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CONTEXT DEPENDENCIES FOR YOUNGER AND OLDER ADULTS IN LEARNING A 4-KEY MOTOR SEQUENCE

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ABSTRACT

Context Dependencies For Younger And Older Adults In Learning A 4-Key Motor Sequence

by

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The role environmental context has on performance level may change based on the skill being learned and the performer of that skill. The present study was designed to examine the role of environmental context in the learning of a 4-key motor sequence task. The present study had two primary purposes: first, replicating findings of a limited context effect in younger adults, and second, extending the findings to older adults to look at changes related to aging and environmental context. ANOVA results revealed no significant context effect in the present study for younger adults, and therefore comparisons between younger and older adults could not be made. Analysis of the data suggests the possibility of low performance levels in the current study being at least one factor related to context dependencies not developing in the learning of the 4-key motor sequence task.

TABLE OF CONTENTS

LIST OF FIGURES

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CHAPTER I

INTRODUCTION

Skill acquisition is important in many every day activities. For example, learning to ride a bike as a child, studying for a school test during adolescence, or working the VCR as an adult are all important skills. As an older adult the re-learning or retention of skills is also an important issue and safety concern, ranging from driving a car, turning off the stove, or even remembering how to exit the building in an emergency.

Environmental conditions during skill acquisition can play an important role in learning both verbal and motor skills. When environmental conditions remain relatively unchanged a distinct learning environment may develop. This learning environment, often referred to as an acquisition context, can be crucial to future performance. Changes occurring in the acquisition context from acquisition to testing situations can impact performance level. For example, Godden & Baddeley (1975) found that, when switching acquisition and testing environments between to natural environments (land and sea), participants' performance was higher when skill acquisition and testing environments remained unchanged. So that a participant who had practiced a skill underwater had a higher performance level when asked to recall that skill underwater, where as if asked to recall that information while being on land, performance for that skill decreased. These changes in environmental context (e.g., trained on land, tested under water) were quite extreme but even more subtle changes in environmental context such as practicing a task in a calm quiet environment, then performing the same task in a crowded noisy room may impact performance. The level of task performance in this new environment (noisy context) may be lower in comparison to performing the task in the original acquisition or practice conditions (quiet context). Obtaining a high performance level is clearly a desirable goal. With this goal in mind, the role of environmental context in changing performance levels has importance. Performance changes occurring from varied environmental contexts is referred to as "context dependent memory," a phenomenon in which cognitive processing is affected by the environmental context in which the event occurs (Smith, 1988). If context remains the same in both learning and testing conditions (same context), then performance levels may be enhanced. If context changes between learning and testing conditions (different context), then performance levels tend to decrease. This effect is referred to as the "context effect" in which changes in performance are due to context dependencies developed during learning (Wright & Shea, 1991).

Context Effects

Context effects can result from a wide range of changes in our environment. Changes in parameters both directly related and unrelated to the learning of a task may both produce context effects. In basketball, the size of the court on which the game is played would be directly related to the learning of the task, whereas the size of the building the game is being played in would be unrelated to the game itself, but changes in either parameter (related, unrelated) may produce context effects. These changes in our environment can be very subtle in nature. For example, changing the color, placement, size, or shape of an object may be sufficient to cause changes in performance.

Context effects have been found in several studies of verbal learning (Bjork, Rhichardson, &Klavehn, 1989; Godden & Baddeley, 1975; Riccio, Richardson, & Ebner, 1984; Smith, 1988; Spencer & Raz, 1995; Watkins, Ho & Tulving, 1976). However, relatively few studies have dealt with context effects associated with motor tasks and so the parameters of context in regard to motor learning are not well defined. Exceptions to this include Wright & Shea (1991) and Wright, Shea, Li, & Whitacre (1996) who found that contextual dependencies were developed during perceptual-motor skill acquisition of a 4-key motor sequence. In these studies, participants practiced a series of typing sequences displayed in varied computer screen contexts. Both visual and auditory aspects were changed in the learning environment. Location, color, and shape of the display as well as varied tones generated by the computer were all manipulated.

Specific environmental contexts corresponded to specific key sequences. These environmental contexts that were presented during the learning of the sequences were then presented in same or different contexts for retention trials. The results showed context dependencies on immediate retention tests, but no context effects were found on 10/min delayed retention tests, unless initial context conditions were re-displayed prior to being tested. This redisplay was referred to as a reinstatement of context, where participants performed nine trials containing original contexts directing their attention back to the original context conditions immediately prior to retention. These 4-key motor sequence tasks were conducted using younger adults and displayed context effects on delayed retention tests only when strengthened by reinstatement. This need for reinstatement suggests that even with a sensitive measure, the context effect lacks in robustness. A similar 4-key task would therefore be needed to test context sensitivity between age groups because of its limited context effect. If older adults are less sensitive to context effects than younger adults then using the 4-key motor task may display no context effects for older adults.

Several studies have compared the effects of context on younger and older adults. A meta-analysis conducted by Spencer and Raz (1995) found that there were greater age differences in memory for context (memory of the environment) than for content (memory of the task). Older adults display a reduced recall for unrelated environmental conditions (context) that are present when learning specific information (content). This decreased memory for context in situations where it is more remote in nature may indicate some decreased context dependency in older adults. If older adults recall remote contexts of a learning environment to a lesser degree than younger adults, dependencies may not develop to these remotely related contexts.

Several studies have shown context dependencies in older adults. Light, La Voie, Valencia-LAvor, Owens, and Mead (1992) showed that both younger and older adults display context dependencies. Additionally, the findings of Jennings & Jacoby (1993) have demonstrated that older adults have no deficit in encoding contextual information. The context effect in older adults has also been displayed in numerous non-motor tasks (Benjamin & Craik, 1995). However, the mixed findings of context effects in older adults fuel the controversy about whether older adults will display context dependencies in all learning or whether dependencies are limited to only certain types of learning. Some researchers have found impaired context memory effects in older adults (Park & Puglisi, 1985; Chiarello & Hoyer, 1988; Park, Smith, Morrell, Puglisi, & Dudley, 1990). Are context dependencies impaired in older adults? This question still remains and further research needs to explore the role of context, and how it relates to both younger and older adults in learning. By exploring the role of context in learning the enhancement of performance may be possible .

Present Study

The purpose of this study was to extend the knowledge of context effects with both younger and older adults in the learning of motor tasks. This study was conducted using the general format established by Wright & Shea (1991) and Wright *et al.* (1996) using a 4-key motor sequence. Younger adults were tested to replicate context dependencies observed in these previous studies. In addition testing was extended to older adults to determine if any age related changes impact context dependencies. With a possible decline in context dependencies in older adults, modifications from the original research include, increasing practice to further strengthen performance (Schmidt, 1988). Total practice was increased by the addition of a second day of practice, doubling the total number of trials. This additional day doubled the number of total acquisition trials that participants received. Extending practice should increase the speed of information processing (Mowbray & Rhoades, 1959) which may further strengthen any context dependencies formed in either the young or old participants.

In addition to measuring performance in terms of percent error, reaction time (RT) was also measured to provide information on changes in information processing. RT, referred to as the chronometric method, is a common measure for changes in information processing (Posner, 1978; Sternberg, 1969). Changes in information processing reflect central processing speed. The additional measure of RT offers another cognitive measure of context dependency which may prove to be more reliable or sensitive in nature than percent error. Findings were interpreted in regard to context dependencies for younger and older adults in the learning of a 4-key motor sequence and the impact of extended practice on context dependencies.

Hypotheses

Several hypotheses could be forged from the current experimental design and question. Context dependencies found in learning a 4-key motor sequence task could be of the same degree, across age groups. In this case, context (color, shape, location, or sound) in learning a 4-key motor sequence would equally affect both age groups. A second hypothesis would suggest that context dependencies found in learning a 4-key motor sequence task will be formed to a lesser degree in one of the age groups. Weakened dependencies may exist in older adults if the processing of the experimental contexts decreases with age. Dependencies may be lower in younger adults if older adults are more sensitive to changes in their learning environment. A third hypothesis would predict the possibility of no context effects being found in one or both of the age groups. The limited context effects (reinstatement dependent) previously found in younger adults may not be replicated. Older adults may not display context effects if environmental contexts do not play a significant role in the learning of this specific task (4-key motor). Possible reasons for no context effects occurring may include very high or low performance levels, high participant variability, context being too remote in nature, decreased encoding with age, or limited importance of context in learning the 4-

key motor task. If the younger adults do not display a context effect then no direct comparison can be made to the data of older adults because no replication of previous findings.

CHAPTER II

LITERATURE REVIEW

Introduction

Studies conducted on context dependencies and the role they play in human memory have found context effects in both the younger and the older adults. Questions exist about whether context plays as distinct a role in learning for older adults as it does for younger adults. Older adults show a general decline in memory with age, and several studies have shown possible declines in memory for certain types of context and remote information (Spencer & Raz, 1995). These declines in memory may lead to differences in any context dependencies formed by older adults. Determining how environmental contexts influence learning in older adults may help to limit age related differences in learning. If the environment plays a different role in learning for older adults, then possible changes in methods of training and practice may be used to facilitate increased learning. This chapter will address current issues in the area of context and the role context plays in human memory and information processing. Current literature is explored to provide a foundation for the context effect in younger and older adults. Reasons for a possible difference in context dependencies with age in learning is discussed, including possible declines in the memory of older adults for context and remote information. Literature demonstrating context dependencies in younger and older adults will also be explored, as well as the findings of Wright & Shea (1991,1996) in their previous studies of learning the 4-key motor sequence.

Measuring Information Processing

Learning is a relatively permanent change in behavior resulting from practice or experience that cannot be directly observed and therefore must be inferred from performance. Because learning is not directly observable, we must determine the level of learning that occurs from behavior. Measuring information processing from behavior allows us to determine performance level. Reaction time (RT) is recognized as a valid behavioral measure of information processing (Schmidt, 1988). RT is the most widely used chronometric method to measure the time interval between the stimulus presentation and the initiation of a response. Based on RT measurements, inferences on human information processing can be made (Posner, 1978). Human information processing has been broken into at least three basic stages (Schmidt, 1988). The first stage is stimulus identification where the stimulus is detected, encoded and classified. The response selection stage is next where information is selected and encoded into appropriate response codes. These codes are then delivered to the last stage, response programming where one appropriate response is selected. RT is used to measure the speed in which information processing occurs because it measures only the time interval before the response is initiated. One method to improve RT is to extend practice. The study of Mowbray & Rhoades (1959) showed decreases in RT with increasing practice on simple reaction tests. The Participant's RT decreased over a 42,000 trial practice period, showing an increase in information processing speed for simple choice reaction tasks as practice is increased.

Context: Implicit & Explicit

The overall context refers to the setting in which an event takes place, with setting being defined as all aspects of the surrounding environment (Smith, 1988). Context can further be divided into two areas: passive or non passive in nature (Davies & Thomson, 1989). That is to say, context may be independent in relation to the target task, or it may play an interactive role in our cognitive processing. Context can also be addressed in relation to the mental and physical state of the individual. Measures of state context are based on arousal level, mood, and altered states of perception caused by illness, disease, or drugs.

Environmental context is all external stimuli in our environment. Smith (1988) defines environmental context as "incidental external stimuli which are not explicitly or implicitly related to the learning material in any meaningful way." *p.14* Environmental contexts are the various characteristics or features in a given learning environment that are not part of the information or skill being learned. Memory for an event can be looked at explicitly (directly related), as a conscious recollection, or implicitly (remotely related), having no conscious recollection but demonstrating changes in test performance (Schacter, 1987). To isolate the effect of implicit information on memory retrieval, a participant makes responses that demonstrate a memory trace or cuing of items presented earlier, even though the participant is unaware of these past items that now reflect changes in his response (Park & Shaw, 1992).

Explicit information is directly related to a stimulus or event. Explicit memories are an attempt at recalling information that should be learned in a given environment. Tests of explicit memory require the participant to actively recall or retrieve information in an attempt to complete the desired task (Park & Shaw, 1992). Stimuli may be directly related to target information and explicit in nature, or unrelated and implicit in nature. Explicit stimuli in our environment such as color, location of objects, sounds, and surrounding items (contexts being used in 4-key test) together with any information which is not considered target information, can be considered context, regardless of whether the participant has any conscious recollection of these context features.

Context can further be grouped into three classifications: integrated, influential, and incidental (Bjork, Rhichardson, &Klavehn, 1989). Integrated context is explicitly associated with the target stimuli during encoding. Influential context means that the context in some way influences the participant's interpretation of the target information. Incidental aspects of context are "independent or isolated from the target information" and do "not influence the subject's interpretation of, or interaction with, the target material at encoding" *p.316* (Bjork et al., 1989). Context therefore can be looked at as all "perceptual and conceptual details associated with an event" *p. 285* (Benjamin & Craik, 1995).

