average requests for help for all subjects in the experiment was 64.26, with a minimum of 26 and a maximum of 118.

Screen Type	Mean	Minimum	Maximum
Help Screen	68	26	118
Blank Screen	59	26	99
Garbage Screen	64	34	101

Table 5: Number of Requests for Help by Screen Type

Age was the only demographic data that significantly correlated with requests for help. The relationship showed that the older subjects requested help more often.

An Analysis of Variance was performed on the model based on the dependent variable of requests for help. Table 6 gives a summary of the ANOVA.

Source	DF	Sum of Squares	Mean Square	F	p
Model	2	492.73	246.36	0.45	0.6410
Error	32	17481.96	546.31		

Table 6: Analysis of Variance: Number of Requests for Help

The probability of the model was 0.6410. The above analysis indicates the requests for help between each group was not significantly different.

Chapter 7

DISCUSSION

The current research project was an examination of human
performance and learning during a task driven, direct
manipulation exercise. The possibility of presenting
subliminal information in a passive manner to reinforce the
learning process and the possibility that this perception
can aid in the absorption of the information needed to learn
was investigated. The basic findings conflict with previous
research, this study showing that the subliminal HELP
screens did not aid the subjects significantly more than a
"garbage" subliminal screen or no subliminal message at all.
This particular task did not lend itself to the necessity of
subliminal help to aid in the learning process.

7.1   Implications of Data Analysis

Only subjects completing the exercise were used in the statistical analysis. Thirty-five subjects completed the spreadsheet question list and saved the results to a file before exiting the program.

Exit interviews were obtained from the subjects on completion of the exercise. The results of the interviews demonstrated that the subjects who completed understood how to accomplish the tasks required in the worksheet, completed the exercise, and if they had never used macros before understood how to use them upon completing the exercise. Only one subject reported a flickering that distracted him while he was entering data. The exit interviews also showed that most subjects found the macro commands somewhat difficult to learn, many suggested that the macro command should reflect the name or purpose of the macro. This was intentionally avoided in this experiment to prevent instant memorization of the macro or the guessing of the correct macro to use. Three subjects claimed that they had memorized the macros by the end of the exercise, the rest said they had memorized some of the macros, mostly those used more often during the exercise.

7.1.1 Accuracy

An analysis of variance was computed using screen content as
the independent variable and accuracy as the dependent
variable. Accuracy was determined by comparing the final
spreadsheet file saved by the subject to an error-free file.
Scoring was done by hand because of the innumerable ways the
final document could look for each error made. An error was
determined if the wrong macro was used or the wrong command
was entered while using a macro. Typing errors were not
considered. The Caps Lock feature was turned on for all
sessions so capitalization was not a factor.

There were no significant differences found among groups.
There was also no significance relating accuracy and
demographic data.

Six out of thirty-five subjects completed the exercise with
no errors. The average error rate across groups was 5 and
twenty-five subjects had 5 or less errors out of a possible
134 errors. This demonstrates that the difficulty of the
tasks was not arduous, while at the same time was not
trivial. The subliminal screens did not appear conducive to
improving accuracy of commands in this environment. The
tasks were fairly straightforward and applying the macros
was not extremely complicated. These results were similar
to the results found in the study using subliminal help

presentations on learning a text editor. The difficulty of
the tasks seemed to be on the same level for both studies
suggesting that a more complex task might show differences
among groups [Wallace91].

7.1.2 Completion Times

An ANOVA was performed with screen content as the
independent variable and the total completion time as the
dependent variable. The TSR program captured the start time
when the spreadsheet was entered and the completion time
when the spreadsheet was exited. The time to complete the
experiment was determined by comparing the starting and
completion time of each subject.

There were no significant differences found among groups.
Demographic data to include computer experience, typing
experience, age and gender all related to the time to
complete the exercise. The more experienced subjects, both
typing and computer experience seemed to finish the
spreadsheet quicker, which was expected. The younger
subjects and female subjects on a whole also completed the
spreadsheet faster. This did not have an effect on the
dependent variable, because there was no significant
differences across screen types in the demographic data.

The HELP screen participants achieved the lowest average completion times for the minimum, maximum and mean, the "HELP" mean falling below the average completion times for all subjects. Although this was not significant and demonstrates that the subliminal screens did not appear conducive to improving speed in this environment, a more complex task might show a more significant difference among the HELP screen participants and the participants not receiving help.

7.1.3   Requests for Help

An ANOVA was performed with screen content as the independent variable and the total requests for help as the dependent variable. The TSR program captured the help requests and a simple program was developed to count the number of occurrences electronically. This method was also verified manually.

There were no significant differences found among groups. Age was the only demographic data that related to the number of requests for help. The older subjects tended to request help more often than the younger subjects. Again, this did relate to the independent variable, screen type, because there was no significant differences across screen types in the demographic data.

The average number of requests for help was lowest with the blank screen participants and highest with the help screen participants, although all average number of requests was within 5 requests of the total average across all groups and not significant. This is in conflict with previous research. Subliminal help presentations on learning a text editor demonstrated that subjects getting subliminal HELP screen presentation used the HELP screen less often. That research project also showed a significant difference between groups getting subliminal HELP screens and groups getting garbage subliminal screens, possibly implying that the groups getting garbage subliminal screens received conflicting information [Wallace91]. The Jacoby and Whitehouse effect demonstrated unconscious perception influences processing of information aroused a feeling of familiarity whereas a disruption (i.e., flashing the wrong word), could lead to confusion [Jacoby89].

