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WORKLOAD HISTORY AND ANTICIPATION:
EFFECTS ON TASK PERFORMANCE AND SUBJECTIVE STRESS

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF PSYCHOLOGY

BY

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Abstract

Though previous research has demonstrated that a sudden change in workload can have negative performance outcomes, there has been little examination of factors that could minimize these effects. The purpose of the present study was to investigate the effect of a sudden workload shift on performance and subjective stress, as well to examine whether anticipation of a future workload shift would decrease the performance decrement generally associated with workload history and temper subjective increases in stress. Participants (N=114) were randomly assigned to a specific anticipatory instruction condition, a general anticipatory instruction condition, or a non-instruction control condition and were then asked to perform a memory search task in which workload level was manipulated (i.e., the participants experienced either a sudden increase or a sudden decrease in workload level). Results revealed significant changes in both performance and subjective stress states following workload shifts in either direction. Although there were no significant differences in performance between instruction conditions, there was significant difference in intrinsic motivation loss in the low-to-high shift condition. Specifically, participants receiving specific anticipatory instructions showed less of a decrease in motivation following a workload shift than those receiving general anticipatory instructions. Implications and future research plans are discussed.

Keywords: workload history, anticipation, subjective stress states, task performance

Introduction

Interest in the dynamics involving sudden workload variability has increased in the last several decades following a growing understanding of its effects on performance and stress. Specifically, examination of the relationship between sudden shifts in workload level and an individual's subsequent performance has become a key area of research within the human factors literature. Previous research in this area has revealed significant detrimental effects on performance (see Cox-Fuenzalida, 2007; Cox-Fuenzalida & Angie, 2005; Cox-Fuenzalida, Beeler, & Sohl, 2006). These studies suggest that either a sudden increase or sudden decrease in workload level will result in significant performance decrements. Additionally, some research has identified that psychological states such as depression and frustration are related to changes in workload whereby greater workload variability leads to the increased occurrence of these symptoms (Beehr, Jex, Stacy & Merray, 2000). Given that (a) many work environments are dynamic with immediate shifts in workload levels commonplace and (b) that major concerns of many organizations include the capitalization of human performance and the reduction of employee stress (Defrank & Ivancevich, 1998), a logical and sensible next step would be to thoroughly and systematically examine potential buffers for these detrimental workload history effects. Indeed, although negative outcomes associated with a sudden change in workload level have been consistently demonstrated, there has been little empirical research aimed at minimizing these negative effects. To date, only one study has examined potential buffers for workload history effects (Hauck,

Anderson-Snyder, & Cox-Fuenzalida, 2008). Specifically, this study tested whether social support might reduce the performance decrement and perceived stress seen after a shift in workload level. To accomplish this, the researchers randomly divided participants experiencing a sudden workload shift in either direction into two conditions: the social support condition and the non-social support condition. Throughout the task, participants in the social support condition received supportive comments such as: "this is a tough task, so if you're having trouble, you're not alone" (Hauck et al., 2008, p. 119), while participants in the non-social support condition did not receive such comments. Although this study found that social support significantly reduced perceived stress following a sudden decrease in workload level, results indicated that there were no significant differences in performance between the support and the no support conditions.

More importantly, for the purposes of this paper, the cognitive interruption literature may help inform our understanding of factors that may be relevant to minimizing the negative effects associated with workload history. Specifically, research in this area has identified anticipation as a moderator of the often negative relationship between task interruption and performance (Altmann & Trafton, 2004; Carton & Aiello, 2009; Czerwinski, Chrisman, & Schumacher, 1991; Nagata, 2003). This research suggests that participants who receive advance warning or anticipate a future interruption perform significantly better than participants who are not given such warning. While not usually defined as a task interruption per se, one could conceptualize a sudden change in task demand as a type of interruption in that one's

prior stable workload level is disrupted by an abrupt increase or decrease in workload intensity. As such, it seems reasonable to use the interruption literature to inform the workload history literature. The purpose of the present study, then, was to verify workload history effects on both performance and subjective stress states. In addition, this study examined the potential moderating effect of anticipation on performance and subjective stress following a sudden shift in task demand.

Workload History and Performance

Historically, research on workload and performance has focused on comparing performance at various stable workloads. For example, Searle, Bright, & Bochner (1999) measured performance at various task demands using a computerized mail-sorting task. Workload level was manipulated by changing presentation rate, and results in this between-subjects design revealed that performance (defined as number of correct vs. incorrect responses) at a high demand level was significantly poorer than performance at a low demand level. While experiments such as this one provide important information concerning a static workload level, most real-world occupations are more dynamic in nature with workload levels fluctuating throughout the day. One area of research that has attempted to examine the more dynamic nature of task demand is that of workload history.

Still a relatively recently studied phenomenon, workload history has been conceptualized as "prior work activity that has an effect on subsequent work activity" (Cox-Fuenzalida, 2007, p. 278). In other words, workload history not only

addresses the fact that real work environments are often dynamic, but it also allows for the possibility that moving from one workload level immediately to a different workload level could have an effect on performance different than that of a continuous workload level. Indeed, previous research examining workload changes has demonstrated that there is a significant decrease in performance following either a sudden decrease (Cox-Fuenzalida, 2007; Cumming & Croft, 1973; Goldberg & Stewart, 1980; Matthews, 1986) or a sudden increase in workload level (Cox-Fuenzalida, 2007).