Context Dependent Memory

Context dependent memory can be explained as the way in which our cognitive processing is affected by changes in coincidental background stimuli. Change in memory levels (performance) resulting from this change in background stimuli change is explained as the environmental reinstatement effect (Smith, 1988). Reinstatement of some previously experienced context cues the memory of information or events which took place in that context. An example of this effect is the inability to recall a classmate's name outside school, but upon returning to school his name can be recalled. In this case returning to the original environmental context of the school enabled the recall of the classmate's name. As previously defined, this ability to recall in the original setting is termed the context effect (Wright & Shea, 1991) where changes in context affect performance. Studies on context have measured recall and recognition performance based on changes in context. Watkins, Ho & Tulving, (1976) in a series of three experiments, showed context affects in the recognition memory of faces. In one experiment participants studied a face beside a second face. Post-tests showed that participants were more likely to recognize a face when paired with the same face (same context) than with a different face (different context). In the second experiment, faces were paired with a verbal description, and again when context remained the same in test conditions recognition was enhanced. In the final experiment participants were aware that they would be tested on the faces being presented, thus forcing the participant to study the target face. The results displayed an increased recognition for faces in the same context and decreased recognition for faces matched with a different context. In another study Godden & Baddeley (1975) showed that a complete change of environment would cause changes in context-dependent memory. In this study divers learned lists of words in two natural environments, on dry land and under water. The results showed that recall for a list studied under water was higher when retested in that environment. Likewise when a list was studied on dry land recall was higher if retested on dry land and not under water.

Encoding-Specificity

Similarity between practice conditions and retrieval conditions can enhance memory and skill performance. This idea is known as the encoding-specificity principle developed by Tulving & Thomson (1973). This principle states that the ability to retrieve skill-related information depends on the degree to which the setting where the information is to be retrieved is similar to the setting where it was originally introduced to the learner. This principle explains context dependent memory. If context dependencies are formed in the initial learning environment then performance can be enhanced based on similarity between future settings and the original settings. Settings refers to the environmental conditions or context.

Age-related declines: Memory for context

Age-related slowing in information processing has been demonstrated on a wide variety of RT tasks both motor and non-motor in nature. Maintaining information processing speed during aging is important not only for the role it plays in everyday events such driving a car, but also because of its relationship with memory for skills such as where the fire-exit is, and when to use it. Information processing is important to learning and memory because of its role in encoding, organizing, and retrieving of information (Rose, 1997).

The question of whether older adults have a greater decline in memory for context compared to content is still being investigated. Several studies have shown mixed results for context memory. Denny, Miller, Dew, & Levav (1991) tested the hypothesis that there would be greater declines in memory for context features of target information in older adults than in younger adults. Participants studied slides which contained a word centered on varied landscapes. Participants were instructed to remember either the word, background, or word-background pair. Tests were then given on memory for the word and background pairs. Results showed declines in memory with age, but older adults showed no greater declines in the recall of context features as opposed to recall of target information. These findings were replicated by Denney & Larson (1994). Participants were tested on their memories of connections between word-background pairs. Older adults showed the same relative difficulty in remembering target information and contextual information. This memory decline with no difference between target and contextual information, provided no support for a specific encoding deficits.

Benjamin & Craik (1995) compared younger and older adults' memory of fonts (context) in which words are presented. Participants studied words presented in one of two fonts and presented in two different voices. Younger adults again showed better memory for words, fonts, and voices. Older adults however showed equal declines in memory for target and contextual information (e.g., font & voice). Therefore, no evidence was found for age-related impairment in encoding context.

In contrast to these studies, Hess (1984) conducted two experiments on encoding of contexts and older adults. In the first experiment participants studied word pairs where the target word was closely linked to the context word (e.g., copper & pot). In the second experiment participants studied word pairs that were not directly related (e.g., copper & cat). The results showed general declines in memory with age. Older adults also showed declines in memory for contexts that were unrelated to target information, but no relative declines in contexts related to the target words (experiment 1). Based on these findings it appears that older adults' memory for context may diminish if context has a weaker connection to the target information or is more implicit in nature. Supporting this finding, Chiarello & Hoyer (1988) found that in testing for word-stem recall in implicit and explicit tasks that older adults' performance was impaired more than younger adults' on implicit retrievals. The additional measure of time course was also used. The time interval was limited for completion of the task, so that if cognitive processing was slow, performance would be impaired. As an increased processing level was needed, older adults' performance was decreased to a greater degree than that of the younger adults. This performance decrease was found in both implicit and explicit measures. Park & Puglisi (1985) examined the memory of older adults for pictures or words, and the color they were presented in. Older adults showed greater declines in memory for the color (context) a word was presented in (e.g., red word) as compared to remembering the color of a drawing such as a house (e.g., red house). From this it was concluded that memory for context is a function of the stimulus with which it is associated. Older adults' ability to recall context if it is not directly related to or easily related with the target task seems to be impaired. Based on Spencer & Raz's (1995) meta-analysis of 46 studies of context, tasks requiring greater information processing showed greater age-related differences for context information memory. If demands on information processing can be decreased then they may show increased contexts effects.

Older adults' processing of the environment may be limited to context cues that are easily linked to the target task or are not implicit in nature. As demands on processing are increased for older adults, their performance level will decline. The study of Park, Smith, Morrell, Puglisi, & Dudley (1990) further investigated the ability of older adults to use integration of context and target. Three different picture condition types were tested. Categorically related (e.g., a spider and an ant), visually interacting (e.g., a spider on top of a cherry) and non-interacting (e.g., a spider on the left, a cherry on the right). Results showed that the non-interacting condition produced the largest age difference, supporting the idea that older adults do not use contexts that are not integrated as well as contexts that are closely integrated. Older adults were also able to use the well-integrated target-context relationships better than the younger adults. These results suggest an important component to older adults' use of context. Older adults seem to be more sensitive to changes in type of context than younger adults. This can be looked at in two ways: (1) If context is not associated to the target then it will not improve the learning of a task, (2) If context can be directly related to a task then learning may be facilitated in older adults. This might suggest a greater relative benefits for older adults if practice can be designed to maintain high levels of integration with future applications. An older adult may receive more benefits if practice is in a more directly applied setting.

Context dependency in the 4-key motor sequence task

The encoding-specificity principle applies to the learning of motor skills, where processing activities engaged in by the learner during acquisition and retention are compatible (Lee & Magil, 1983). The 4-key motor sequence task used by Wright & Shea (1991) displays this compatibility. Participants practiced the 4-key task with specific computer contexts attached to the sequence display. These contexts were color, surrounding shapes, sound, and screen position. After practice trials were completed, an immediate retention test was given in either the same context or with a different context. In line with encoding-specificity, retention of the sequence was better in the same context condition than it was in the different context condition.

Further investigating context dependencies, Wright, Shea, Li, & Whitacre (1996) extended their findings on the same 4-key motor task to include a delayed retention test. Findings from Wright & Shea (1991) were based on an immediate retention test, and did not show whether dependencies would diminish with an extended time interval. Using a delayed retention test condition, findings showed no context effect until a reinstatement condition was added prior to the delayed retention test. This reinstatement was used to redirect the participants' attention to the incidental stimuli that were presented during acquisition. Reinstatement consisted of one block of the original contexts, and was not considered to be significant to overall acquisition. Reinstatement allowed context dependencies to be refreshed in memory. Since dependencies were established on a delayed retention test it was concluded that context had a influence on the learning of the 4-key motor sequence.

With the Wright et al. (1996) protocol displaying context dependencies in younger adults, the same basic protocol were used to determine possible context dependencies in older adults and to replicate dependencies found in younger adults. Context dependencies have been found in older adults, but the presentation modality (Lehman & Mellinger, 1984), the degree to which contexts are related to source material (Light & Singh, 1980; Hess, 1984; Park & Shaw, 1992), or task type and complexity (Wright, 1991) could all mediate whether the 4-key protocol will elicit similar effects in older adults.

CHAPTER III

METHOD

Participants

Participants were classified into younger and older adult groups. Participants for the older adult group consisted of 20 (8 men, 12 women) volunteers from the Las Vegas area aged 55-71 with a mean age of 62.25. Participants for the younger adult group consisted of 20 (11 men, 9 women) volunteers from the student population at UNIV aged 20-26 with a mean age 21.05. All participants were naive as to the theoretical implications of the study. Prior to the study, all participants signed an informed consent/health sheet to ensure that they were in good health and had normal hearing and vision (Appendix A).

Design

A 2 (Age) x 2 (Context) x 2 (Day) mixed design was employed with age and context being between-subjects and day being a within-subjects. The dependent measures of interest were reaction time in milliseconds and percent error. Both measures were collected for all acquisition and retention trials.

Apparatus

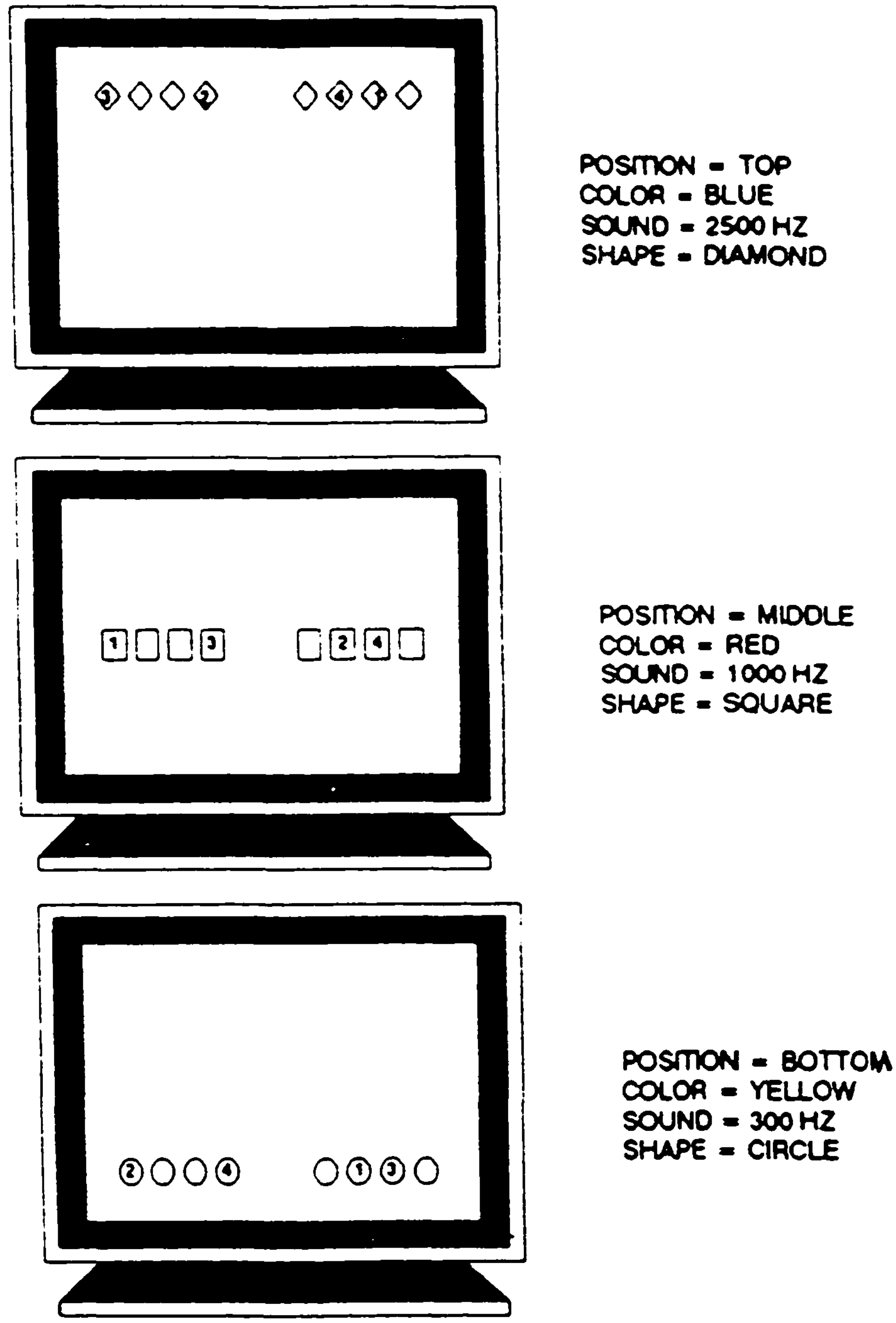
The apparatus consisted of a 386 IBM-compatible microcomputer with 12 inch color monitor and standard keyboard to measure RT and percent error. The computer was used to run the experiments protocol including all visual displays.

Procedures

Based on the protocol used by Wright, Shea, Li, & Whitacre (1996), participants practiced a computer generated 4-key motor sequence. Participants were seated in front of the computer and informed that a display of the numbers 1-4 would appear on the monitor. These numbers would indicate a sequence of four key strokes to type on the keyboard and which keys to press. Participants placed their fingers in the home position on the keyboard (i.e., a, s, d, f, keys for the left hand, and j, k, l, ; keys for the right hand). Participants were informed that the display sequence showed the order in which to press the keys (1,2,3,4) and which keys to press. Participants were also informed that the only keys being used were from the home position keys. Thus, the only key choices for each sequence would be the keys their fingers rested on. No other key would need to be pressed. Three different sequences were used, each with its own separate context which varied in location, color, tone, and shape. The location varied by screen placement (top, middle, or bottom). The display was in one of three colors (blue, red, or yellow).