The subliminal presentations had no effect on the task in this research project. One possibility for these results could be due to the difference in task between the line editor and the spreadsheet. The spreadsheet environment was very restrictive in this study. This was necessary to lead the subjects through the spreadsheet one question at a time, to avoid confusion, and to keep all the information needed on the screen. Once a macro was invoked the subject could not back out of the macro and try again. This may have

caused some hesitation to select a macro without verifying
it on the HELP screen. The HELP screen was easy to access
and took very little time to verify because of its
simplicity. These features were purposely designed into the
application for the novice user. It may however, have
induced the subjects to use the HELP screen even if they
consciously or subconsciously knew the macro, simply to
confirm it. The subjects were more likely to check the HELP
screen than make an error. This is confirmed by the low
number of errors made across all groups. Again, an
experiment involving a more experienced group of users doing
a more complex task may yield more significant results.

7.2 Conclusions

This research study was modeled on a previous study involving the use of a TSR program loaded in primary storage to present subliminal screens to the subject. The experimental work was done using novice computer subjects and a simple straightforward spreadsheet. The subliminal presentations had no effect on the particular task chosen. In order to quantify the results, a simple straightforward spreadsheet with a clear direction was created. The tasks required were rudimentary. The design of the menu structure was based on human factor studies and was also simplified for easy use. Due to the ease of use and the ability to get HELP quickly, the individual subject may have tended not to trust his/her instincts and verified the macros before applying them. The lack of ability to measure quantitatively the subject's reason for using help each time help was requested, could mask the results found using the subliminal presentation screens.

7.3 Suggestions for Further Research

There is still much research needed in this area. Using subliminal presentations in a direct manipulation interface may be more helpful for complex tasks in a more advanced environment using expert subjects. Subliminal presentation could be used in the cognitive environment where the subject is creating a task instead of editing or following specific directions. Changes could also be made in the design of screen layouts, color choices, and the wording of messages.

The amount of exposure to the subliminal presentations could be increased. This research study flashed the subliminal screen at a fixed response rate of every 8 keystrokes. This number could be decreased to see if more exposure to the subliminal presentation will significantly affect the subjects' learning rate.

Other areas where subliminal presentations may be helpful is using different interaction styles such as menu selection, form fill-in, command language, or even natural language. Subliminal Information transfer should be tested in these different environments to determine if it has an effect and if it affects performance distinctly.

REFERENCES

[Bernstein91]
    Bernstein, Ira H. and K. R. Welch, "Awareness, False
    Recognition, and the Jacoby-Whitehouse Effect," <u>Journal</u>
    <u>of Experimental Psychology: General</u> 120, 3, (1991),
    pp. 324- 328.

[Brody89]
    Brody, Nathan, "Unconscious Learning of Rules: Comment
    on Reber's Analysis of Implicit Learning," <u>Journal of</u>
    <u>Experimental Psychology: General</u> 118, 3 (1989), pp.
    236-238.

[Groeger84]
    Groeger, J. A., "Evidence of unconscious semantic
    processing from a forced error situation," <u>British</u>
    <u>Journal of Psychology</u> 75, (1984), pp. 305-314.

[Jacoby87]
    Jacoby, Larry L. and C. M. Kelley, "Unconscious
    Influences of Memory for a Prior Event," <u>Personality</u>
    <u>and Social Psychology Bulletin</u> 13, 3, (1987), pp. 314-
    336.

[Jacoby89]
    Jacoby, Larry L. and K. Whitehouse, "An Illusion of
    Memory: False Recognition Influenced by Unconscious
    Perception," <u>Journal of Experimental Psychology:</u>
    <u>General</u> 118, 2 (1989), pp. 126-135.

[Lewicki89]
    Lewicki, Pawel and T. Hill, "On the Status of
    Nonconscious Processes in Human Cognition: Comment On
    Reber," <u>Journal of Experimental Psychology: General</u>
    118, 3   (1989), pp. 239-241.

[Pea85]
   Pea, Roy D., "Beyond Amplification: Using the Computer
   to Reorganize Mental Functioning," Educational
   Psychologist 20, 4, (1985), pp. 167-182.

[Reber89]
   Reber, Arthur S., "Implicit Learning and Tacit
   Knowledge," Journal of Experimental Psychology:
   General 118, 3, (1989), pp. 219-235.

[Shneiderman88]
   Shneiderman, Ben, "We Can Design Better User
   Interfaces: A Review of Human-Computer Interaction
   Styles," Ergonomics 31, 5, (1988), pp. 699-710.

[Shneiderman92]
   Shneiderman, Ben, Designing the User Interface,
   Strategies for Effective Human-Computer Interaction,
   2nd Edition, Addison-Wesley Publishing Company, Inc.,
   1992.

[Teeni89]
   Te'eni, Dov, "Direct Manipulation As A Source of
   Cognitive Feedback: A Human-Computer Experiment With A
   Judgement Task," International Journal Man-Machine
   Studies 33, (1990), pp. 453-466.