In one of the first studies examining changes in workload, Cumming and Croft (1973) employed an auditory monitoring task. The authors of this study manipulated workload by systematically increasing and decreasing workload, and participants performed the task continuously as the task demand shifted. Results indicated that the performance decrement was greatest following a decrease in task demand compared to an increase in task demand. The authors theorized that this decrease in performance could be due to a mismatch in expectancies. In other words, if participants expected a shift in task demand, their performance would increase; if, however, participants did not anticipate the sudden decrease, their performance would be impaired.

Attempting to test this potential expectancy effect, Goldberg and Stewart (1980) designed a study in which a sudden shift in task demand was cued via a visual signal that alerted the subject that the task demand was either increasing or decreasing. The authors hypothesized that if the performance decrement found by

Cumming and Croft (1973) was indeed due to a mismatch in expectancies, then the presence of the cue should eliminate the negative performance outcomes. Despite the visual cue given at the onset of the shift, however, Goldberg and Stewart (1980) found that a significant performance decrement was still evident when moving from a high workload to a low workload. The authors then suggested that the decrements could perhaps be due to temporary short-term memory (STM) overload.

Extending this line of research and testing Goldberg and Stewart's (1980) STM overload theory, Matthews (1986) employed a visual task that was designed in such a way that it placed limited demands on STM. Similar to the previous studies, a significant decrease in performance was seen following a sudden decrease in workload but not following a sudden increase in workload. Because this task could not be ascribed to a failure of STM, Matthews (1986) proposed that this decrement was due to a strategic persistence in which participants were overworking the task following a sudden decrease in task demand.

While these three studies provide a foundation for workload history research, they failed to include a training trial or a baseline measure of performance at a stable workload with which to compare to performance following a sudden shift. In an effort to both replicate and expand upon these previous findings, Cox-Fuenzalida (2007) developed a testing paradigm in which an individual's performance on an auditory vigilance task following a sudden increase or a sudden decrease in task performance could be compared to the same individual's performance at a stable workload level. Like the three studies before, Cox-Fuenzalida (2007) found that

there was a significant performance decrement following a sudden decrease in workload. More interesting, however, was the fact that these results indicated a significant performance decrement following a sudden increase in workload as well. Unlike the performance decrement following a sudden decrease in workload, which appeared immediately following the shift, however, the performance decrement following a shift from low-to-high task demand didn't appear until minutes after the shift occurred, suggesting a more long-term workload history effect. In follow-up studies extending this paradigm to different tasks (such as a memory search task) and to a dual task environment, results have demonstrated that an immediate performance decrement can be seen following shifts in either direction (Cox-Fuenzalida & Angie, 2005; Cox-Fuenzalida et al., 2006).

In sum, previous research suggests that a sudden shift in task demand results in decreased task performance.

Hypothesis 1: A sudden workload shift from either high to low or low to high would result in decreased performance.

Workload History and Stress

Understanding the relationship between work-related strains and perceived levels of stress has been a common focus in the occupational stress literature (Beehr et al., 2000; Hauck et al., 2008). In his theory of occupational stress, Karasek (as cited in Searle et al., 1999) maintained that jobs with high task demand are more stressful than jobs with low task demand. Indeed, many studies have identified this positive association between task demand and perceived stress (i.e., as task demand

increases, so does an individual's subjective stress level). For example, in their laboratory study involving a mail-sorting task, Searle, Bright, & Bochner (2001) varied task demand by increasing or decreasing the rate at which participants were required to sort mail. Participants completed a stress measure both prior to and after completion of the task. Results indicated that the subjective stress reported at the low workload level was significantly lower than the subjective stress reported at the high workload level.

Similar to early studies examining workload and performance, most research looking at workload and stress has employed a fixed workload level. As stated above, these studies have limited ecological validity in that most real-world environments deal with variations in workload levels as opposed to static workload levels. Thus, it is important to examine the effects of shifts in workload level on subjective stress states.

In a step towards ecological validity, Cox-Fuenzalida, Swickert, & Hittner (2004) looked at the relationship between the personality trait of neuroticism, a trait that has been linked to individual stress responses (Eysenck, 1967), and workload history. Results indicated that neuroticism was significantly positively related to a performance decrement following either an increase or decrease in workload level (Cox-Fuenzalida et al., 2004). In light of their results, the authors suggested that "any change in workload conditions might serve as a stimulus that induces stress" (Cox-Fuenzalida et al., 2004, p. 248-249). Similarly, Warm, Parasuraman, & Matthews (2008) suggested that an aversive stimulus (such as task vigilance) often

leads to an increase in subjective stress. Taken together, the results of these studies indicate that the relationship between workload history and subjective stress deserves more attention.