A tone was produced along with the screen display in one of three frequencies (2500, 1000, or 300 Hz) and a shape (diamond, square, or circle) outlined the letters to be reproduced (Figure 3.1).

All contexts were constantly mapped throughout the entire acquisition phase. Different contexts were attached to each sequence, but the same four fingers (left-little, left-index, right-middle, and right-ring) in different orders, were used during all typing sequences, so that finger variability was eliminated. Participants were not informed of the contexts attached to the sequences or that the same four fingers were being used. Trial displays were presented for 400, 600, or 800 ms. Participants were informed to initiate the displayed sequence as soon as the display had disappeared and to do so as rapidly and accurately as possible but not to begin until the display had disappeared. Instructions were given verbally and in written form on a participant instruction sheet which also showed a sample display (Appendix B). The lab instructor checked on participants and would observe whether participants were following the before mentioned instructions. Reminders were given to begin the sequence only after the display had disappeared and as fast and accurately as possible. If participants were making methodological errors during testing such as placing their hands on the wrong keys, then the lab instructor would stop the participants and show them the correct home position key locations. After each trial, feedback was displayed by an on-screen message: "Good trial" for a successful completion, or "Bad trial" in the event the incorrect keys were pressed or if participants began typing the sequence prior to the display disappearing.



Computer Display of 4-Key Sequences

Figure 3.1

Participants were also limited to 2 seconds in which to enter the correct sequence. Participants preformed nine acquisition blocks of 12 trials with four trials of each of the three motor sequences randomly ordered in each block. Each block of trials was separated by a 20-second interval.

A ten minute delayed retention test consisted of nine exposures of the original context for all participants. Half (10) of the participants then received three trials with one of each of the sequences in the original contexts (same context condition). The other half of the participants received three trials with different contexts attached (switched context conditions). The combined retention test thus represented an entire block (12 trials). Participants were randomly assigned to the same or switched conditions. Participants returned 24 hours later and completed the same procedures as on the previous day with nine more acquisition blocks to increase their training. Then participants were again tested on the ten minute delayed, same or switched context retention test showing what effects the increased training may have had. Reaction time and percent error data were recorded for all acquisition and retention test block.

CHAPTER IV

ANALYSIS AND RESULTS

The dependent variables of mean reaction time and percent error were analyzed using separate analysis of variance (ANOVA) procedures. Separate ANOVA for each acqusisition and retention data were also run. ANOVA procedures were written in SAS language. Tukey's follow up analysis was run on all main effects. Interactons did not receive a follow up analysis but were visualy anazized with trends being discussed in the next section.

Reaction time represents the time interval (msec) from removal of the display to the first key stroke made by the participant. A reaction time of zero was recorded if the participant's first key stroke was less than 100 msec or prior to removal of the display. A reaction time of zero was considered to represent anticipation and was not included in the calculation on mean reaction times.

Percent error was calculated based on the percentage of "Bad Trials" performed. A "Bad Trial" reading was obtained if a subject made an error in the key sequence or did not enter the sequence within the limited time interval. The time interval started at the end of the anticipation period (100 msec) and ended at two seconds.

Acquisition

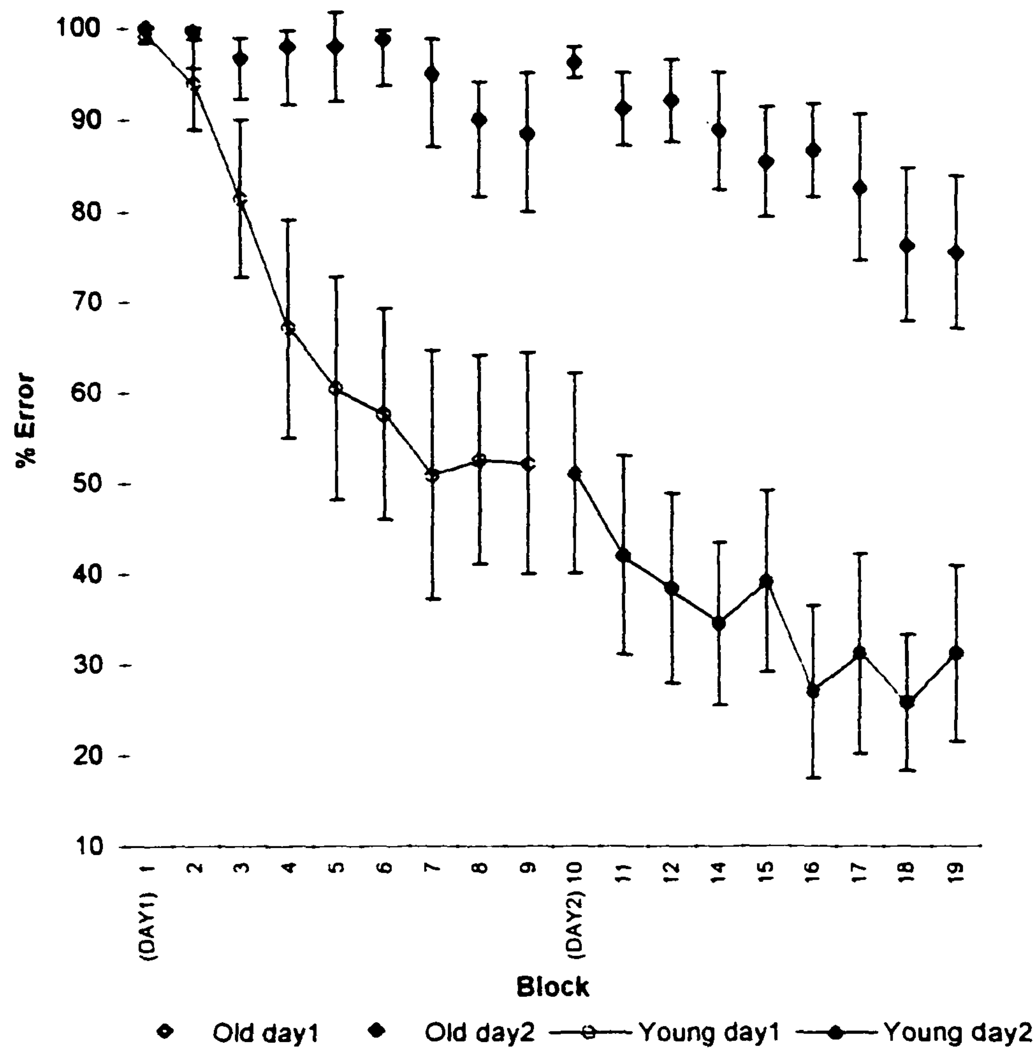
Mean percent error for acquisition data were analyzed by using a 2 (Age) x 2 (Context) x 2 (Day) x 9 (Block) ANOVA with repeated measures on the last two factors. The analysis revealed significant main effects for day, $F(1,36) = 56.99$, $p < .001$, with means being 82 and 60.9 percent for the first and second days respectively. Main effects for age, $F(1,36) = 45.32$, $p < .001$, with means being 52 and 90.9 percent for the young and old age groups respectively and a main effect for block, $F(8,288) = 20.12$, $p < .001$. No main effects were found for context. Significant interactions for Day x Age, $F(1,36) = 17.09$, $p < .001$, Block x Age, $F(8,288) = 5.2$, $p < .001$, and Day x Block x Age, $F(8,288) = 3.53$, $p < .001$ were also found. No interactions were found for Context or Block x Day (Figure 4.1).

Mean reaction time for acquisition data for the young adults were analyzed by using a 2 (Context) x 2 (Day) x 9 (Block) ANOVA with repeated measures on the last two factors. Data from the older adult group was omitted from the analysis because of a lack of readings. Data collected for reaction time revealed that older adults keyed in responses prior to removal of the display or had anticipated (<100 msec) the removal resulting in readings of zero in the vast majority of trials. Readings of zero could not be used in calculation of reaction times, results for older adults were not analyzed. The analysis on younger adults revealed significant main effects for day, F (1,18) = 34.02, $p < .001$, with means being 292.7 and 173.4 msec for the first and second days, respectively. Main effects for block, F (8,144) = 9.27, $p < .001$. No main effect for context was found. Significant interactions for Day x Block, F (8,144) = 4.42, $p < .001$, and Day x Block x Group, F (8,144) = 4.42, $p < .049$. No interactions for Group (Context) were found (Figure 4.2).

Retention

Mean percent error for retention data were analyzed by using a 2 (Age) x 2 (Context) x 2 (Day) ANOVA with repeated measures on the last factor. The analysis revealed significant main effects for day, F (1,36) = 18.45, $p < .013$, with means being 71.5 and 58.1 percent for the first and second days respectively. and age, F (1,36) = 18.45, $p < .001$, with means being 45.6 and 84.1 percent for the young and old age groups respectively. No main effects for Context were found. No significant interactions were found for Age, Context, or Day (Figure 4.3).

Mean reaction time retention data were analyzed by using a 2 (Context) x 2 (Day) ANOVA with repeated measures on the last factor. Data from the older adult group was not used due to a lack of readings. Analysis revealed significant main effects for day, F (1,18) = 5.39, $p < .0322$, with means being 203.6 and 183.8 msec for the first and second days respectively. No main effect for context was found. No interactions were found (Figure 4.4).



Acquisition % Error (Day x Age x Block)