[Wallace91]
   Wallace, F. Layne, J. M. Flanery and G. A. Knezek,
   "The Effect of Subliminal Help Presentations on
   Learning a Text Editor," Information Processing and
   Management 27, 2/3 (1991), pp. 211-218

APPENDIX A

HELP SCREEN

HELP MENU

ALT M ADD CHECK   ALT S DELETE LAST CHECK

ALT P ADD DEPOSIT   ALT N DELETE LAST DEPOSIT

ALT L IMPORT DATA FROM FILE   ALT W SORT IMPORTED DATA

ALT D QUERY DATA FOR CHECKS   ALT F SAVE FILE

ALT K QUERY DATA FOR DEPOSITS   ALT Q QUIT

        COMMANDS MAY BE ACTIVATED FROM THE HELP SCREEN
        PRESS BOTH REQUIRED KEYS SIMULTANEOUSLY

GARBAGE SCREEN

MJQU RJSZ

FQY R FII HMJHP   FQY X IJQJYJ QFXY HMJHP

FQY U FII IJUTXNY   FQY S IJQJYJ QFXY IJUTXNY

FQY Q NRUTWY IFYF KWTR KNQJ   FQY \ XTWY NRUTWYJI IFYF

FQY I VZJW^ IFYF KTW HMJHPX   FQY K XF[J KNQJ

FQY P VZJW^ IFYF KTW IJUTXNYX   FQY V VZNY

HTRRFSIX RF^ GJ FHYN[FYJI KWTR YMJ MJQU XHWJJS
UWJXX GTYM WJVZNWJI PJ^X XNRZQYFSJTZXQ^

APPENDIX C

BLANK SCREEN

INSTRUCTIONS TO SUBJECTS

You are experimenting with a new lotus spreadsheet that will
record your financial records. All information is given
within the spreadsheet.

1. THE PROGRAM WILL BEGIN WITH DEMOGRAPHIC QUESTIONS.
PLEASE SELECT THE ANSWER THAT APPLIES MOST CLOSELY TO YOU.
ON THE COMPLETION OF THE LAST QUESTION THE PROGRAM WILL OPEN
THE LOTUS 123 VERSION 2.3 SPREADSHEET THAT WILL BE USED FOR
THE EXERCISE AND THE SESSION WILL BEGIN. (The spreadsheet
will take a few minutes to load please wait until it is
fully loaded before continuing.)

2. INSTRUCTIONS ARE SELF EXPLANATORY. THE SPREADSHEET WILL
BE DIVIDED INTO TWO WINDOWS. THE TOP WINDOW WILL HAVE
INSTRUCTIONS AND QUESTIONS TO COMPLETE THE EXERCISE, SHOWN
ONE AT A TIME. THE BOTTOM WINDOW WILL HAVE THE TABLES WHERE
INFORMATION IS ENTERED AND THE HELP MENU WILL ALSO BE
DISPLAYED IN THE BOTTOM WINDOW. THERE ARE 102 QUESTIONS.
THE LAST QUESTION WILL BE TO QUIT THE PROGRAM. THE EXERCISE
IS NOT COMPLETE UNTIL THE MACRO TO QUIT HAS BEEN EXECUTED.
MACROS WILL BE USED TO COMPLETE ALL TASKS, THE FUNCTION
KEYS, ESCAPE KEYS, ARROW KEYS AND MENU KEY WILL BE DISABLED.

A HELP SCREEN WILL DISPLAY THE MACROS NEEDED TO COMPLETE THE
TASKS. WHENEVER HELP IS NEEDED PRESS THE ALTERNATE KEY AND
THE H KEY AT THE SAME TIME, THIS COMMAND WILL BE PRINTED ON
THE TOP LINE OF THE SPREADSHEET AND WILL BE IN VIEW AT ALL
TIMES DURING THE SESSION.

3.   THE INSTRUCTION WINDOW WILL ALSO REMAIN IN VIEW AT ALL
TIMES, DISPLAYING ONE QUESTION AT A TIME, MOVING TO THE NEXT
QUESTION AFTER COMPLETION OF EACH TASK, AUTOMATICALLY.   IT
IS NOT NECESSARY TO USE THE ARROW KEYS, PAGE KEYS, FUNCTION
KEYS, OR HOME/END KEYS TO MOVE AROUND THE SPREADSHEET.   THE
MACROS WILL MOVE TO THE WINDOW NECESSARY TO COMPLETE THE
TASK.

4.   WHILE EXECUTING A MACRO, ONCE INFORMATION IS ENTERED
(the enter key should be pressed after each cell of
information is entered, not the arrow keys) DO NOT ATTEMPT
TO GO BACK AND CHANGE OR CORRECT DATA.   ONCE YOU HAVE
INITIATED A MACRO, FOLLOW IT THROUGH, DO NOT TRY TO ESCAPE
OUT OF IT, EVEN IF YOU HAVE TO ENTER FALSE INFORMATION.   THE
MACROS WILL MOVE YOU TO THE NEXT QUESTION IN THE TOP SCREEN,
AFTER A MACRO IS EXECUTED, DO NOT ATTEMPT TO GO BACK TO
CORRECT A PREVIOUS QUESTION.

5. MUST COMPLETE TASK LIST OF 102 QUESTIONS TO COMPLETE THE

EXERCISE. THE EXERCISE IS ONLY COMPLETE WHEN THE LOTUS

PROGRAM IS SUCCESSFULLY EXITED.

6. THANK YOU FOR PARTICIPATING IN THIS EXERCISE, PLEASE

PICK UP AN EXIT INTERVIEW WHEN YOU ARE FINISHED.