In light of the findings reported by Cox-Fuenzalida et al (2004), Hauck et al. (2008) attempted to measure subjective stress levels in response to a workload variation. Employing workload shifts in a multitask environment, the authors measured subjective stress responses both prior to and following task completion. Though results revealed that subjective stress significantly decreased following workload shifts in either direction, Hauck et al. (2008) reported that the provision of social support in the high-to-low shift condition resulted in significantly more of a decrease in subjective stress than when no social support was present. The authors concluded that providing social support may help buffer the stress that accompanies changing workloads.

Recent research has suggested that subjective stress related to performance is a multi-dimensional construct (Matthews & Campbell, 2010; Matthews et al., 2002), with dimensions involving affect, motivation, and cognition. Specifically, these studies suggest that different patterns of subjective stress states can emerge in response to different tasks. Although the study of Hauck et al. (2008) is inconsistent with these findings, it is important to note that Hauck et al. (2008), measured subjective stress as a uni-dimensional construct. Consequently, the present study, in contrast, aimed to systematically examine the relationship between subjective stress states and workload history by using the Dundee Stress State Questionnaire (DSSQ;

Matthews et al., 2002; see Appendix B), a measure which identified 11 first-order factors of stress that all relate to one of three domains of experience: affect, motivation, and cognition. By including a multi-dimensional measure of stress, the present study was designed to investigate the effects of workload history on subjective stress states. Specifically, this study examined how specific dimensions of mood, motivation, and cognition changed in light of a sudden shift in workload.

Hypothesis 2: A sudden workload shift from either high to low or low to high would result in a change in reported stress states when compared to reported stress states following a baseline measure in which no workload shift occurred.

Anticipation and Performance

A vast amount of research has examined the negative effects of both nonsocial interruptions (e.g., a computer malfunction) and social interruptions (e.g., a telephone call) on performance. Nonsocial interruptions, or those interruptions initiated by a non-human, have been consistently shown to cause performance-related deficits. For example, interruptions have been connected to memory impairment (Edwards & Gronlund, 1998), a reduction in human reliability (Griffon-Fouco & Ghertman, 1984), and resumption lag (Altmann & Trafton, 2004). Social interruptions, or interruptions caused by a human, have also been theorized to have negative effects on performance, though most research on interruptions have focused solely on the effects of non-social interruptions (Carton & Aiello, 2009).

Given the significant and extensive negative consequences associated with task interruptions, recent research has attempted to identify interventions that could

potentially buffer these performance decrements. One such intervention that has proved to be successful is anticipation of the interruption itself. For instance, in a series of studies designed to measure the effect of aversive stimuli on performance and reported stress, Glass & Singer (1972) allowed the anticipation of the aversive event in some of their participants. Specifically, the authors of this study prepared some participants for future aversive stimuli by alerting them to the fact that a loud noise would be occurring at some point in the future. Results indicated that participants who were given early information about the later occurrence of aversive stimuli performed better and reported reduced stress. Similarly, in a study examining the effect of multitasking and interruptions on mobile web tasks, Nagata (2003) found that anticipated interruptions resulted in better task performance. In this study, participants were asked to perform a mobile web task while being interrupted by calls and instant messages. Some participants, however, were alerted to these future interruptions and allowed to expect them. Those participants who anticipated the interruptions produced better performance than those who did not.

In an effort to expand previous literature by examining the anticipation of a social interruption, Carton & Aiello (2009) informed some participants that a later social interruption would occur at some point during the experiment. In line with the previously mentioned studies examining anticipation and nonsocial interruptions, results revealed that participants who were able to anticipate the interruption performed significantly better than participants who were unable to anticipate the interruption.

While interruptions have not been previously operationally defined as sudden shifts in workload, theoretically it seems conceivable given previous research. First, Wickens (1984) defines an interruption in work activity as something that increases workload. Consequently, in terms of the low-to-high workload shift, this definition is applicable to workload history. More generally, Carton & Aiello (2009) define an interruption as "any disruptive event that impedes progress" (p. 170). Given that previous research has consistently indicated that a sudden workload shift in either direction leads to a decrease in performance, it seems reasonable to conceptualize a shift in workload as a type of interruption. In addition to the definition mentioned above, Carton & Aiello (2009) also characterize an interruption as an aversive stimulus. Similarly, as previously mentioned, Cox-Fuenzalida et al. (2004), understood a sudden increase or decrease in workload level as a "stimulus that induces stress" (p. 449). Thus, previous literature seems to support an understanding of a workload shift as an interruption.

In sum, a shift in workload can, at least for the low-to-high workload shift, lead to an increase in workload and often does impede successful performance. Additionally, workload variability does appear to be aversive and stress inducing. Taken together, a shift in workload can be theoretically conceived of as an interruption.

In light of the interruption literature, then, the present study explored the effects of anticipation on performance following sudden workload shifts.

Specifically, it was expected that anticipatory instructions might buffer the negative performance effects associated with a sudden change in workload level.

Hypothesis 3: Participants who were not able to anticipate a shift in workload would demonstrate a greater performance decrement than participants who were allowed the anticipation of the workload shift.

It should be noted that these results were expected following instructions specific to the direction of the shift. The general anticipatory instruction condition was exploratory in nature as it is possible that participants might have anticipated a shift in the wrong direction.