Figure 4.1

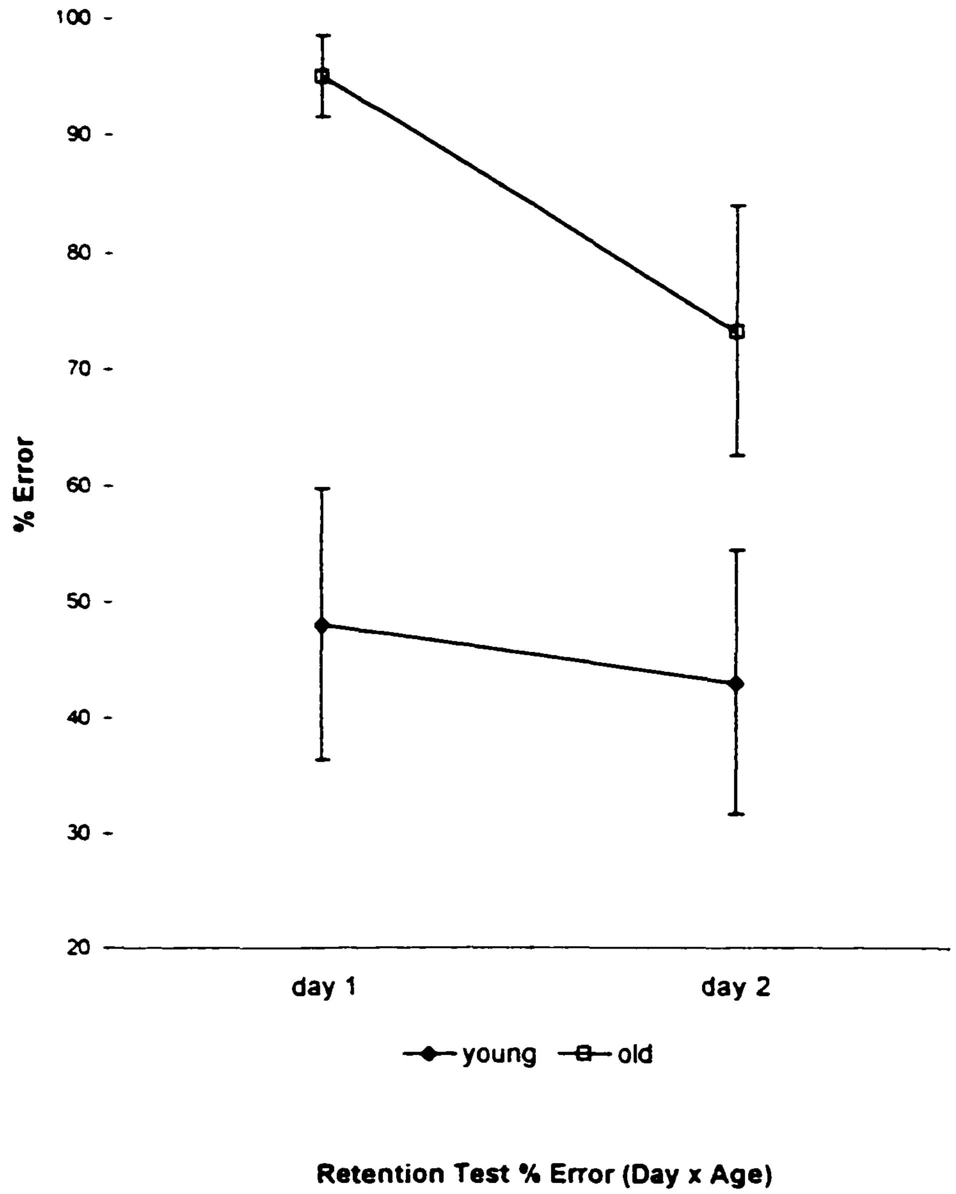
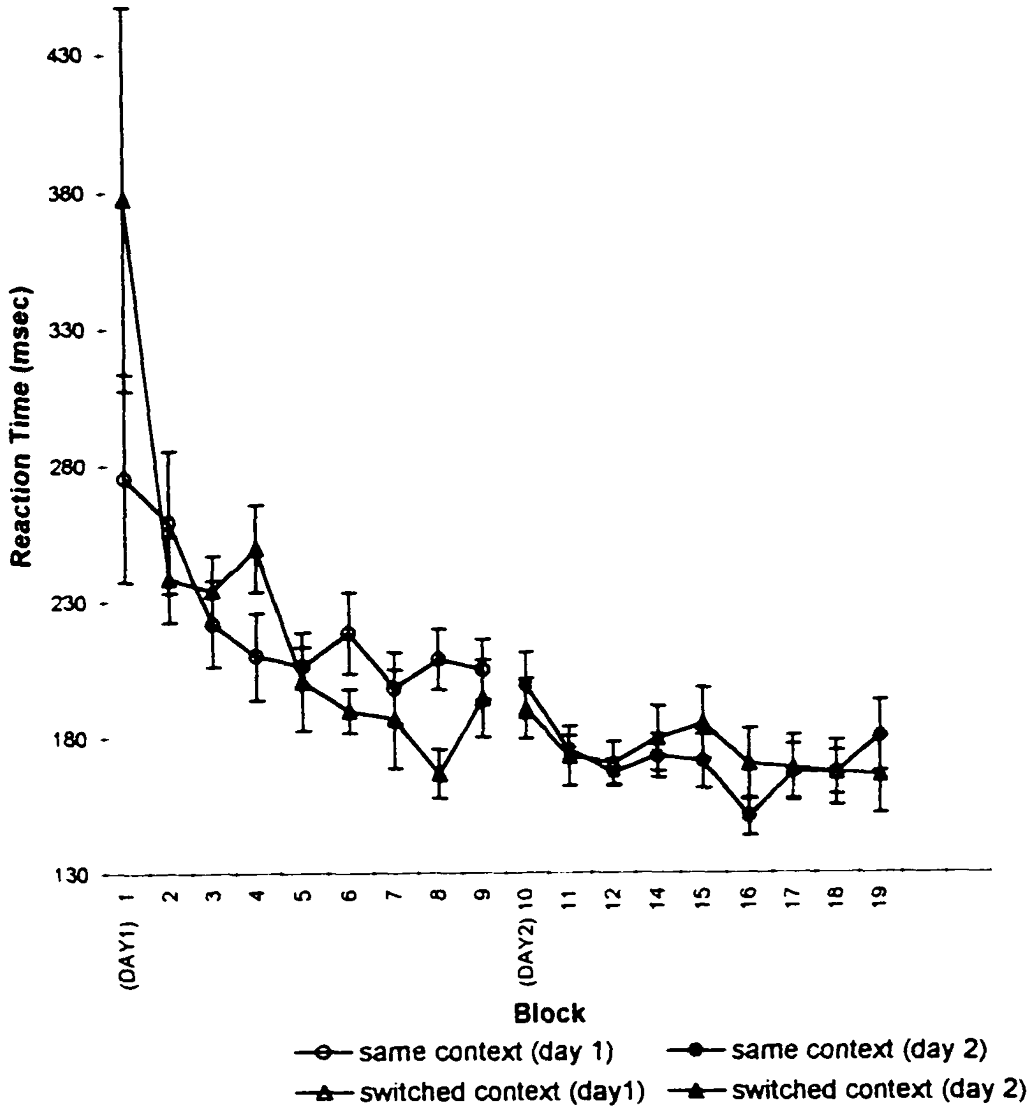
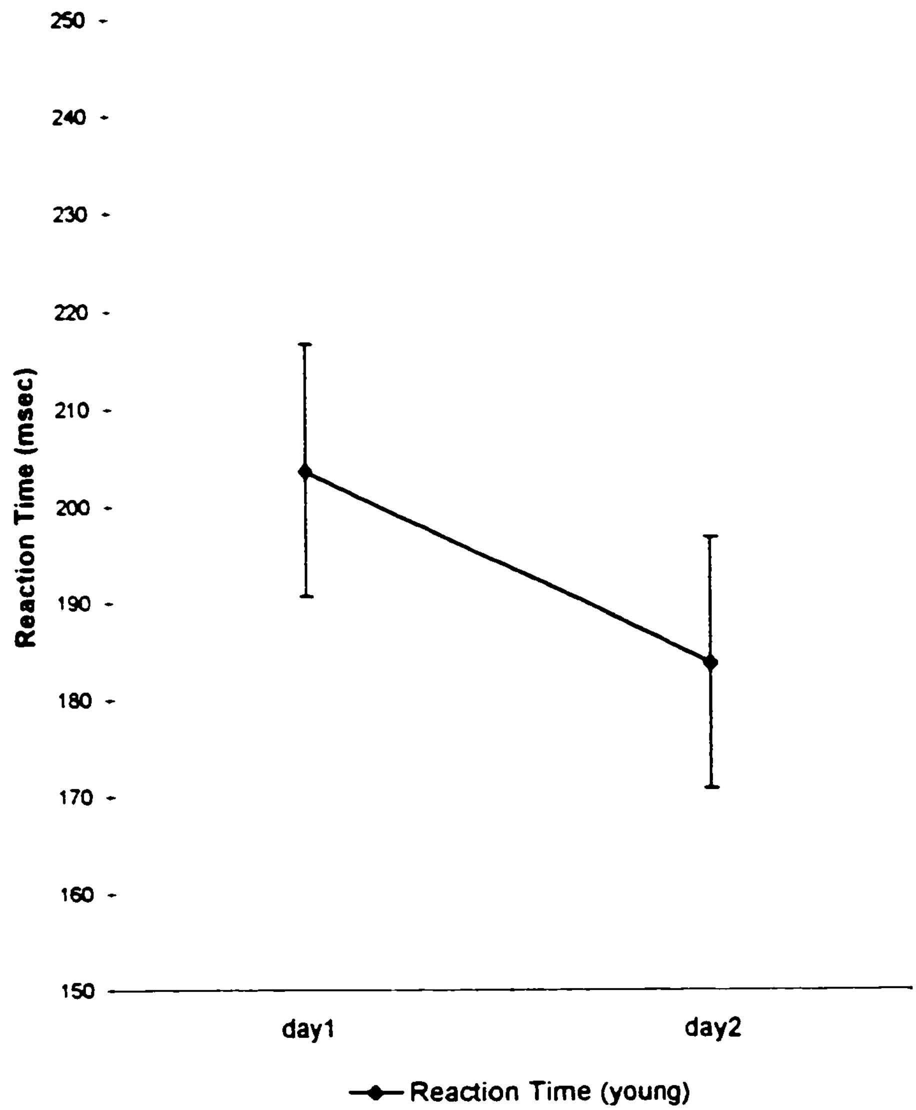

100
90
80
70
60
50
40
30
20
% Error
day 1
day 2
young
old
Retention Test % Error (Day x Age)

Figure 4.2



Acquisition Reaction Time Young (Context x Day x Block)

Figure 4.3



Retention Test Reaction Time (Young)

Figure 4.4

CHAPTER V

DISCUSSION

Changes occurring in the learning environment from acquisition to testing situations can impact performance level. If changes occur in environmental context between the acquisition of a skill and when the skill must be preformed then performance level may decrease. The role that context plays in acquisition and subsequent performance level can be affected by several factors including the specific skill, the level of the performer and what context changes occur. These factors influencing context's role in the acquisition and subsequent performance level are important considerations when tring to maximize performance.

The role context plays in acquisition may change based on each specific skill, whether motor or nonmotor in nature, due to the uniqueness of different skills. The level of the performer or the actual performance level achieved for the task, as well as the age of the performer may influence the role context plays. Poor performance levels place increased demands on information processing (Park

With no replication of context effects in younger adults, no direct comparison can be made to the role of context and older adults. Although the current data conflict with those obtained in previous studies, many of the same overall trends (with one notable exception) exist. This notable exception is the fact that the overall performance level of participants in the current study was significantly lower (Figure 4.1, 4.3).

During acquisition, main effects for Block were observed (Figure 4.1) which reflect younger adults' performance level improving with practice, this is consistent with previous findings in the 4-key task and the practice performance relationship (Mowbray & Rhoades, 1959). No main effect was found for Context during acquisition, showing that prior to being tested in the retention phase that the two context groups were not statistically different and had received the same training. This again is consistent with previous research and displays that the two context groups were equal when tested for a context effect in the retention test. Other logical trends displayed by the data which remain consistent include significant main effects for Day and Age, with the younger adults performing better than the older adults and both age groups performing better on the second day of practice (Figure 4.1, 4.2).

In looking at the additional measure of RT which was not used in the previous studies of the 4-key task, the same basic results are displayed in RT data that are displayed in percent error data in younger adults. Main effects were again found for Day and Block, showing younger adults improving with practice. RT data for older adults was not analyzed due to the lack of usable data obtained. resulting from anticipation or entering the sequence prior to removal of the display. These findings may represent a defensive mechanism of older adults to their inability to enter in the correct response in the limited time interval (less than 2 sec). They may have initiated responses prior to removal of the display in an effort to overcome the lack of time available.

The exception to the consistency between the current study and the previous studies are large differences in the actual level of performance, with percent error levels for context groups in the previous study being substantially lower at 6.1 and 16.7% (same, switched) compared to 46.3 and 49.8 % (same, switched) in the current study. Since the level of performance in the present study was very poor (high percent error) context had a limited amount of performance to impact. In younger adults who achieved a higher performance level (<50% error), closer to levels achieved in the previous studies differences in context appear to be more pronounced and more consistent with past results. Younger adults retention test percent error means (<50% error) for day 1 of 16.7 and 22% for same and switched contexts respectively display a greater relative and absolute change in performance than the total younger adult means (46.3 % same, 49.8% switched). This greater influence of context on participants with higher performance level supports the inference that at least one factor attributed to no replication of context effects in the current study is performance level, and that contexts effects may be limited to performers with higher performance in the 4-key motor task.

Why were performance levels of participants in the current study so low? Participants were randomly selected from a participant pool very similar to that of the two previous studies, with all studies using students enrolled in health science classes at major universities. The level of the performer for the task or the motivation of participants in the studies may still have varied. The same testing protocol was used with computer program, and the testing methods. One possible difference could be in the overall timing or presentation of the computer program itself. Although the same program was used, slight changes in the timing of the displays presented on the screen may have occurred because of the rate at which different computers process data. In the current study an older IBM-compatible 386 computer and 12 inch color monitor were used to replicate the same type of computers and monitors being used in the previous studies. The computer program was also fine tuned so as to limit any timing changes in displays. Never the less, possible changes in brightness, contrast, and shades of colors presented on the screen, as well as any other minor changes in testing location or context ranging from height of the chair to lighting in the room, may have adversely affected performance level.

Another possible reason for differences in performance and whether context dependencies may be related to methodology. Relatively few trials are recorded to calculate means for percent error and determine context effects. By using the established protocol. only three retention trials were recorded in either same or switched contexts. Just one "Bad Trial" display would result in a 33.3% error mean being obtained for a participant. in contrast to a 0% error mean for no "Bad Trail" readings. Thus changes in performance level are assessed by a very limited number responses. making the retention test very sensitive. The limited time interval (>100msec & <2sec) used may have impacted a participants' performance level. Even if the correct sequence is entered a "Bad Trial" reading is obtained if the timing is not with in the narrow time limits. If the time limit were removed then percent error would be a direct reflection of accuracy of key strokes. RT time could still be used as a measure of change in the response speed aspect of performance.

CHAPTER VI

FUTURE DIRECTIONS AND RECOMMENDATIONS

Based on the results obtained in the present study, the role of context on both younger and older adults in learning the 4-key motor task is still an open question, because the present study was unable determine context effects for younger adults. Context effects related to aging and possible ways of improving safety and performance for older adults cannot be explored until the context effect for the 4-key task in younger adults is validated. To determine whether context effects do exist in younger adults several changes are recommended. To increase performance levels in participants, remove the time limit, increase computer display times, and use a pretest questionnaire to assess computer familiarity of participants. In addition increase the number of retention test trials to a full block (12 trials) of same or switched contexts this should increase the overall amount of data in which to determine context effects.