APPENDIX E

DATA REPOSITORY TABLES

CASH SUMMARY

FROM: Jan 1 93   TO: DEC 31, 92

INITIAL BALANCE	$1,000.00
INITIAL RECEIPTS	$59,852.00
TOTAL PAYMENTS	$17,414.50
ENDING BALANCE	$43,437.50

DEPOSIT ADDITION:

ADD NEW DEPOSIT

	#	DATE	DESCRIPTION	AMOUNT
EXAMPLE:	200	DEC 31, 92	PAYEE	0.00

ADD DEP>

```
===    ==========    ====================    ========
```

CHECK ADDITION:

ADD NEW CHECK

	#	DATE	DESCRIPTION	AMOUNT
EXAMPLE:	100	DEC 31, 92	PAYEE	0.00

ADD CHECK>

```
===    ==========    ====================    ========
```

CHECK REGISTER

#	DATE	DESCRIPTION	AMOUNT	CODE
160	DEC 25, 93	PARTY	$25.00	c
161	DEC 25, 93	PARTY	$300.00	c
162	DEC 25, 93	PARTY	$500.00	c
163	DEC 25, 93	PARTY	$900.00	c
164	DEC 25, 93	PARTY	$45.00	c
155	NOV 25, 93	PARTY	$25.00	c
156	NOV 25, 93	PARTY	$300.00	c
157	NOV 25, 93	PARTY	$500.00	c
158	NOV 25, 93	PARTY	$900.00	c
159	NOV 25, 93	PARTY	$45.00	c
154	OCT 31, 93	PARTY	$45.00	c
153	OCT 31, 93	PARTY	$900.00	c
152	OCT 31, 93	PARTY	$500.00	c
151	OCT 31, 93	PARTY	$300.00	c
150	OCT 31, 93	PARTY	$25.00	c
145	SEPT 24,93	PARTY	$25.00	c
146	SEPT 24,93	PARTY	$300.00	c
147	SEPT 24,93	PARTY	$500.00	c
148	SEPT 24,93	PARTY	$900.00	c
149	SEPT 24,93	PARTY	$45.00	c
140	AUG 16, 93	PARTY	$25.00	c
141	AUG 16, 93	PARTY	$300.00	c
142	AUG 16, 93	PARTY	$500.00	c
143	AUG 16, 93	PARTY	$900.00	c
144	AUG 16, 93	PARTY	$45.00	c
139	JUL 4, 93	PARTY	$45.00	c
138	JUL 4, 93	PARTY	$900.00	c
137	JUL 4, 93	PARTY	$500.00	c
136	JUL 4, 93	PARTY	$300.00	c
135	JUL 4, 93	PARTY	$25.00	c
130	APR 11, 93	PARTY	$25.00	c
131	APR 11, 93	PARTY	$300.00	c
132	APR 11, 93	PARTY	$500.00	c
133	APR 11, 93	PARTY	$900.00	c
134	APR 11, 93	PARTY	$45.00	c
129	FEB 14, 93	PARTY	$45.00	c
128	FEB 14, 93	PARTY	$900.00	c
127	FEB 14, 93	PARTY	$500.00	c
126	FEB 14, 93	PARTY	$300.00	c
125	FEB 14, 93	PARTY	$25.00	c

```
101 JAN 1, 93    CATERERS                    600.00

103 JAN 15, 93   ELECTRICITY                 120.00
104 JAN 15, 93   CABLE                        30.00

106 MAR 25, 93   GASOLINE                     15.00
107 MAY 1, 93    RENT                        600.00

109 MAY 20, 93   CABLE                        34.00
110 MAY 21, 93   CREDIT CARD                 200.00

112 JUL 20, 93   TELEPHONE BILL               80.00
113 SEP 1, 93    RENT                        600.00

115 SEP 8, 93    TELEPHONE BILL              135.00
116 SEP 8, 93    GASOLINE                     14.50

118 OCT 8, 93    ELECTRICITY                  96.00
119 NOV 1, 93    CREDIT CARD                 230.00

121 NOV 5, 93    AIRPLANE TICKET             380.00
122 NOV 5, 93    HOTEL                       120.00

124 DEC 13, 93   CATERERS                    600.00
```

DEPOSIT REGISTER

#	DATE	DESCRIPTION	AMOUNT	CODE
260	DEC 25, 93	PARTY	$50.00	d
261	DEC 25, 93	PARTY	$40.00	d
262	DEC 25, 93	PARTY	$240.00	d
263	DEC 25, 93	PARTY	$900.00	d
264	DEC 25, 93	PARTY	$220.00	d
255	NOV 25, 93	PARTY	$50.00	d
256	NOV 25, 93	PARTY	$40.00	d
257	NOV 25, 93	PARTY	$240.00	d
258	NOV 25, 93	PARTY	$900.00	d
259	NOV 25, 93	PARTY	$220.00	d
254	OCT 31, 93	PARTY	$220.00	d
253	OCT 31, 93	PARTY	$900.00	d
252	OCT 31, 93	PARTY	$240.00	d
251	OCT 31, 93	PARTY	$40.00	d
250	OCT 31, 93	PARTY	$50.00	d
245	SEPT 24,93	PARTY	$50.00	d
246	SEPT 24,93	PARTY	$40.00	d
247	SEPT 24,93	PARTY	$240.00	d
248	SEPT 24,93	PARTY	$900.00	d
249	SEPT 24,93	PARTY	$220.00	d
240	AUG 16, 93	PARTY	$50.00	d
241	AUG 16, 93	PARTY	$40.00	d
242	AUG 16, 93	PARTY	$240.00	d
243	AUG 16, 93	PARTY	$900.00	d
244	AUG 16, 93	PARTY	$220.00	d
239	JUL 4, 93	PARTY	$220.00	d
238	JUL 4, 93	PARTY	$900.00	d
237	JUL 4, 93	PARTY	$240.00	d
236	JUL 4, 93	PARTY	$40.00	d
235	JUL 4, 93	PARTY	$50.00	d
230	APR 11, 93	PARTY	$50.00	d
231	APR 11, 93	PARTY	$40.00	d
232	APR 11, 93	PARTY	$240.00	d
233	APR 11, 93	PARTY	$900.00	d
234	APR 11, 93	PARTY	$220.00	d
229	FEB 14, 93	PARTY	$220.00	d
228	FEB 14, 93	PARTY	$900.00	d
227	FEB 14, 93	PARTY	$240.00	d
226	FEB 14, 93	PARTY	$40.00	d
225	FEB 14, 93	PARTY	$50.00	d

```
201 JAN 10,93    ANNUAL BONUS              5000.00

203 MAR 1, 93    PAYCHECK                  5000.00

205 MAR 15, 93   PAYCHECK                  2500.00
206 MAR 16, 93   REBATE                       2.00
207 MAY 15, 93   PAYCHECK                  5000.00

209 JUL 1, 93    PAYCHECK                  5000.00

211 JUL 15, 93   PAYCHECK                  1000.00
212 JUL 17, 93   CASH                       100.00
213 SEP 6, 93    PAYCHECK                  2500.00

215 OCT 1, 93    PAYCHECK                  5000.00

217 OCT 5, 93    CASH                       500.00
218 OCT 8, 93    CASH                        50.00
219 NOV 1, 93    PAYCHECK                  5000.00

221 DEC 1, 93    PAYCHECK                  5000.00

223 DEC 8, 93    COMMISSION CHECK          1000.00
224 DEC 9, 93    ANNUAL BONUS              5000.00
```

```
160 DEC 25, 93  PARTY                              $25.00 c
161 DEC 25, 93  PARTY                             $300.00 c
162 DEC 25, 93  PARTY                             $500.00 c



                        QUERY SELECTION




 #    DATE       DESCRIPTION              AMOUNT        CODE
-------------------------------------------------------------
                                                         D

                                                    ^ enter

                                    c to select checks
                                            or
                                    d to select deposits
```