In addition, the role of anticipation on the level of perceived stress is ambiguous due to contradictory findings in this literature. Specifically, Glass & Singer (1972) reported that participants able to anticipate aversive noise reported reduced stress compared to those who did not anticipate the noise, while Yamamotova et al. (2000) found that the anticipation of acute stress turned out to be a greater stressor than the aversive event itself. Likewise, in a study examining the effects of stress vs. anticipated stress on multiple factors, Mefford & Wieland (1966) found that the anticipation of a stressful stimulus had no effect on some participants and caused an alarm reaction in others. As mentioned above, one possible explanation for these results may be the way in which subjective stress was measured. It is possible that certain tasks influence different factors of subjective stress in different ways (Matthews & Campbell, 2010). In other words, some tasks evoke stress responses related to task engagement, some to distress, some to worry,

while others to a combination of the three. The present study aimed to shed light on the relationship between anticipation and stress by examining the effect of anticipation on the different dimensions of subjective stress.

In sum, previous research has clearly established that performance decrements following a sudden shift in workload persist despite the nature of the task, the direction of the shift, or the environment of the shift (e.g. a single or dual task environment). In addition, there is evidence of increased subjective stress as a result of workload variations. Because workload variation is a common real-world occurrence, it seems both logical and prudent to identify potential buffers of this detrimental performance outcome. Literature examining task interruptions has identified anticipation as an intervention that can limit performance decrements resulting from both social and nonsocial task interruptions. The present study used this literature to inform the workload history literature and tested the effect of anticipation on task performance and reported stress.

Method

Participants

One hundred twenty-four participants were recruited from various psychology courses at the University of Oklahoma. 10 participants were dropped (1 for incomplete data, and 9 for equipment failure), resulting in a total of 114 participants (19 per cell). Participants were primarily female (80%), Caucasian (71%), and ranging in ages between eighteen and twenty-two (91%). Participants received extra credit for his or her participation.

Design

The current study employed a design that was a two between (2 shift, 3 instructions) x one within (2 time). Specifically, the workload design that was used in this study was similar to the design employed by Hauck et al. (2008), in which participants were randomly assigned to one of six conditions, with each condition receiving no anticipatory instructions, general anticipatory instructions, or specific anticipatory instructions and a high-to-low or a low-to-high sudden workload shift. All participants were then measured at both a baseline and a testing time.

Measures

Performance. A computerized version of the Sternberg Memory Task (1966) was administered to the participants. Specifically, the "Memory Search" task of the Automated Neuropsychological Assessment Metric (ANAM4™) was employed to measure performance (for screen shots of the task, see Appendix A, Figure 1). In this task, participants were presented with a set of four random letters for a brief period of time and instructed to memorize the set. Subsequently, a series of probe letters were presented and the participants were asked to identify whether or not the probe letter was a part of the original memorized set. Workload was manipulated by changing the speed of presentation of the probe letters (i.e. the gap time between stimulus presentation was manipulated so that a high workload consisted of one letter presented every 0.45 seconds, and a low workload consisted of one letter presented every 1.25 seconds). The exact parameters were determined according to those set in previous research using a similar task (Cox-Fuenzalida et al.

2006) as well as via a pilot study in which the high and low workload levels were confirmed via performance level and subjective workload. Performance on this task was measured in terms of total percent correct (i.e. the number of probe letters correctly identified as either within or not within the original memorized letter set divided by the total number of probe letters presented, then multiplied by 100) and reaction time (i.e. the time it takes participants to respond "yes" or "no" to each probe letter).

Stress. Subjective stress states were measured using the Dundee State Stress Questionnaire, a tool employed for measuring eleven first-order factors of mood, motivation, and cognition in performance settings (Matthews et al., 2002). The questionnaire contains a total of 96 items that together produce eleven subscales: energetic arousal, tense arousal, hedonic tone, intrinsic task motivation, success motivation, self-focused attention, self-esteem, concentration, confidence and control, task-relevant cognitive interference, and task-irrelevant personal interference. The DSSQ dimensions are internally consistent (Matthews et al., 2002).

Procedure

When participants arrived at the laboratory, they were seated at individual workstations and asked to fill out the appropriate informed consent and demographic forms (see complete demographic form in Appendix C). All participants completed the experimental task in groups no larger than four. Due to the nature of the instructions, all participants within each group were part of the same instruction and shift condition, though they were randomly assigned to each testing group and to a

specific counterbalanced sequence of testing trials. Workstations were separated by partitions to minimize distractions. The participants were, however, able to easily view the experimenter during the administration of instructions. Immediately following the informed consent, participants were asked to complete Eysenck's Personality Inventory (1968; see Appendix D). Upon completion of this personality questionnaire, information concerning the computer task was given. These instructions were exactly the same in all conditions with the exception of the anticipation manipulation. All experimenters followed a detailed protocol to administer all instructions. In the control condition, no advanced noticed about a future shift in workload was given. In the general anticipatory instruction condition, participants were told that there would a sudden change in workload level at some point during the testing trial. Finally, in the specific anticipatory instruction condition, participants were informed that there would be a sudden increase in workload (if they were in the low-high testing condition) or that there would be a sudden decrease in workload (if they were in the high-low testing condition). The anticipatory instruction manipulation was given prior to performance on the testing condition (described below). Following the experimental task, all participants were thanked for their participation and debriefed. Administration of the DSSQ as well as the employment of distracter tasks will be discussed below. In an effort to control for time-of-day effects, all participants completed the study between the hours of 9:00 a.m. and 4:00 p.m. (Revelle, Humpreys, Simon, & Gilliland, 1980).