Use of these changes in future testing may help to validate the context effect in younger adults so that comparisons can then be made to older adults. Eventual implications of this line of research include the possible development of specialized training for older adults based on the role environmental context plays in learning. The context effect can be a negative impact on performance when changes occur between training and testing. If context plays an increased role in learning for older adults then, by maintaining specific contexts that exhibit strong effects, older adults' performance might be enhanced to a greater relative degree than that of younger adults. If this can be accomplished then maybe the context effect can be a positive impact on skill acquisition and performance of older adults.

APPENDIX C

4-Key Sign In Sheet **Group #1**

Name (Subject)	Age	Day 1,2	Subject's Code Name	Condition (Retention)	Experimenter (Initials)	Comments
		1	aaxk,raxk	ret1		
		2	abxk,rbxk			
		1	aaxl,raxl	ret1		
		2	abxl,rbxl			
		1	aaxm,raxm	ret2		
		2	abxm,rbxm			
		1	aaxn,raxn	ret1		
		2	abxn,rbxn			
		1	aaxo,raxo	ret2		
		2	abxo,rbxo			
		1	aaxp,raxp	ret2		
		2	abxp,rbxp			
		1	aaxq,raxq	ret2		
		2	abxq,rbxq			
		1	aaxr,raxr	ret1		
		2	abxr,rbxr			
		1	aaxs,raxs	ret1		
		2	abxs,rbxs			
		1	aaxt,raxt	ret2		
		2	abxt,rbxt			

4-Key Sign In Sheet **Group #2**

Name (Subject)	Age	Day 1,2	Subject's Code Name	Condition (Retention)	Experimenter (Initials)	Comments
		1	aazk,razk	ret1		
		2	abzk,rbzk			
		1	aazl,razl	ret1		
		2	abzl,rbzl			
		1	aazm,razm	ret2		
		2	abzm,rbzm			
		1	aazn,razn	ret1		
		2	abzn,rbzn			
		1	aazo,razo	ret2		
		2	abzo,rbzo			
		1	aazp,razp	ret2		
		2	abzp,rbzp			
		1	aazq,razq	ret2		
		2	abzq,rbzq			
		1	aazr,razr	ret1		
		2	abzr,rbzr			
		1	aazs,razs	ret1		
		2	abzs,rbzs			
		1	aazt,razt	ret2		
		2	abzt,rbzt			

Name ______ Age ______ Phone ______ Comments ______ ______ ______	Date Time Day 1 ____ ____ Day 2 ____ ____ Special arrangements needed ______ ______ Experimenter Approval of time ____ ____	Date Time Day 1 ______ ______ **4-KEY TASK** Day 2 ______ ______ Location UNLV, Motor Behav Lab Building BHS RM215 Phone 895-1241 Tall five story building on northwest corner of campus From Flamingo, turn south into campus at 1st light west of Maryland Turn right at first stop sign (T in road) Then left at next stop sign (T in road) BHS building is directly ahead, across parking lot If before 5pm park in a metered spot (right next to building) Experimenter can provide you with change for meter If you are unclear as to location or would like to be met in parking lot or lobby please call
Name ______ Age ______ Phone ______ Comments ______ ______ ______	Date Time Day 1 ____ ____ Day 2 ____ ____ Special arrangements needed ______ ______ Experimenter Approval of time ______	Date Time Day 1 ______ ______ **4-KEY TASK** Day 2 ______ ______ Location UNLV, Motor Behav Lab Building BHS RM215 Phone 895-1241 Tall five story building on northwest corner of campus From Flamingo, turn south into campus at 1st light west of Maryland Turn right at first stop sign (T in road) Then left at next stop sign (T in road) BHS building is directly ahead, across parking lot If before 5pm park in a metered spot (right next to building) Experimenter can provide you with change for meter If you are unclear as to location or would like to be met in parking lot or lobby please call
Name ______ Age ______ Phone ______ Comments ______ ______ ______	Date Time Day 1 ____ ____ Day 2 ____ ____ Special arrangements needed ______ ______ Experimenter Approval of time ____ ____	Date Time Day 1 ______ ______ **4-KEY TASK** Day 2 ______ ______ Location UNLV, Motor Behav Lab Building BHS RM215 Phone 895-1241 Tall five story building on northwest corner of campus From Flamingo, turn south into campus at 1st light west of Maryland Turn right at first stop sign (T in road) Then left at next stop sign (T in road) BHS building is directly ahead, across parking lot If before 5pm park in a metered spot (right next to building) Experimenter can provide you with change for meter If you are unclear as to location or would like to be met in parking lot or lobby please call

APPENDIX D

The SAS System 11:02 Wednesday, April 22, 1998 1

PERCENT ERROR RETENTION TEST

------------------------------ GROUP=1 CONTEXT=1 ------------------------------

Variable	N	Mean	Std Error
T1	10	89.9000000	7.1685269
T2	10	59.9000000	13.8992006

------------------------------ GROUP=1 CONTEXT=2 ------------------------------

Variable	N	Mean	Std Error
T1	10	100.0000000	0
T2	10	86.5000000	7.4375175

-------------------------- GROUP=2 CONTEXT=1 ----------------------------

Variable	N	Mean	Std Error
T1	10	46.3000000	11.2704629
T2	10	39.7000000	10.8392804

-------------------------- GROUP=2 CONTEXT=2 ---------------------------

Variable	N	Mean	Std Error
T1	10	49.8000000	12.4327524
T2	10	46.4000000	12.3452195

Analysis of Variance Procedure

Class Level Information

Class	Levels	Values
GROUP	2	1 2
CONTEXT	2	1 2

Number of observations in data set = 40

Analysis of Variance Procedure

Dependent Variable: T1

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	22567.40000000	7522.46666667	9.04	0.0001
Error	36	29968.60000000	832.46111111		
Corrected Total	39	52536.00000000			

R-Square	C.V.	Root MSE	T1 Mean
0.429561	40.35301	28.85240217	71.50000000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	21996.10000000	21996.100000	26.42	0.0001
CONTEXT	1	462.40000000	462.40000000	0.56	0.4609
GROUP*CONTEXT	1	108.90000000	108.90000000	0.13	0.7197

The SAS System 11:02 Wednesday, April 22, 1998 4

Analysis of Variance Procedure

Dependent Variable: T2

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	12852.47500000	4284.15833333	3.31	0.0310
Error	36	46655.90000000	1295.99722222		
Corrected Total	39	59508.37500000			

R-Square	C.V.	Root MSE	T2 Mean
0.215978	61.93542	35.99996142	58.12500000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	9090.22500000	9090.22500000	7.01	0.0119
CONTEXT	1	2772.22500000	2772.22500000	2.14	

		0.1523		
GROUP*CONTEXT	1	990.02500000	990.02500000	0.76
		0.3879		

Analysis of Variance Procedure
Repeated Measures Analysis of Variance
Repeated Measures Level Information

Dependent Variable	T1	T2
Level of DAY	1	2

Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY Effect
H = Anova SS&CP Matrix for DAY E = Error SS&CP Matrix
S=1 M=-0.5 N=17

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.83943370	6.8861	1	36	0.0127
Pillai's Trace	0.16056630	6.8861	1	36	0.0127
Hotelling-Lawley Trace	0.19127931	6.8861	1	36	0.0127
Roy's Greatest Root	0.19127931	6.8861	1	36	0.0127

Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY*GROUP Effect
H = Anova SS&CP Matrix for DAY*GROUP E = Error SS&CP Matrix
S=1 M=-0.5 N=17

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.93023424	2.6999	1	36	0.1091
Pillai's Trace	0.06976576	2.6999	1	36	0.1091
Hotelling-Lawley Trace	0.07499806	2.6999	1	36	0.1091
Roy's Greatest Root	0.07499806	2.6999	1	36	0.1091

Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY*CONTEXT Effect
H = Anova SS&CP Matrix for DAY*CONTEXT E = Error SS&CP Matrix
S=1 M=-0.5 N=17

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.97472024	0.9337	1	36	0.3404
Pillai's Trace	0.02527976	0.9337	1	36	0.3404
Hotelling-Lawley Trace	0.02593540	0.9337	1	36	0.3404
Roy's Greatest Root	0.02593540	0.9337	1	36	0.3404

Analysis of Variance Procedure
Repeated Measures Analysis of Variance

Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY*GROUP*CONTEXT Effect
H = Anova SS&CP Matrix for DAY*GROUP*CONTEXT E = Error SS&CP Matrix
S=1 M=-0.5 N=17

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.98831685	0.4256	1	36	0.5183
Pillai's Trace	0.01168315	0.4256	1	36	0.5183
Hotelling-Lawley Trace	0.01182126	0.4256	1	36	0.5183
Roy's Greatest Root	0.01182126	0.4256	1	36	0.5183

Analysis of Variance Procedure
Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	29683.51250000	29683.51250000	18.45	0.0001
CONTEXT	1	2749.51250000	2749.51250000	1.71	0.1994
GROUP*CONTEXT	1	877.81250000	877.81250000	0.55	0.4649
Error	36	57919.85000000	1608.88472222		

Analysis of Variance Procedure
Repeated Measures Analysis of Variance
Univariate Tests of Hypotheses for Within Subject Effects

Source: DAY

DF	Anova SS	Mean Square	F Value	Pr > F	Adjusted Pr > F G - G	H - F
1	3577.81250000	3577.81250000	6.89	0.0127	.	.

Source: DAY*GROUP

DF	Anova SS	Mean Square	F Value	Pr > F	Adjusted Pr > F G - G	H - F
1	1402.81250000	1402.81250000	2.70	0.1091	.	.

Source: DAY*CONTEXT

DF	Anova SS	Mean Square	F Value	Pr > F	Adjusted Pr > F G - G	H - F
1	485.11250000	485.11250000	0.93	0.3404	.	.

Source: DAY*GROUP*CONTEXT Adjusted Pr > F

DF	Anova SS	Mean Square	F Value	Pr > F	G - G	H - F
1	221.11250000	221.11250000	0.43	0.5183	.	.

Source: Error(DAY)

DF	Anova SS	Mean Square
36	18704.65000000	519.57361111

RETENTION REACTION TIMES YOUNG

------------------------------------ GROUP=1 --

Variable	N	Mean	Std Error
T1	10	186.9000000	12.1430822
T2	10	170.5000000	9.1824107

------------------------------------ GROUP=2 --

Variable	N	Mean	Std Error
T1	10	220.3000000	14.8129448
T2	10	197.1000000	18.6711007

Analysis of Variance Procedure
Class Level Information

Class	Levels	Values
GROUP	2	1 2

Number of observations in data set = 20

Analysis of Variance Procedure
Dependent Variable: T1

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	5577.80000000	5577.80000000	3.04	0.0983
Error	18	33019.00000000	1834.38888889		
Corrected Total	19	38596.80000000			

R-Square	C.V.	Root MSE	T1 Mean
0.144515	21.03623	42.82976639	203.60000000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	5577.80000000	5577.80000000	3.04	0.0983

Analysis of Variance Procedure
Dependent Variable: T2

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	3537.80000000	3537.80000000	1.63	0.2173
Error	18	38963.40000000	2164.63333333		
Corrected Total	19	42501.20000000			

R-Square	C.V.	Root MSE	T2 Mean
0.083240	25.31318	46.52562018	183.80000000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	3537.80000000	3537.80000000	1.63	0.2173

Analysis of Variance Procedure
Repeated Measures Analysis of Variance
Repeated Measures Level Information

Dependent Variable	T1	T2
Level of DAY	1	2

Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY Effect
H = Anova SS&CP Matrix for DAY E = Error SS&CP Matrix
S=1 M=-0.5 N=8

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.76962403	5.3880	1	18	0.0322
Pillai's Trace	0.23037597	5.3880	1	18	0.0322
Hotelling-Lawley Trace	0.29933573	5.3880	1	18	0.0322
Roy's Greatest Root	0.29933573	5.3880	1	18	0.0322

Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY*GROUP Effect
H = Anova SS&CP Matrix for DAY*GROUP E = Error SS&CP Matrix
S=1 M=-0.5 N=8

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.99125078	0.1589	1	18	0.6949
Pillai's Trace	0.00874922	0.1589	1	18	0.6949
Hotelling-Lawley Trace	0.00882645	0.1589	1	18	0.6949
Roy's Greatest Root	0.00882645	0.1589	1	18	0.6949

Analysis of Variance Procedure
Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	9000.00000000	9000.00000000	2.75	0.1145
Error	18	58885.40000000	3271.41111111		

Analysis of Variance Procedure
Repeated Measures Analysis of Variance
Univariate Tests of Hypotheses for Within Subject Effects

Source: DAY

DF	Anova SS	Mean Square	F Value	Pr > F	Adjusted Pr > F G - G	H - F
1	3920.40000000	3920.40000000	5.39	0.0322	.	.

Source: DAY*GROUP

DF	Anova SS	Mean Square	F Value	Pr > F	justed Pr > F G - G	H - F
1	115.60000000	115.60000000	0.16	0.6949	.	.