IMPORTED DATA REGISTER

#	DATE	DESCRIPTION	AMOUNT	CODE
260	DEC 25, 93	PARTY	$50.00	d
261	DEC 25, 93	PARTY	$40.00	d
262	DEC 25, 93	PARTY	$240.00	d
263	DEC 25, 93	PARTY	$900.00	d
264	DEC 25, 93	PARTY	$220.00	d
160	DEC 25, 93	PARTY	$25.00	c
161	DEC 25, 93	PARTY	$300.00	c
162	DEC 25, 93	PARTY	$500.00	c
163	DEC 25, 93	PARTY	$900.00	c
164	DEC 25, 93	PARTY	$45.00	c

APPENDIX F

SPREADSHEET INSTRUCTIONS/QUESTIONS

DIRECTIONS - ENTER {alt-h} FOR THE HELP MENU

1. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
   101 JAN 1, 93   CATERERS   600.00

2. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
   102 JAN 5, 93   BAND   200.00

3. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
   201 JAN 10, 93   ANNUAL BONUS   5000.00

4. DELETE THE LAST CHECK ADDED TO THE CHECK REGISTER:
   102 JAN 5, 93   BAND   200.00

5. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
   202 JAN 15, 93   PAYCHECK   5000.00

6. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
   103 JAN 15, 93   ELECTRICITY   120.00

7. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
   104 JAN 15, 93   CABLE   30.00

8. DELETE THE LAST DEPOSIT ADDED TO THE DEPOSIT REGISTER:
   202 JAN 15, 93   PAYCHECK   5000.00

9. IMPORT THE FOLLOWING DATA FROM THE FILE DESCRIBED:
   FILENAME: FEB.PRN

10. SORT THE LATEST DATA IMPORTED
    IN DESCENDING ORDER

11. QUERY IMPORTED DATA, ENTER CHECKS IN THE CHECK
    REGISTER.
        TYPE "c" IN THE CHECK CRITERIA RANGE

12. QUERY IMPORTED DATA, ENTER DEPOSITS IN THE DEPOSIT
    REGISTER.
        TYPE "d" IN THE CHECK CRITERIA RANGE

13. SAVE THE SPREADSHEET TO THE FOLLOWING FILE:
        FILENAME: FILE1

14. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
        203 MAR 1, 93   PAYCHECK   5000.00

15. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
        204 MAR 5, 93   TAX REFUND   890.00

16. DELETE THE LAST DEPOSIT ADDED TO THE DEPOSIT REGISTER:
        204 MAR 5, 93   TAX REFUND   890.00

17. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
        105 MAR 10, 93   ELECTRICITY   80.00

18. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
        205 MAR 15, 93   PAYCHECK   2500.00

19. DELETE THE LAST CHECK ADDED TO THE CHECK REGISTER:
        105 MAR 10, 93   ELECTRICITY   80.00

20. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
        206 MAR 16, 93   REBATE   2.00

21. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
        106 MAR 25, 93   GASOLINE   15.00

22. IMPORT THE FOLLOWING DATA FROM THE FILE DESCRIBED:
        FILENAME: APRIL.PRN

23. SORT THE LATEST DATA IMPORTED
        IN ASCENDING ORDER

24. QUERY IMPORTED DATA, ENTER CHECKS IN THE CHECK
     REGISTER.
          TYPE "c" IN THE CHECK CRITERIA RANGE

25. QUERY IMPORTED DATA, ENTER DEPOSITS IN THE DEPOSIT
     REGISTER.
          TYPE "d" IN THE CHECK CRITERIA RANGE

26. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
          107 MAY 1, 93   RENT   600.00

27. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
          108 MAY 5, 93   ELECTRICITY   92.00

28. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
          207 MAY 15, 93   PAYCHECK   5000.00

29. DELETE THE LAST CHECK ADDED TO THE CHECK REGISTER:
          108 MAY 5, 93   ELECTRICITY   92.00

30. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
          208 MAY 20, 93   REBATE   5.00

31. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
          109 MAY 20, 93   CABLE   34.00

32. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
          110 MAY 21, 93   CREDIT CARD   200.00

33. DELETE THE LAST DEPOSIT ADDED TO THE DEPOSIT REGISTER:
          208 MAY 20, 93   REBATE   5.00

34. IMPORT THE FOLLOWING DATA FROM THE FILE DESCRIBED:
          FILENAME: JULY.PRN

35. SORT THE LATEST DATA IMPORTED
          IN DESCENDING ORDER

36. QUERY IMPORTED DATA, ENTER CHECKS IN THE CHECK
     REGISTER.
          TYPE "c" IN THE CHECK CRITERIA RANGE

37. QUERY IMPORTED DATA, ENTER DEPOSITS IN THE DEPOSIT
    REGISTER.
              TYPE "d" IN THE CHECK CRITERIA RANGE

38. SAVE THE SPREADSHEET TO THE FOLLOWING FILE:
              FILENAME: FILE2

39. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
        209 JUL 1, 93   PAYCHECK   5000.00

40. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
        210 JUL 5, 93   TRANSFER   1000.00

41. DELETE THE LAST DEPOSIT ADDED TO THE DEPOSIT REGISTER:
        210 JUL 5, 93   TRANSFER   1000.00

42. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
        111 JUL 15, 93   CREDIT CARD   150.00

43. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
        211 JUL 15, 93   PAYCHECK   1000.00

44. DELETE THE LAST CHECK ADDED TO THE CHECK REGISTER:
        111 JUL 15, 93   CREDIT CARD   150.00

45. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
        212 JUL 17, 93   CASH   100.00

46. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
        112 JUL 20, 93   TELEPHONE BILL   80.00

47. IMPORT THE FOLLOWING DATA FROM THE FILE DESCRIBED:
              FILENAME: AUGUST.PRN

48. SORT THE LATEST DATA IMPORTED
        IN ASCENDING ORDER

49. QUERY IMPORTED DATA, ENTER CHECKS IN THE CHECK
    REGISTER.
              TYPE "c" IN THE CHECK CRITERIA RANGE

50. QUERY IMPORTED DATA, ENTER DEPOSITS IN THE DEPOSIT
    REGISTER.
          TYPE "d" IN THE CHECK CRITERIA RANGE

51 ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
       113 SEP 1, 93   RENT   600.00

52 ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
       114 SEP 1, 93   ELECTRICITY   130.00

53 ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
       213 SEP 6, 93   PAYCHECK   2500.00

54 DELETE THE LAST CHECK ADDED TO THE CHECK REGISTER:
       114 SEP 1, 93   ELECTRICITY   130.00

55. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
       214 SEP 7, 93   REBATE   2.00

56. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
       115 SEP 8, 93   TELEPHONE BILL   135.00

57. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
       116 SEP 8, 93   GASOLINE   14.50

58. DELETE THE LAST DEPOSIT ADDED TO THE DEPOSIT REGISTER:
       214 SEP 7, 93   REBATE   2.00

59. IMPORT THE FOLLOWING DATA FROM THE FILE DESCRIBED:
          FILENAME: SEPT.PRN

60. SORT THE LATEST DATA IMPORTED
       IN ASCENDING ORDER

61. QUERY IMPORTED DATA, ENTER CHECKS IN THE CHECK
    REGISTER.
          TYPE "c" IN THE CHECK CRITERIA RANGE

62. QUERY IMPORTED DATA, ENTER DEPOSITS IN THE DEPOSIT
    REGISTER.
          TYPE "d" IN THE CHECK CRITERIA RANGE

63. SAVE THE SPREADSHEET TO THE FOLLOWING FILE:
        FILENAME: FILE3

64. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
        215 OCT 1, 93   PAYCHECK   5000.00

65. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
        216 OCT 1, 93   TRANSFER   200.00

66. DELETE THE LAST DEPOSIT ADDED TO THE DEPOSIT REGISTER:
        216 OCT 1, 93   TRANSFER   200.00

67. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
        117 OCT 5, 93   RENT   600.00

68. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
        217 OCT 5, 93   CASH   500.00

69. DELETE THE LAST CHECK ADDED TO THE CHECK REGISTER:
        117 OCT 5, 93   RENT   600.00

70. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
        218 OCT 8, 93   CASH   50.00

71. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
        118 OCT 8, 93   ELECTRICITY   96.00

72. IMPORT THE FOLLOWING DATA FROM THE FILE DESCRIBED:
        FILENAME: OCTOBER.PRN

73. SORT THE LATEST DATA IMPORTED
        IN DESCENDING ORDER

74. QUERY IMPORTED DATA, ENTER CHECKS IN THE CHECK
    REGISTER.
        TYPE "c" IN THE CHECK CRITERIA RANGE

75. QUERY IMPORTED DATA, ENTER DEPOSITS IN THE DEPOSIT
    REGISTER.
        TYPE "d" IN THE CHECK CRITERIA RANGE

76. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
    119 NOV 1, 93   CREDIT CARD   230.00

77. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
    120 NOV 1, 93   TELEPHONE BILL   160.00

78. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
    219 NOV 1, 93   PAYCHECK   5000.00

79. DELETE THE LAST CHECK ADDED TO THE CHECK REGISTER:
    120 NOV 1, 93   TELEPHONE BILL   160.00

80. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
    220 NOV 3, 93   CASH   300.00

81. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
    121 NOV 5, 93   AIRPLANE TICKET   380.00

82. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
    122 NOV 5, 93   HOTEL   120.00