Training and Baseline Data Collection. Participants performed the memory search task following a particular series of training, baseline, and testing sessions as outlined in Cox-Fuenzalida (2007). Each participant was randomly assigned to one of eight training/baseline/test sequences (see Appendix A, Table 1 for counterbalanced sequences for each condition). To ensure a thorough understanding of the task, participants received specific instructions about the task and were familiarized with the operation of the computer program and the mouse response buttons. The participants then engaged in two three-minute training trials (one at a high workload and one at a low workload).

Following adequate training on the task, participants completed two three-minute baseline sessions (one at a high workload level and one at a low workload level) to establish baseline data for later comparisons. It should be noted that five minute breaks were employed between all conditions in the training and baseline sessions to avoid the experience of the desired test effect (i.e. a sudden shift in workload level) and to lessen participant fatigue. During this time, participants were given a distracter task in which they were asked to mark out every third "a" on a piece of paper. The distracter task was meant to help decrease carryover effects without taxing the cognitive load of the participant. After the final baseline measure was collected, there was a fifteen-minute break before the testing session in which participants completed the DSSQ.

Testing Session. Following the fifteen-minute break, participants began the testing session, which lasted a total of five minutes and included either a sudden

increase or a sudden decrease in task demand. Participants in the High-to-Low (decreasing) test condition first performed the memory search task for two minutes at a high workload level followed immediately by three minutes at a low workload level. In contrast, participants in the Low-to-High (increasing) test condition performed the memory search task for two minutes at a low workload level followed immediately by three minutes at a high workload level. This testing session created a situation in which participants were able to create a workload history at one level and then move immediately to a different workload level. Unlike the training and baseline sessions, however, there was no break between this shift in workload and participants therefore perceived the test trial as five continuous minutes. After the testing session, participants again completed the DSSQ to assess current stress states. Once the participants finished the second administration of the DSSQ, they were asked to complete a performance assessment questionnaire in which subjective perceptions of a workload shift were assessed (see Appendix E). Finally, all participants were debriefed and thanked for their participation in the experiment.

Results

Four sets of analyses were performed. First, the effects of a sudden shift in workload on performance were tested. Next, the effects of either an immediate increase or an immediate decrease in workload level on subjective stress state were examined. Finally, analyses were performed to test the effects of anticipatory instructions on both performance and subjective stress state.

Hypothesis One

In order to test hypothesis one, which predicted a decrease in performance following a sudden shift in workload, separate paired t-tests were employed to test for a difference in performance between the baseline session and the various testing sessions. Specifically, for each measure of performance (percent correct and reaction time), the mid-baseline score (performance at minute 2 in the baseline sequence) was compared to the testing score at minutes one, two, and three. Looking at participants' performance at each testing trial provided a system to examine time course effects of workload history, with minute one giving immediate effects and minutes two and three providing longer term effects. In each instance, the workload level during the baseline measurement matched the level of workload immediately following the workload shift (i.e. in the high-low testing condition, mean performance at the one, two, and three minutes following the workload shift to a low workload level will be compared to mean performance at minute two of the low baseline sequence). All means and standard deviations for percent correct and reaction in both the high-to-low and the low-to-high shifts can be found in Appendix A, Table 2.

Because the change in performance from baseline to after the workload shift was measured three times for each shift direction, the Bonferroni correction to adjust for Type I error was used. Thus, the standard alpha of .05 was divided by three to avoid an increased potential for Type 1 error, resulting in a significance level of .0167.

High-to-Low Shift Condition. Consistent with expectations, results in the high to low shift condition approached significance as there was a decrease in percent correct when comparing baseline performance and testing performance at minute two , $t(56)=2.23$, $p=.03$. While there were no significant differences in reaction time when comparing baseline performance to either minute one, two, or three in the testing condition, the difference between reaction time at baseline and testing at minute two approached significance, $t(56)=1.98$, $p=.05$. In other words, individuals in the high to low shift condition tended to respond more quickly (and at the expense of accuracy) at minute two of the testing sequence than at baseline. Although these decrements were not significant under the Bonferroni correction, there was a trend towards performance impairment seen one minute after a sudden shift from high to low workload levels.

Low-to-High Shift Condition. Contrary to expectations, in comparing baseline to testing performance immediately following the workload shift in the low-to-high condition, performance (as measured by percent correct) approached significance, with performance after the shift better than performance before the shifts, $t(56)=-2.15$, $p=.03$. Furthermore, results indicated a significant decrease in reaction time when comparing baseline performance to testing at minute one, $t(56)=6.34$, $p<.01$; minute two, $t(56)=6.59$ $p<.01$; and minute three, $t(56)=6.94$, $p<.01$. In the low-to-high shift condition, then, there was no speed accuracy trade-off; instead participants performed better and significantly faster.