Source: Error(DAY)

DF	Anova SS	Mean Square
18	13097.00000000	727.61111111

ACQUISITION PERCENT ERROR

------------------------------- GROUP=1 CONTEXT=----------------------------------

Variable	N	Mean	Std Error
T1	9	100.0000000	0
T2	9	99.1111111	0.8888889
T3	9	92.5555556	7.4444444
T4	9	68.6666667	10.8140855
T5	9	94.4444444	3.1185427
T6	9	87.0000000	5.5851987
T7	9	97.2222222	1.9845079
T8	9	99.1111111	0.8888889
T9	9	97.2222222	1.9845079
T10	9	100.0000000	0
T11	9	100.0000000	0
T12	9	95.3333333	2.4888641
T13	9	88.0000000	3.1710496
T14	9	35.2222222	11.0877532
T15	9	77.8888889	5.3656429
T16	9	82.3333333	2.5766041
T17	9	87.8888889	2.0979120

T18	9	96.3333333	2.0275875

--------------------------------------- GROUP=1 CONTEXT=2 ---------------------------------------

Variable	N	Mean	Std Error
T1	9	97.2222222	2.7777778
T2	9	97.2222222	1.9845079
T3	9	99.1111111	0.8888889
T4	9	100.0000000	0
T5	9	100.0000000	0
T6	9	97.2222222	1.9845079
T7	9	98.1111111	1.8888889
T8	9	91.6666667	5.5627731
T9	9	100.0000000	0
T10	9	98.2222222	1.1758895
T11	9	77.8888889	8.7534826
T12	9	80.4444444	8.2733023
T13	9	86.1111111	6.3954073
T14	9	89.8888889	5.3500894
T15	9	98.2222222	1.1758895
T16	9	97.2222222	1.9845079
T17	9	94.6666667	1.3333333
T18	9	77.7777778	6.3591093

--------------------------------------- GROUP=2 CONTEXT=1 ---------------------------------------

Variable	N	Mean	Std Error
T1	9	43.5555556	14.4078597
T2	9	9.2222222	9.2222222
T3	9	96.3333333	2.8087166
T4	9	89.0000000	3.4034296
T5	9	88.0000000	4.2524503
T6	9	52.8888889	12.8532794
T7	9	92.5555556	7.4444444
T8	9	89.7777778	5.3665056
T9	9	63.0000000	13.2528823
T10	9	85.2222222	10.8343304
T11	9	20.3333333	10.7986625
T12	9	15.6666667	5.7999042

T13	9	24.1111111	8.3023498
T14	9	52.6666667	7.5055535
T15	9	50.8888889	7.9170078
T16	9	12.8888889	5.0537237
T17	9	32.3333333	7.3805299
T18	9	57.4444444	9.7711467

------------- GROUP=2 CONTEXT=2 ---------------------------------------

Variable	N	Mean	Std Error
T1	9	26.8888889	14.1455180
T2	9	79.7777778	5.7440253
T3	9	60.3333333	8.7384845
T4	9	40.7777778	14.5437823
T5	9	70.4444444	10.0996577
T6	9	94.4444444	3.1185427
T7	9	96.3333333	2.0275875
T8	9	87.0000000	3.4399612
T9	9	55.6666667	14.4712358
T10	9	45.4444444	11.4529364
T11	9	1.7777778	1.1758895
T12	9	1.8888889	1.8888889
T13	9	22.1111111	5.9194699
T14	9	1.7777778	1.1758895
T15	9	80.5555556	4.4193737
T16	9	86.1111111	3.1200269
T17	9	41.5555556	8.4395088
T18	9	72.2222222	6.0547910

Analysis of Variance Procedure

Class Level Information

Class	Levels	Values
GROUP	2	1 2
CONTEXT	2	1 2

Number of observations in data set = 36

Analysis of Variance Procedure

Dependent Variable: T1

> F

Model	3	8781.63888889	2927.21296296	9.26	0.0001
Error	32	10113.11111111	316.03472222		
Corrected Total	35	18894.75000000			

R-Square	C.V.	Root MSE	T3 Mean
0.464766	20.41420	17.77736545	87.08333333

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	2756.25000000	2756.25000000	8.72	0.0059
CONTEXT	1	1950.69444444	1950.69444444	6.17	0.0184
GROUP*CONTEXT	1	4074.69444444	4074.69444444	12.89	0.0011

Analysis of Variance Procedure

Dependent Variable: T4

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	18285.00000000	6095.00000000	7.97	0.0004
Error	32	24483.55555556	765.11111111		
Corrected Total	35	42768.55555556			

R-Square	C.V.	Root MSE	T4 Mean
0.427534	37.07309	27.66064191	74.61111111

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	3402.77777778	3402.77777778	4.45	0.0429
CONTEXT	1	641.77777778	641.77777778	0.84	0.3666
GROUP*CONTEXT	1	14240.44444444	14240.44444444	18.61	0.0001

Analysis of Variance Procedure

Dependent Variable: T5

Source DF Sum of Squares Mean Square F Value Pr

> F

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	4441.77777778	1480.59259259	5.07	0.0055
Error	32	9346.44444444	292.07638889		
Corrected Total	35	13788.22222222			

R-Square	C.V.	Root MSE	T5 Mean
0.322143	19.37181	17.09024251	88.22222222

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	2916.00000000	2916.00000000	9.98	0.0034
CONTEXT	1	324.00000000	324.00000000	1.11	0.3001
GROUP*CONTEXT	1	1201.77777778	1201.77777778	4.11	0.0509

Analysis of Variance Procedure
Dependent Variable: T6

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	11302.88888889	3767.62962963	7.97	0.0004
Error	32	15124.66666667	472.64583333		
Corrected Total	35	26427.55555556			

R-Square	C.V.	Root MSE	T6 Mean
0.427693	26.22839	21.74041935	82.88888889

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	3061.77777778	3061.77777778	6.48	0.0159
CONTEXT	1	6032.11111111	6032.11111111	12.76	0.0011
GROUP*CONTEXT	1	2209.00000000	2209.00000000	4.67	0.0382

Analysis of Variance Procedure
Dependent Variable: T7

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	161.22222222	53.74074074	0.36	0.7849
Error	32	4826.66666667	150.83333333		

Source	DF	Sum of Squares
Corrected Total	35	4987.88888889

R-Square	C.V.	Root MSE	T7 Mean
0.032323	12.78575	12.28142228	96.05555556

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	93.44444444	93.44444444	0.62	0.4370
CONTEXT	1	49.00000000	49.00000000	0.32	0.5727
GROUP*CONTEXT	1	18.77777778	18.77777778	0.12	0.7265

Analysis of Variance Procedure
Dependent Variable: T8

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	725.11111111	241.70370370	1.48	0.2374
Error	32	5210.44444444	162.82638889		
Corrected Total	35	5935.55555556			

R-Square	C.V.	Root MSE	T8 Mean
0.122164	13.88671	12.76034439	91.88888889

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	441.00000000	441.00000000	2.71	0.1096
CONTEXT	1	235.11111111	235.11111111	1.44	0.2383
GROUP*CONTEXT	1	49.00000000	49.00000000	0.30	0.5871

Analysis of Variance Procedure
Dependent Variable: T9

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	14161.41666667	4720.47222222	5.39	0.0041
Error	32	28007.55555556	875.23611111		
Corrected Total	35	42168.97222222			

R-Square	C.V.	Root MSE	T9 Mean

0.335826	37.46177	29.58438965	78.97222222

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	13884.69444444	13884.69444444	15.86	0.0004
CONTEXT	1	46.69444444	46.69444444	0.05	0.8188
GROUP*CONTEXT	1	230.02777778	230.02777778	0.26	0.6117

Analysis of Variance Procedure
Dependent Variable: T10

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	17402.88888889	5800.96296296	10.32	0.0001
Error	32	17995.33333333	562.35416667		
Corrected Total	35	35398.22222222			

R-Square	C.V.	Root MSE	T10 Mean
0.491632	28.84136	23.71400782	82.22222222

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	10268.44444444	10268.44444444	18.26	0.0002
CONTEXT	1	3885.44444444	3885.44444444	6.91	0.0131
GROUP*CONTEXT	1	3249.00000000	3249.00000000	5.78	0.0222

Analysis of Variance Procedure
Dependent Variable: T11

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	58349.55555556	19449.85185185	44.42	0.0001
Error	32	14012.44444444	437.88888889		
Corrected Total	35	72362.00000000			

R-Square	C.V.	Root MSE	T11 Mean
0.806356	41.85159	20.92579482	50.00000000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	54600.11111111	54600.11111111	124.69	0.0001
CONTEXT	1	3721.00000000	3721.00000000	8.50	0.0064
GROUP*CONTEXT	1	28.44444444	28.44444444	0.06	0.8005

Analysis of Variance Procedure
Dependent Variable: T12

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	58178.88888889	19392.96296296	77.06	0.0001
Error	32	8053.11111111	251.65972222		
Corrected Total	35	66232.00000000			

R-Square	C.V.	Root MSE	T12 Mean
0.878411	32.82163	15.86378650	48.33333333

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	56327.11111111	56327.11111111	223.82	0.0001
CONTEXT	1	1849.00000000	1849.00000000	7.35	0.0107
GROUP*CONTEXT	1	2.77777778	2.77777778	0.01	0.9170

Analysis of Variance Procedure
Dependent Variable: T13

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	36834.08333333	12278.02777778	35.22	0.0001
Error	32	11154.66666667	348.58333333		
Corrected Total	35	47988.75000000			

R-Square	C.V.	Root MSE	T13 Mean
0.767557	33.89480	18.67038653	55.08333333

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	36800.02777778	36800.02777778	105.57	0.0001
CONTEXT	1	34.02777778	34.02777778	0.10	0.7567
GROUP*CONTEXT	1	0.02777778	0.02777778	0.00	0.9929

Analysis of Variance Procedure

Dependent Variable: T14

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	36337.55555556	12112.51851852	25.72	0.0001
Error	32	15068.00000000	470.87500000		
Corrected Total	35	51405.55555556			

R-Square	C.V.	Root MSE	T14 Mean
0.706880	48.34081	21.69965438	44.88888889

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	11236.00000000	11236.00000000	23.86	0.0001
CONTEXT	1	32.11111111	32.11111111	0.07	0.7957
GROUP*CONTEXT	1	25069.44444444	25069.44444444	53.24	0.0001

Analysis of Variance Procedure

Dependent Variable: T15

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	10310.00000000	3436.66666667	13.59	0.0001
Error	32	8091.55555556	252.86111111		
Corrected Total	35	18401.55555556			

R-Square	C.V.	Root MSE	T15 Mean

0.560279 20.68128 15.90160719
76.88888889

Source DF Anova SS Mean Square F Value
Pr > F

GROUP 1 4489.00000000 4489.00000000 17.75
0.0002

CONTEXT 1 5625.00000000 5625.00000000 22.25
0.0001

GROUP*CONTEXT 1 196.00000000 196.00000000 0.78
0.3852

Analysis of Variance Procedure
Dependent Variable: T16

Source DF Sum of Squares Mean Square F Value Pr
> F

Model 3 39724.97222222 13241.65740741 128.35
0.0001

Error 32 3301.33333333 103.16666667

Corrected Total 35 43026.30555556

R-Square C.V. Root MSE T16 Mean
0.923272 14.58538 10.15709932
69.63888889

Source DF Anova SS Mean Square F Value
Pr > F

GROUP 1 14600.69444444 14600.69444444 141.53
0.0001

CONTEXT 1 17468.02777778 17468.02777778
169.32 0.0001

GROUP*CONTEXT 1 7656.25000000 7656.25000000 74.21
0.0001

Analysis of Variance Procedure
Dependent Variable: T17

Source DF Sum of Squares Mean Square F Value Pr
> F

Model 3 27158.44444444 9052.81481481 30.51
0.0001

Error 32 9495.11111111 296.72222222

Corrected Total 35 36653.55555556

R-Square C.V. Root MSE T17 Mean
0.740950 26.86840 17.22562690
64.11111111

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	26569.00000000	26569.00000000	89.54	0.0001
CONTEXT	1	576.00000000	576.00000000	1.94	0.1731
GROUP*CONTEXT	1	13.44444444	13.44444444	0.05	0.8328

Analysis of Variance Procedure
Dependent Variable: T18

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	6976.55555556	2325.51851852	5.85	0.0026
Error	32	12721.33333333	397.54166667		
Corrected Total	35	19697.88888889			

R-Square	C.V.	Root MSE	T18 Mean
0.354178	26.25399	19.93844695	75.94444444

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	4444.44444444	4444.44444444	11.18	0.0021
CONTEXT	1	32.11111111	32.11111111	0.08	0.7781
GROUP*CONTEXT	1	2500.00000000	2500.00000000	6.29	0.0174

Analysis of Variance Procedure
Repeated Measures Analysis of Variance
Repeated Measures Level Information

Dependent Variable	T1	T2	T3	T4	T5	T6	T7	T8
Level of DAY	1	1	1	1	1	1	1	1
Level of BLOCK	1	2	3	4	5	6	7	8