83. DELETE THE LAST DEPOSIT ADDED TO THE DEPOSIT REGISTER:
    220 NOV 3, 93   CASH   300.00

84. IMPORT THE FOLLOWING DATA FROM THE FILE DESCRIBED:
        FILENAME: NOV.PRN

85. SORT THE LATEST DATA IMPORTED
        IN ASCENDING ORDER

86. QUERY IMPORTED DATA, ENTER CHECKS IN THE CHECK
    REGISTER.
        TYPE "c" IN THE CHECK CRITERIA RANGE

87. QUERY IMPORTED DATA, ENTER DEPOSITS IN THE DEPOSIT
    REGISTER.
        TYPE "d" IN THE CHECK CRITERIA RANGE

88. SAVE THE SPREADSHEET TO THE FOLLOWING FILE:
        FILENAME: FILE4

89. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
         221 DEC 1, 93   PAYCHECK   5000.00

90. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
         222 DEC 1, 93   REBATE   2.00

91. DELETE THE LAST DEPOSIT ADDED TO THE DEPOSIT REGISTER:
         222 DEC 1, 93   REBATE   2.00

92. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
         123 DEC 1, 93   RENT   600.00

93. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
         223 DEC 8, 93   COMMISSION CHECK   1000.00

94. DELETE THE LAST CHECK ADDED TO THE CHECK REGISTER:
         123 DEC 1, 93   RENT   600.00

95. ADD THE FOLLOWING DEPOSIT TO THE DEPOSIT REGISTER:
         224 DEC 9, 93   ANNUAL BONUS   5000.00

96. ADD THE FOLLOWING CHECK TO THE CHECK REGISTER:
         124 DEC 13, 93   CATERERS   600.00

97. IMPORT THE FOLLOWING DATA FROM THE FILE DESCRIBED:
         FILENAME: DEC.PRN

98. SORT THE LATEST DATA IMPORTED
         IN ASCENDING ORDER

99. QUERY IMPORTED DATA, ENTER CHECKS IN THE CHECK
     REGISTER.
         TYPE "c" IN THE CHECK CRITERIA RANGE

100. QUERY IMPORTED DATA, ENTER DEPOSITS IN THE DEPOSIT
     REGISTER.
         TYPE "d" IN THE CHECK CRITERIA RANGE

101. SAVE THE SPREADSHEET TO THE FOLLOWING FILE:
         FILENAME: LASTFILE

102. QUIT.
         PLEASE INITIATE QUIT MACRO TO EXIT.

APPENDIX G

SUMMARY TASK LIST

1. Add a check to the check register.

2. Add a deposit to the deposit register.

3. Delete the last check from the check register.

4. Delete the last deposit from the deposit register.

5. Import data from a file.

6. Sort imported data.

7. Query imported data for checks.

8. Query imported data for deposits

9. Save the spreadsheet

10. Quit.

EXIT INTERVIEW

1. DID YOU UNDERSTAND HOW TO ACCOMPLISH THE TASKS REQUIRED
IN THE WORK SHEET?   (YES   or   NO   )

comments:

2. WERE YOU ABLE TO COMPLETE ALL 102 QUESTIONS IN THE
EXERCISE?
     (YES   or   NO)

comments:

3. DID YOU KNOW HOW TO USE MACROS BEFORE THIS EXERCISE?
                    (YES   or   NO)
     DO YOU NOW? (YES   or   NO)

comments:

4. DID YOU FIND THE MACROS EASY TO LEARN/MEMORIZE?
     (YES   or   NO   )
     DID YOU HAVE THEM MEMORIZED BY THE END OF THE EXERCISE?
     (SOME   ALL   NONE)

comments:

5. WOULD YOU LIKE TO DISCUSS THE END RESULTS OF THIS
RESEARCH PROJECT WHEN IT IS COMPLETE? (YES   or   NO   )

comments:(If yes, please provide a name and telephone number
on the sign up list at the front of the lab)

6. PLEASE DO NOT DISCUSS THIS EXERCISE WITH ANYONE AFTER YOU
LEAVE THIS ROOM. THERE ARE SEVERAL WEEKS OF TESTING STILL
TO BE CONDUCTED AND MANY STUDENTS ARE PARTICIPATING IN THE
STUDY. THE RESULTS OF THE RESEARCH MAY BE UNNECESSARILY
SKEWED IF SOME SUBJECTS HAVE MORE INFORMATION THAN OTHERS.

7. THANK YOU FOR PARTICIPATING IN THIS STUDY. YOUR NAME
WILL BE GIVEN TO YOUR INSTRUCTOR TO ENSURE YOUR EXTRA CREDIT
POINTS ARE RECEIVED.

(if additional comments, please use back of this form)

MACROS

ADD CHECK
\m

{WINDOW}{goto}add_c~

        moves to summary worksheet

{goto}check~{?}{r}{?}{r}{?}{r}{?}~

        input next check

{goto}checkregister~{goto}new_check~

        moves to check register

/wgpd~/wir~

        inserts row for new check

/c{esc}check~~/recheck~

        adds check to register

{let to_date,+last_date2}/wgpe~

        updates last date

{WINDOW}{d}{d}{d}

        returns to instructions

{quit}

        ends macro

ADD_DEPOSIT
\p

{WINDOW}{goto}add_d~

                    moves to summary worksheet

{goto}deposit~{?}{r}{?}{r}{?}{r}{?}~

                    input next deposit

{goto}depositregister~{goto}new_deposit~

                    moves to deposit register

/wgpd~/wir~

                    inserts row for new deposit

/c{esc}deposit~~/redeposit~

                    adds deposit to register

{let to_date,+last_date1}/wgpe~

                    updates last date

{WINDOW}{d}{d}{d}

                    returns to instructions

{quit}

                    ends macro

```
{window}{goto}checkregister~
                          switch windows
                          moves to check register

{goto}new_check~
                          go to new check data

{U}
                          go to last entry

{menucall CONFIRM}
                          DISPLAY MENU
```