Hypothesis Two

To test hypothesis two, the prediction that there would be an increase in subjective stress following a workload shift, similar statistical analyses to those described above were used. Specifically, two-dependent sample t-tests compared subjective stress states before a sudden workload shift and following a sudden workload shift. Once again, the Bonferroni correction was used to adjust for Type I error. All means and standard deviations for subjective stress states in the high-to-low condition can be found in Appendix A, Table 3, and means and standard deviations for subjective stress states in the low-to-high condition can be found in Appendix A, Table 4.

High-to-Low Shift Condition. Consistent with hypothesis two, the high to low workload shift results revealed an increase in subjective stress states related to both mood, with a trend towards an increase in subjective anger when comparing pre-shift levels to post shift levels, $t(56)=2.09$, $p<.05$, and to motivation, with significant decreases in success motivation, $t(56)=-4.34$, $p<.01$, intrinsic motivation, $t(56)=-4.92$, $p<.01$, and overall motivation, $t(56)=-4.73$, $p<.01$.

Interestingly, results in the high to low condition also revealed a decrease in subjective stress states related to cognition, with a significant decrease in self-focused thinking, $t(56)=-4.41$, $p<.01$, a significant increase in self-esteem, $t(56)=5.76$, $p<.01$, a significant decrease in task-irrelevant interference, $t(52)=-4.63$, $p<.01$, and a significant decrease in task-related interference, $t(52)=-2.69$, $p=.01$.

Low-to-High Shift Condition. Similar to results found in the high-to-low shift condition, there was a decrease in subjective stress states in the low-to-high

shift condition. Specifically, there was a decrease in subjective stress related to cognition, with a significant decrease in self focused thinking, $t(56)= -4.61$, $p<.01$, a significant increase in self-esteem, $t(56)=4.69$, $p<.01$, a trend towards an increase in concentration, $t(56)=2.27$, $p=.03$, a significant decrease in task-irrelevant interference, $t(50)=-4.08$, $p<.01$, and a significant decrease task-related interference, $t(50)=-3.61$, $p<.01$.

Although there was not a significant increase in subjective stress states for the low-to-high shift condition, there were some trends related to both mood and motivation. Specifically, results revealed an increase in tense arousal that approached significance, $t(56)=2.26$, $p=.03$, as well as a trend towards a decrease in success motivation, $t(56)=-1.94$, $p=.05$.

In sum, these finding indicate that a sudden shift in workload can have a complex effect on subjective stress states, with both significant increases and decreases in subjective stress states occurring following a shift in workload in either direction. While there were some variations in the changes seen when looking at either the high-to-low shift condition or the low-to-high shift condition, both conditions revealed a significant increase in self-esteem and a significant decrease in self-focused thinking, task-related interference, and task-irrelevant interference.

Hypothesis Three

Hypothesis three purported that participants in the specific anticipatory instruction condition would demonstrate a lower performance decrement than those participants in the control condition. There was no specific hypothesis concerning

the participants in the general anticipatory instruction condition and their performance.

Multiple separate one-way ANOVAs were conducted for each shift condition in which condition was the independent variable and difference scores in which baseline performance was subtracted from testing performance at minutes 1, 2, & 3 (for both percent correct and reaction time) were the dependent measures. Results did not reveal a significant effect for condition, as there were no significant differences in performance decrements between the three instruction conditions. Thus, hypothesis three was not supported.

Anticipation and Stress

Given the equivocal results of previous literature looking at the relationship between anticipation and perceived stress, this portion of the present study was exploratory in nature. In other words, no directional hypotheses related to the effect of anticipatory instructions on subjective stress states were proposed. To test this relationship, difference scores were once again calculated from the pre and post scores on each stress state scale and separate one-way ANOVAs were used to test for differences between the instruction conditions in both the high-to-low and the low-to-high shift conditions.

Results indicated a significant effect for the low-to-high shift condition on intrinsic motivation. Specifically, differences in intrinsic motivation differed significantly across the three conditions, $F(2, 54)=3.96$, $p<.03$. Tukey post-hoc comparisons of the three groups revealed that participants in the specific anticipatory

condition showed significantly less of a decrease in intrinsic motivation (and in fact displayed an increase in motivation from pre to post) than the general anticipatory condition $p<.05$. There were no significant differences between the control condition and the general anticipatory condition nor between the control condition and the specific anticipatory condition, though the control condition did approach significance in comparison to the specific anticipatory condition, $p=.06$ (see Appendix A, Figure 2 and Table 5).

Thus, these results suggest that providing specific anticipatory instructions before a shift in workload can lead to less motivation loss in participants.