Dependent Variable	T9	T10	T11	T12	T13	T14	T15	T16
Level of DAY	1	2	2	2	2	2	2	2
Level of BLOCK	9	1	2	3	4	5	6	7

Dependent Variable	T17	T18
Level of DAY	2	2
Level of BLOCK	8	9

Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY Effect
H = Anova SS&CP Matrix for DAY E = Error SS&CP Matrix
S=1 M=-0.5 N=15

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.17635884	149.4482	1	32	0.0001
Pillai's Trace	0.82364116	149.4482	1	32	0.0001
Hotelling-Lawley Trace	4.67025736	149.4482	1	32	0.0001
Roy's Greatest Root	4.67025736	149.4482	1	32	0.0001

Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY*GROUP Effect
H = Anova SS&CP Matrix for DAY*GROUP E = Error SS&CP Matrix
S=1 M=-0.5 N=15

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.41104451	45.8505	1	32	0.0001
Pillai's Trace	0.58895549	45.8505	1	32	0.0001
Hotelling-Lawley Trace	1.43282657	45.8505	1	32	0.0001
Roy's Greatest Root	1.43282657	45.8505	1	32	0.0001

Analysis of Variance Procedure
Repeated Measures Analysis of Variance
Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY*CONTEXT Effect
H = Anova SS&CP Matrix for DAY*CONTEXT E = Error SS&CP Matrix
S=1 M=-0.5 N=15

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.99954090	0.0147	1	32	0.9043
Pillai's Trace	0.00045910	0.0147	1	32	0.9043
Hotelling-Lawley Trac	0.00045931	0.0147	1	32	0.9043
Roy's Greatest Root	0.00045931	0.0147	1	32	0.9043

Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY*GROUP*CONTEXT Effect
H = Anova SS&CP Matrix for DAY*GROUP*CONTEXT E = Error SS&CP Matrix

S=1 M=-0.5 N=15

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.99503772	0.1596	1	32	0.6922
Pillai's Trace	0.00496228	0.1596	1	32	0.6922
Hotelling-Lawley Trace	0.00498702	0.1596	1	32	0.6922
Roy's Greatest Root	0.00498702	0.1596	1	32	0.6922

Manova Test Criteria and Exact F Statistics for the Hypothesis of no BLOCK Effect
H = Anova SS&CP Matrix for BLOCK E = Error SS&CP Matrix
S=1 M=3 N=11.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.13696042	19.6918	8	25	0.0001
Pillai's Trace	0.86303958	19.6918	8	25	0.0001
Hotelling-Lawley Trace	6.30137924	19.6918	8	25	0.0001
Roy's Greatest Root	6.30137924	19.6918	8	25	0.0001

Manova Test Criteria and Exact F Statistics for the Hypothesis of no BLOCK*GROUP Effect
H = Anova SS&CP Matrix for BLOCK*GROUP E = Error SS&CP Matrix
S=1 M=3 N=11.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.14997172	17.7123	8	25	0.0001
Pillai's Trace	0.85002828	17.7123	8	25	0.0001
Hotelling-Lawley Trace	5.66792371	17.7123	8	25	0.0001
Roy's Greatest Root	5.66792371	17.7123	8	25	0.0001

Analysis of Variance Procedure
Repeated Measures Analysis of Variance
Manova Test Criteria and Exact F Statistics for the Hypothesis of no BLOCK*CONTEXT Effect
H = Anova SS&CP Matrix for BLOCK*CONTEXT E = Error SS&CP Matrix
S=1 M=3 N=11.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.16318338	16.0252	8	25	0.0001
Pillai's Trace	0.83681662	16.0252	8	25	0.0001

Hotelling-Lawley Trace	5.12807502	16.0252	8	25	0.0001
Roy's Greatest Root	5.12807502	16.0252	8	25	0.0001

Manova Test Criteria and Exact F Statistics for the Hypothesis of no
BLOCK*GROUP*CONTEXT Effect
H = Anova SS&CP Matrix for BLOCK*GROUP*CONTEXT E = Error SS&CP Matrix

S=1 M=3 N=11.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.17469293	14.7635	8	25	0.0001
Pillai's Trace	0.82530707	14.7635	8	25	0.0001
Hotelling-Lawley Trace	4.72433007	14.7635	8	25	0.0001
Roy's Greatest Root	4.72433007	14.7635	8	25	0.0001

Manova Test Criteria and Exact F Statistics for the Hypothesis of no
DAY*BLOCK Effect
H = Anova SS&CP Matrix for DAY*BLOCK E = Error SS&CP Matrix

S=1 M=3 N=11.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.17156177	15.0900	8	25	0.0001
Pillai's Trace	0.82843823	15.0900	8	25	0.0001
Hotelling-Lawley Trace	4.82880434	15.0900	8	25	0.0001
Roy's Greatest Root	4.82880434	15.0900	8	25	0.0001

Manova Test Criteria and Exact F Statistics for the Hypothesis of no
DAY*BLOCK*GROUP Effect
H = Anova SS&CP Matrix for DAY*BLOCK*GROUP E = Error SS&CP Matrix

S=1 M=3 N=11.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.26142598	8.8287	8	25	0.0001
Pillai's Trace	0.73857402	8.8287	8	25	0.0001
Hotelling-Lawley Trace	2.82517449	8.8287	8	25	0.0001
Roy's Greatest Root	2.82517449	8.8287	8	25	0.0001

The SAS System 11:02 Wednesday, April 22, 1998
54

Analysis of Variance Procedure

Repeated Measures Analysis of Variance

Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY*BLOCK*CONTEXT Effect
H = Anova SS&CP Matrix for DAY*BLOCK*CONTEXT E = Error SS&CP Matrix

S=1 M=3 N=11.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.07408869	39.0542	8	25	0.0001
Pillai's Trace	0.92591131	39.0542	8	25	0.0001
Hotelling-Lawley Trace	12.49733617	39.0542	8	25	0.0001
Roy's Greatest Root	12.49733617	39.0542	8	25	0.0001

Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY*BLOCK*GROUP*CONTEXT Effect
H = Anova SS&CP Matrix for DAY*BLOCK*GROUP*CONTEXT E = Error SS&CP Matrix
S=1 M=3 N=11.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.10171843	27.5971	8	25	0.0001
Pillai's Trace	0.89828157	27.5971	8	25	0.0001
Hotelling-Lawley Trace	8.83105970	27.5971	8	25	0.0001
Roy's Greatest Root	8.83105970	27.5971	8	25	0.0001

Analysis of Variance Procedure
Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	223892.01388889	223892.01388889	109.70	0.0001
CONTEXT	1	646.00154321	646.00154321	0.32	0.5776
GROUP*CONTEXT	1	1091.48302469	1091.48302469	0.53	0.4699
Error	32	65309.54320988	2040.92322531		

Analysis of Variance Procedure
Repeated Measures Analysis of Variance
Univariate Tests of Hypotheses for Within Subject Effects

Source: DAY

DF	Anova SS	Mean Square	F Value	Adjusted Pr > F	Pr > F G - G	H - F
1	58387.03858025	58387.03858025	149.45	0.0001	.	.

Source: DAY*GROUP

DF	Anova SS	Mean Square	F Value	Adjusted Pr > F	Pr > F G - G	H - F
1	17913.03858025	17913.03858025	45.85	0.0001	.	.

Source: DAY*CONTEXT

DF	Anova SS	Mean Square	F Value	Adjusted Pr > F	Pr > F G - G	H - F
1	5.74228395	5.74228395	0.01	0.9043	.	.

Source: DAY*GROUP*CONTEXT

DF	Anova SS	Mean Square	F Value	Adjusted Pr > F	Pr > F G - G	H - F
1	62.34722222	62.34722222	0.16	0.6922	.	.

Source: Error(DAY)

DF	Anova SS	Mean Square
32	12501.88888889	390.68402778

Source: BLOCK

DF	Anova SS	Mean Square	F Value	Adjusted Pr > F	Pr > F G - G	H - F
8	34392.05555556	4299.00694444	13.06	0.0001	0.0001	0.0001

Source: BLOCK*GROUP

DF	Anova SS	Mean Square	F Value	Adjusted Pr > F	Pr > F G - G	H - F
8	32514.33333333	4064.29166667	12.35	0.0001	0.0001	0.0001

Source: BLOCK*CONTEXT

DF	Anova SS	Mean Square	F Value	Adjusted Pr > F	Pr > F G - G	H - F
8	30235.79012346	3779.47376543	11.48	0.0001	0.0001	0.0001

Source: BLOCK*GROUP*CONTEXT

Adjusted Pr > F

DF	Anova SS	Mean Square	F Value	Pr > F	G - G	H - F
8	42873.25308642	5359.15663580	16.28	0.0001	0.0001	0.0001

Analysis of Variance Procedure
Repeated Measures Analysis of Variance
Univariate Tests of Hypotheses for Within Subject Effects

Source: Error(BLOCK)

DF	Anova SS	Mean Square
256	84267.01234568	329.16801698

Greenhouse-Geisser Epsilon = 0.6422
Huynh-Feldt Epsilon = 0.8514

Source: DAY*BLOCK

					Adjusted Pr > F	
DF	Anova SS	Mean Square	F Value	Pr > F	G - G	H - F
8	48976.80864198	6122.10108025	21.27	0.0001	0.0001	0.0001

Source: DAY*BLOCK*GROUP

					Adjusted Pr > F	
DF	Anova SS	Mean Square	F Value	Pr > F	G - G	H - F
8	33655.75308642	4206.96913580	14.62	0.0001	0.0001	0.0001

Source: DAY*BLOCK*CONTEXT

					Adjusted Pr > F	
DF	Anova SS	Mean Square	F Value	Pr > F	G - G	H - F
8	23074.27160494	2884.28395062	10.02	0.0001	0.0001	0.0001

Source: DAY*BLOCK*GROUP*CONTEXT

					Adjusted Pr > F	
DF	Anova SS	Mean Square	F Value	Pr > F	G - G	H - F

8	28954.50000000	3619.31250000	12.58	0.0001	0.0001

0.0001

Source: Error(DAY*BLOCK)

DF	Anova SS	Mean Square
256	73675.11111111	287.79340278

Greenhouse-Geisser Epsilon = 0.6305

ACQUISITION REACTION TIMES YOUNGER ADULTS

------------------------------------- GROUP=1 ---

Variable	N	Mean	Std Error
T1	10	275.3000000	38.8947440
T2	10	259.1000000	26.8739651
T3	10	221.7000000	16.2316905
T4	10	209.8000000	16.9278206
T5	10	205.8000000	7.8369495
T6	10	218.3000000	15.5842157
T7	10	198.1000000	13.1921273
T8	10	208.5000000	12.3479643
T9	10	204.7000000	11.9080272
T10	10	377.3000000	70.8924146
T11	10	238.2000000	16.5400524
T12	10	234.0000000	13.4973248
T13	10	249.6000000	16.6854561
T14	10	200.3000000	18.6333333
T15	10	189.6000000	8.1706793
T16	10	186.7000000	18.2726572
T17	10	166.5000000	9.2906763
T18	10	194.1000000	14.0834418

------------------------------- GROUP=2 --

Variable	N	Mean	Std Error
T1	10	199.1000000	12.5878689
T2	10	175.4000000	5.0181891

T3	10	167.0000000	5.6253395
T4	10	173.0000000	8.1581588
T5	10	171.0000000	9.8160866
T6	10	150.5000000	6.6084962
T7	10	167.3000000	10.2762401
T8	10	167.0000000	8.5166504
T9	10	180.4000000	13.6261187
T10	10	190.4000000	11.4593000
T11	10	173.0000000	11.4037031
T12	10	170.4000000	8.6412448
T13	10	179.4000000	12.6246672
T14	10	185.0000000	13.5252850
T15	10	170.0000000	13.5572859
T16	10	168.6000000	12.0850688
T17	10	166.9000000	12.0161465
T18	10	165.9000000	14.2317720

Analysis of Variance Procedure
Class Level Information

Class	Levels	Values
GROUP	2	1 2

Number of observations in data set = 20

Analysis of Variance Procedure
Dependent Variable: T1

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	29032.20000000	29032.20000000	3.47	0.0787
Error	18	150413.00000000	8356.27777778		
Corrected Total	19	179445.20000000			

R-Square	C.V.	Root MSE	T1 Mean
0.161789	38.53823	91.41267843	237.20000000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	29032.20000000	29032.20000000	3.47	0.0787