==

```
CONFIRM     CONTINUE                      ESCAPE

This is the correct item to delete
                          This is the wrong item to delete

        /RE{R}{R}{R}~                {window}{D}{D}{D}

        {window}{D}{D}{D}            {quit}

        {quit}
```

==

DEL_LAST_D
\n

{window}{goto}depositregister~

                     switch windows,
                     moves to deposit register

{goto}new_deposit~

                     go to new_deposit

{U}

                     go to last entry

{menucall CONFIRM}

                     DISPLAY MENU

==

CONFIRM   CONTINUE   ESCAPE

This is the correct item to delete
                     This is the wrong item to delete

        /RE{R}{R}{R}~   {window}{D}{D}{D}

        {window}{D}{D}{D}   {quit}

        {quit}

==

```
/fs{esc}{esc}{?}~
                        save file, user input name

{window}
                        switch windows

{goto}summary~{window}
                        go to summary table

{d}{d}{d}
                        go to next question

{quit}
                        ends macro
```

{WINDOW}
           switch windows

/WGPD
           disable protection

{GOTO}IMPORT_OUT~
           go to import screen

/FIT{?}~
           import text

/DPFCFE
           parse data,

{R}{R}{R}{R}{R}{R}
           create and edit format

{R}{R}{R}{R}{R}
           move to format change

>>>>>>>>>*L~
           change format line

RI.{D}{D}{D}{D}{D}{D}{D}
           reset, set input range

{D}{D}{D}~OIMPORT_DATA~G
           set output range

/REIMPORT_OUT~
           erase old information

{goto}import~
           show moved information

/WGPE{WINDOW}{D}{D}{D}
           protect, switch, move
           to next question

{QUIT}
           ends macro

INITIATE PROGRAM
\0

{goto}begin~

               initiate screen set up

{window}{goto}MENU_SCREEN~

               display help menu in lower window

{window}

               display first question and cursor
               in top window

{quit}

               ends macro

```
{window}{goto}MENU_SCREEN~
                         move to bottom window
                         put menu in bottom screen

{window}
                         return cursor to top window

{quit}
                    *    ends macro
```

QUERY_CHECKS
\d

```
{window}                                 switch windows

/wgpd                                    disable protection

{GOTO}CHECKREGISTER~                     go to register

{GOTO}begin_check~                       go to the first line

/WIR{D}{D}{D}{D}~                        insert five rows

/rndBEGIN_CHECK~                         delete old first line label

/rncBEGIN_CHECK~~                        name new first line

/rndIMP_CHECK_OUT~                       delete old import range

{U}{U}                                   move to beginning of range

/rncIMP_CHECK_OUT~                       name new range

{d}{d}{d}{d}{d}{d}                        define new range

{R}{R}{R}{R}{R}~                         define new range

{goto}criteria_range~                    go to the criteria area

{goto}criteria~{?}~                      enter correct criteria

/dqiQUERY~cCRITERIA_RANGE~
                                         define query criteria

oIMP_CHECK_OUT~eq
                                         define query output, quit

{goto}checkregister~                     view check register

/wgpe                                    enable protection

{window}{d}{d}{d}                        switch windows, move to
                                         next question

{quit}                                   ends macro
```

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{window}	switch windows
/wgpd	disable protection
{GOTO}DEPOSITREGISTER~	go to register
{GOTO}begin_deposit~	go to the first line
/WIR{D}{D}{D}{D}~	insert five rows
/rndBEGIN_DEPOSIT~	delete old first line label
/rncBEGIN_DEPOSIT~~	name new first line
/rndIMP_DEPOSIT_OUT~	delete old import range
{U}{U}	move to beginning of range
/rncIMP_DEPOSIT_OUT~	name new range
{d}{d}{d}{d}{d}{d}	define new range
{R}{R}{R}{R}{R}~	define new range
{goto}criteria_range~	go to the criteria area
{goto}criteria~{?}~	enter correct criteria
/dqiQUERY~cCRITERIA_RANGE~	define query criteria
oIMP_DEPOSIT_OUT~eq	define query output, quit
{goto}depositregister~	view deposit register
wgpe	enable protection
{window}{d}{d}{d}	switch windows, move to next question
{quit}	ends macro

/q

quits program

{quit}

user must type yes
to confirm exit

{WINDOW}

               switch windows

{GOTO}IMPORT~

               go to import screen

/DSDSORT_RANGE~

               sort import data

pFIRST~{?}~sSECOND~{?}~g

               set variables

{WINDOW}

               switch windows

{d}{d}{d}

               next question

{quit}

               quit

VITA

Lieutenant Tammy Campbell has a Bachelor of Science degree from Jacksonville University in Business Management, 1984, and expects to receive a Master of Science in Computer Information Sciences from the University of North Florida, May 1993. Dr. Layne Wallace of the University of North Florida is serving as Tammy's thesis adviser.

Tammy has served as an officer in the United States Navy for 9 years receiving her commission after receiving her bachelor degree in 1984. She accomplished her graduate work while serving in the navy under the Advanced Education Program.

Tammy's graduate work has specialized in human factors. She has programming experience in COBOL, C, Basic, dBASE IV, and SIMSCRIPT. Tammy has been married for 11 years and has 2 children.