Discussion

The purpose of this study was three-fold. First, the study aimed to replicate previous studies involving workload variation by examining the effects of workload history on performance. Consistent with prior research, results indicated a trend towards a performance decrement, at least in terms of percent correct, following a sudden decrease in performance. In this study, the decrement following a sudden shift in workload from high to low appeared in the second minute following the shift. While the explanatory mechanisms underlying these performance decrements remains unknown, various theoretical models have been suggested. Matthews (1986), for example, suggested that strategic persistence might account for the decrement seen following a sudden decrease in workload. Specifically, he proposed that participants might employ an effective strategy to deal with the high workload but be unable to quickly shift to a strategy suitable for a low workload. As a result,

participants might maintain the strategy used at a high workload and overdrive the task at a low workload level. Given the nature of my findings, however, the strategic persistence model fails to provide a satisfactory explanation for the fact that the performance decrement seen in the present study did not appear until the second minute following the shift in workload. Regardless of the mechanism behind these effects, it appears that there is a trend towards detrimental effects in performance over a longer time course following a sudden decrease in workload.

In terms of a sudden increase in workload, results revealed an immediate increase in correct response performance that approached significance as well as an immediate decrease in reaction time following the shift in workload. While the initial increase in correct performance disappeared at minute two following the shift, the decrease in reaction time last through minute three following the shift. While these results were unexpected, they might make sense in light of another theoretical explanation proposed to be behind performance following a workload shift. In contrast with the strategic persistence model mentioned above, Cox-Fuenzalida (2007) suggested an adaptation-based model to explain performance phenomena associated with a sudden shift in workload. Specifically, this theory suggests that while a low workload might not completely deplete resources, a sudden increase in workload level would require participants to gather the essential resources to meet the demand of the task. In other words, because a low workload might not fully deplete resources, the participant might have enough resources initially available to immediately meet the demands of the task. As the task continued at a high

workload, however, resource depletion might occur and this initial increase in performance would disappear. An adaptation-based model might help explain the results of this study, as it would make sense that there would be an immediate increase in performance followed by a return to performance that matched baseline performance at minute two and three. In addition, an attempt of the participant to recruit resources necessary to meet task demand might explain the significant increase in reaction time following the shift from low-to-high. Furthermore, it is important to note that the findings of the present study are consistent with previous research, as Cox-Fuenzalida (2007) also observed an immediate increase in performance following a shift from low-to-high. Instead of returning to baseline levels at later times as seen here, however, performance significantly decreased following the initial increase in the study by Cox-Fuenzalida (2007). Again, these results suggest that the dynamics involving workload history are quite complex and deserve further attention.

A second purpose of this study was to begin to explore the effects of workload variations on subjective stress states. Prior to the current study, only one study (Hauck et al., 2008) had looked at subjective stress states specifically in light of sudden changes in workload. The present study attempted to expand previous research by using a multidimensional measure of subjective stress states. Much of the recent literature looking at subjective stress and performance suggests that subjective stress is a multi-dimensional construct involving the experience dimensions of mood, motivation, and cognition (Matthews & Campbell, 2009, 2010;

Matthews et al., 2002). In fact, it has been suggested that task with differing demands obtain qualitatively different stress responses (Matthews et al., 2002, 2006). Given that different mechanisms might be at play behind performance following either a sudden decrease or a sudden increase in workload, it is theoretically plausible that different stress response patterns might emerge following each shift direction. Indeed, results indicated that a sudden shift from high-to-low workload levels produces a different pattern of subjective stress responses than a sudden shift from low-to-high workload levels. Specifically, the shift from high-to-low resulted in a decrease in all types of motivation, an increase in self-esteem, a decrease in self-focused thinking, an increase in feelings of anger and frustration, and a decrease in thinking content that was both related to and irrelevant to the task at hand. Results following a sudden shift from a low to a high workload level, however, revealed a somewhat different pattern of response, with an increase in tense arousal, a decrease in only success motivation, an increase in self-esteem and concentration, a decrease in self-focused thinking, and a decrease in both task-related and task irrelevant thoughts. While the aim of this part of the present study was exploratory in nature and expected only a change in subjective stress states, the results did indicate some interesting findings. For instance, a decrease in intrinsic motivation—an interest in the task at hand—was observed only following a sudden decrease in workload level. A closer look, however, reveals that within the low-to-high workload shift, there was a significant difference in intrinsic motivation between instruction conditions, with the control and general anticipatory conditions becoming less intrinsically motivated

and the specific anticipatory condition becoming more intrinsically motivated. It is plausible that this decrease in task interest could be related to the rather easy nature of the task, but that anticipation of a future shift change, at least from a low-to-high workload level, might allow the participant to re-engage in the task at hand. Future research may want to look at intrinsic motivation patterns on more challenging tasks in an effort to better understand the nature of these results. In addition, further exploration of factors potentially responsible for post-shift changes in mood and cognition would be helpful. For example, it is possible that the tense arousal observed in the low-to-high shift might accompany the participant's effort to switch performance strategies and meet the high task demand. Clearly, there is still much to understand involving the relationship between subjective stress states and workload variation.