Analysis of Variance Procedure
Dependent Variable: T2

Source DF Sum of Squares Mean Square F Value Pr
> F

Model 1 35028.45000000 35028.45000000 9.37
0.0067

Error 18 67265.30000000 3736.96111111

Corrected Total 19 102293.75000000

R-Square C.V. Root MSE T2 Mean

0.342430 28.13841 61.13068878
217.25000000

Source DF Anova SS Mean Square F Value Pr >
F

GROUP 1 35028.45000000 35028.45000000 9.37
0.0067

Analysis of Variance Procedure

Dependent Variable: T3

Source DF Sum of Squares Mean Square F Value Pr
> F

Model 1 14960.45000000 14960.45000000 10.14
0.0051

Error 18 26560.10000000 1475.56111111

Corrected Total 19 41520.55000000

R-Square C.V. Root MSE T3 Mean

0.360314 19.76487 38.41303309
194.35000000

Source DF Anova SS Mean Square F Value Pr >
F

GROUP 1 14960.45000000 14960.45000000 10.14
0.0051

Analysis of Variance Procedure

Dependent Variable: T4

Source DF Sum of Squares Mean Square F Value Pr
> F

Model 1 6771.20000000 6771.20000000 3.84
0.0659

Error 18 31779.60000000 1765.53333333

Corrected Total 19 38550.80000000

R-Square C.V. Root MSE T4 Mean
0.175644 21.95311 42.01825000
191.40000000

Source DF Anova SS Mean Square F Value Pr >
F

GROUP 1 6771.20000000 6771.20000000 3.84
0.0659

Analysis of Variance Procedure
Dependent Variable: T5

Source DF Sum of Squares Mean Square F Value Pr
> F

Model 1 6055.20000000 6055.20000000 7.68
0.0126

Error 18 14199.60000000 788.86666667
Corrected Total 19 20254.80000000

R-Square C.V. Root MSE T5 Mean
0.298951 14.90805 28.08677031
188.40000000

Source DF Anova SS Mean Square F Value Pr >
F

GROUP 1 6055.20000000 6055.20000000 7.68
0.0126

Analysis of Variance Procedure
Dependent Variable: T6

Source DF Sum of Squares Mean Square F Value Pr
> F

Model 1 22984.20000000 22984.20000000 16.04
0.0008

Error 18 25788.60000000 1432.70000000
Corrected Total 19 48772.80000000

R-Square C.V. Root MSE T6 Mean
0.471250 20.52659 37.85102376
184.40000000

Source DF Anova SS Mean Square F Value Pr >
F

GROUP 1 22984.20000000 22984.20000000 16.04
0.0008

Analysis of Variance Procedure
Dependent Variable: T7

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	4743.20000000	4743.20000000	3.39	0.0820
Error	18	25167.00000000	1398.16666667		
Corrected Total	19	29910.20000000			

R-Square	C.V.	Root MSE	T7 Mean
0.158581	20.46637	37.39206689	182.70000000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	4743.20000000	4743.20000000	3.39	0.0820

Analysis of Variance Procedure
Dependent Variable: T8

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	8611.25000000	8611.25000000	7.65	0.0127
Error	18	20250.50000000	1125.02777778		
Corrected Total	19	28861.75000000			

R-Square	C.V.	Root MSE	T8 Mean
0.298362	17.86494	33.54143375	187.75000000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	8611.25000000	8611.25000000	7.65	0.0127

Analysis of Variance Procedure
Dependent Variable: T9

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	2952.45000000	2952.45000000	1.80	0.1960
Error	18	29472.50000000	1637.36111111		
Corrected Total	19	32424.95000000			

R-Square	C.V.	Root MSE	T9 Mean
0.091055	21.01497	40.46431899	192.55000000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	2952.45000000	2952.45000000	1.80	0.1960

Analysis of Variance Procedure
Dependent Variable: T10

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	174658.05000000	174658.05000000	6.77	0.0180
Error	18	464134.50000000	25785.25000000		
Corrected Total	19	638792.55000000			

R-Square	C.V.	Root MSE	T10 Mean
0.273419	56.57138	160.57786273	283.85000000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	174658.05000000	174658.05000000	6.77	0.0180

Analysis of Variance Procedure
Dependent Variable: T11

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	21255.20000000	21255.20000000	10.53	0.0045
Error	18	36325.60000000	2018.08888889		
Corrected Total	19	57580.80000000			

R-Square	C.V.	Root MSE	T11 Mean
0.369137	21.84978	44.92314425	205.60000000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	21255.20000000	21255.20000000	10.53	0.0045

Analysis of Variance Procedure
Dependent Variable: T12

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F

Model 1 20224.80000000 20224.80000000 15.75
0.0009
Error 18 23116.40000000 1284.24444444
Corrected Total 19 43341.20000000
R-Square C.V. Root MSE T12 Mean
0.466641 17.72322 35.83635646
202.20000000
Source DF Anova SS Mean Square F Value Pr >
F
GROUP 1 20224.80000000 20224.80000000 15.75
0.0009

Analysis of Variance Procedure
Dependent Variable: T13
Source DF Sum of Squares Mean Square F Value Pr
> F
Model 1 24640.20000000 24640.20000000 11.26
0.0035
Error 18 39400.80000000 2188.93333333
Corrected Total 19 64041.00000000
R-Square C.V. Root MSE T13 Mean
0.384757 21.81167 46.78603780
214.50000000
Source DF Anova SS Mean Square F Value Pr >
F
GROUP 1 24640.20000000 24640.20000000 11.26
0.0035

Analysis of Variance Procedure
Dependent Variable: T14
Source DF Sum of Squares Mean Square F Value Pr
> F
Model 1 1170.45000000 1170.45000000 0.44
0.5148
Error 18 47712.10000000 2650.67222222
Corrected Total 19 48882.55000000
R-Square C.V. Root MSE T14 Mean
0.023944 26.72446 51.48467949
192.65000000
Source DF Anova SS Mean Square F Value Pr >
F
GROUP 1 1170.45000000 1170.45000000 0.44
0.5148

Analysis of Variance Procedure
Dependent Variable: T15

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1920.80000000	1920.80000000	1.53	0.2315
Error	18	22550.40000000	1252.80000000		
Corrected Total	19	24471.20000000			

R-Square	C.V.	Root MSE	T15 Mean
0.078492	19.68571	35.39491489	179.80000000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	1920.80000000	1920.80000000	1.53	0.2315

Analysis of Variance Procedure
Dependent Variable: T16

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1638.05000000	1638.05000000	0.68	0.4195
Error	18	43194.50000000	2399.69444444		
Corrected Total	19	44832.55000000			

R-Square	C.V.	Root MSE	T16 Mean
0.036537	27.57482	48.98667619	177.65000000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	1638.05000000	1638.05000000	0.68	0.4195

Analysis of Variance Procedure
Dependent Variable: T17

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.80000000	0.80000000	0.00	0.9793
Error	18	20763.40000000	1153.52222222		
Corrected Total	19	20764.20000000			

R-Square	C.V.	Root MSE	T17 Mean
0.000039	20.37405	33.96354255	166.70000000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	0.80000000	0.80000000	0.00	0.9793

Analysis of Variance Procedure
Dependent Variable: T18

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	3976.20000000	3976.20000000	1.98	0.1760
Error	18	36079.80000000	2004.43333333		
Corrected Total	19	40056.00000000			

R-Square	C.V.	Root MSE	T18 Mean
0.099266	24.87272	44.77089829	180.00000000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	3976.20000000	3976.20000000	1.98	0.1760

Repeated Measures Analysis of Variance
Repeated Measures Level Information

Dependent Variable	T1	T2	T3	T4	T5	T6	T7	T8
Level of DAY	1	1	1	1	1	1	1	1
Level of BLOCK	1	2	3	4	5	6	7	8

Dependent Variable	T9	T10	T11	T12	T13	T14	T15	T16
Level of DAY	1	2	2	2	2	2	2	2
Level of BLOCK	9	1	2	3	4	5	6	7

Dependent Variable	T17	T18
Level of DAY	2	2
Level of BLOCK	8	9

Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY Effect
H = Anova SS&CP Matrix for DAY E = Error SS&CP Matrix
S=1 M=-0.5 N=8

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.99474436	0.0951	1	18	0.7613
Pillai's Trace	0.00525564	0.0951	1	18	0.7613
Hotelling-Lawley Trace	0.00528341	0.0951	1	18	0.7613
Roy's Greatest Root	0.00528341	0.0951	1	18	0.7613

Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY*GROUP Effect
H = Anova SS&CP Matrix for DAY*GROUP E = Error SS&CP Matrix
S=1 M=-0.5 N=8

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.99952882	0.0085	1	18	0.9276
Pillai's Trace	0.00047118	0.0085	1	18	0.9276
Hotelling-Lawley Trace	0.00047140	0.0085	1	18	0.9276
Roy's Greatest Root	0.00047140	0.0085	1	18	0.9276

Analysis of Variance Procedure
Repeated Measures Analysis of Variance

Manova Test Criteria and Exact F Statistics for the Hypothesis of no BLOCK Effect
H = Anova SS&CP Matrix for BLOCK E = Error SS&CP Matrix
S=1 M=3 N=4.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.16513354	6.9516	8	11	0.0022
Pillai's Trace	0.83486646	6.9516	8	11	0.0022
Hotelling-Lawley Trace	5.05570496	6.9516	8	11	0.0022
Roy's Greatest Root	5.05570496	6.9516	8	11	0.0022

Manova Test Criteria and Exact F Statistics for the Hypothesis of no BLOCK*GROUP Effect
H = Anova SS&CP Matrix for BLOCK*GROUP E = Error SS&CP Matrix

S=1 M=3 N=4.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.31172364	3.0360	8	11	0.0457
Pillai's Trace	0.68827636	3.0360	8	11	0.0457
Hotelling-Lawley Trace	2.20796969	3.0360	8	11	0.0457
Roy's Greatest Root	2.20796969	3.0360	8	11	0.0457

Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY*BLOCK Effect

H = Anova SS&CP Matrix for DAY*BLOCK E = Error SS&CP Matrix

S=1 M=3 N=4.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.11618088	10.4600	8	11	0.0004
Pillai's Trace	0.88381912	10.4600	8	11	0.0004
Hotelling-Lawley Trace	7.60726804	10.4600	8	11	0.0004
Roy's Greatest Root	7.60726804	10.4600	8	11	0.0004

Manova Test Criteria and Exact F Statistics for the Hypothesis of no DAY*BLOCK*GROUP Effect

H = Anova SS&CP Matrix for DAY*BLOCK*GROUP E = Error SS&CP Matrix

S=1 M=3 N=4.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.11069079	11.0470	8	11	0.0003
Pillai's Trace	0.88930921	11.0470	8	11	0.0003
Hotelling-Lawley Trace	8.03417512	11.0470	8	11	0.0003
Roy's Greatest Root	8.03417512	11.0470	8	11	0.0003

Analysis of Variance Procedure
Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	233733.13611111	233733.13611111	28.26	0.0001
Error	18	148857.47222222	8269.85956790		

Analysis of Variance Procedure
Repeated Measures Analysis of Variance
Univariate Tests of Hypotheses for Within Subject Effects

Source: DAY

DF	Anova SS	Mean Square	F Value	Pr > F	Adjusted Pr > F G - G	H - F
1	807.0027778	807.0027778	0.10	0.7613	.	.

Source: DAY*GROUP

DF	Anova SS	Mean Square	F Value	Pr > F	Adjusted Pr > F G - G	H - F
1	72.0027778	72.0027778	0.01	0.9276	.	.

Source: Error(DAY)

DF	Anova SS	Mean Square

DF	Anova SS	Mean Square
18	152742.8277778	8485.7126543

Source: BLOCK

DF	Anova SS	Mean Square	F Value	Pr > F	Adjusted Pr > F G - G	H - F
8	212138.7388889	26517.3423611	11.05	0.0001	0.0001	0.0001

Source: BLOCK*GROUP

DF	Anova SS	Mean Square	F Value	Pr > F	Adjusted Pr > F G - G	H - F
8	100822.2388889	12602.7798611	5.25	0.0001	0.0075	0.0042

Source: Error(BLOCK)

DF	Anova SS	Mean Square
144	345612.5777778	2400.0873457

Greenhouse-Geisser Epsilon = 0.2794
Huynh-Feldt Epsilon = 0.3386

Source: DAY*BLOCK

DF	Anova SS	Mean Square	F Value	Pr > F	Adjusted Pr > F G - G	H - F
8	34918.0722222	4364.7590278	1.32	0.2391	0.2774	0.2792

Source: DAY*BLOCK*GROUP

DF	Anova SS	Mean Square	F Value	Pr > F	Adjusted Pr > F G - G	H - F
8	45995.7722222	5749.4715278	1.74	0.0949	0.1991	0.1956

Analysis of Variance Procedure
Repeated Measures Analysis of Variance
Univariate Tests of Hypotheses for Within Subject Effects

Source: Error(DAY*BLOCK)

DF	Anova SS	Mean Square
144	476960.8222222	3312.2279321

Greenhouse-Geisser Epsilon = 0.1911
Huynh-Feldt Epsilon = 0.2168

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Thesis Examination Commitee:
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Committe Member, Dr. Mark Hoffman, Ph. D.
Committe Member, Dr. Richard D. Tandy, Ph. D.
Graduate Faculty Representative, Dr. Frank Dempster, Ph.d.

IMAGE EVALUATION TEST TARGET (QA-3)

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6"

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