Finally, this study attempted to examine the effectiveness of a potential buffer for both the performance and the stress decrements associated with a sudden shift in workload. Specifically, the current study looked at the use of anticipation of a future workload shift as a buffer that might diminish the decrements in performance and stress traditionally associated with a sudden increase or decrease in workload levels. Contrary to expectations, results did not reveal a difference in performance decrements between participants receiving no anticipatory instructions, general anticipatory instructions, or specific anticipatory instructions. More importantly, however, there was support for the use of anticipation as a buffer for intrinsic motivation loss, as participants in the specific anticipatory condition

demonstrated an increase in intrinsic motivation compared to their counterparts in both the control and general anticipatory condition who all demonstrated a decrease in intrinsic motivation following a sudden increase in workload levels.

Indeed, these results suggest that the use of anticipation in situations in which sudden shifts in workload may occur can be of value. It would certainly be useful to examine the effects of anticipation on workload variation in situations that better resemble a real world environment. While the memory search task has been successfully used in the past to generate workload history effects, it lacks the ecological validity seen in more real world or field settings. Future research using workload tasks that more closely resemble real work environments might be useful in better understanding how and when anticipation should be used.

Taken as a whole, these results suggest that workload history is a complex phenomenon and one that deserves future attention as most work environments experience sudden shifts in workload on a regular basis. In particular, occupations dealing with safety concerns or emergency situations would benefit from a clearer understanding of the effects of a sudden shift in workload, as performance decrements in those situations could be life-threatening.

The results of this study lend themselves well to several areas of future research. First, as stated above, testing the moderating effects of anticipation in a field study or with respect to a more complex task would extend the ecological validity of the study. In addition, given that workload history effects are seen in a variety of task environments (e.g. single task, dual task, multi-task), it would useful

to understand anticipation in relation to these environments as well. Second, the somewhat ambiguous performance and stress results seen in this study might better understood in light of individual differences. Future research would benefit from looking at various personality traits such as neuroticism and extraversion and their relationship with both performance and subjective stress states following a sudden shift in workload. Finally, recent attention has been given to the relationship between performance and subjective stress (Matthews & Campbell, 2009, 2010). It would be of interest to examine whether certain performance decrements predict certain subjective stress states and vice versa.

In conclusion, the present study was the first to systematically test the use of anticipation in a workload history environment. Specifically, the present study examined whether the anticipation of a future workload shift might minimize the negative performance outcomes and increased stress states that have been known to accompany sudden workload variation. Furthermore, the present study was the first to employ a multi-dimensional stress state measure in a study examining workload history effects. Consequently, it extended previous workload history literature and provided another picture of the complex effects resulting from either a sudden increase or a sudden decrease in workload levels.

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Appendix A

Table 1

Counterbalanced Training-Baseline-Testing Sequence

Instruction Condition	Shift Condition	Sequence	Within Sequence Order								
			Training	Break	Training	Break	Baseline	Break	Baseline	Break	Testing
			3 min.	5 min.	3 min.	5 min.	3 min.	5 min.	3 min.	15 min.	5 min.
	A (H-L)	1	LLL		HHH		LLL		HHH		HHLLL
Control,	A	2	LLL		HHH		HHH		LLL		HHLLL
General,	A	3	HHH		LLL		LLL		HHH		HHLLL
or	A	4	HHH		LLL		HHH		LLL		HHLLL
	B (L-H)	5	LLL		HHH		LLL		HHH		LLHHH
Specific	B	6	LLL		HHH		HHH		LLL		LLHHH
	B	7	HHH		LLL		LLL		HHH		LLHHH
	B	8	HHH		LLL		HHH		LLL		LLHHH

Table 2

Means and Standard Deviations of Percent Correct and Reaction Time for All Trials

Shift	Time	Measure	N	Mean	Std. Deviation	Std. Error Mean
Hi-Lo						
	Baseline	%Corr	57	97.68	3.51	0.46
		RT	57	620.07	100.26	13.28
	Test 1	% Corr	57	97.21	3.56	0.47
		RT	57	613.03	111.04	14.71
	Test 2	% Corr	57	96.27	4.71	0.62
		RT	57	593.75	93.97	12.45
	Test 3	%Corr	57	96.99	4.36	0.58
		RT	57	617.48	113.69	15.06
Lo-Hi						
	Baseline	%Corr	57	92.42	14.47	1.92
		RT	57	678.22	147.82	19.58
	Test 1	%Corr	57	94.11	13.49	1.79
		RT	57	591.93	107.55	14.25
	Test 2	%Corr	57	93.21	13.59	1.8
		RT	57	596.89	105.37	13.96
	Test 3	% Corr	57	93.68	13.75	1.82
		RT	57	582.51	122.68	16.25

%Corr = percent correct
RT = reaction time

Table 3

Means and Standard Deviations of Pre- and Post-Subjective Stress States for the High-Lo Shift Condition

Subjective Stress States		N	Mean	Std. Deviation	Std. Error Mean
Energetic Arousal	Pre	57	18.25	5.62	0.74
	Post	57	17.96	4.85	0.64
Tense Arousal	Pre	57	16.21	4.69	0.62
	Post	57	16.74	5.24	0.69
Hedonic Arousal	Pre	57	24.91	5.06	0.67
	Post	57	23.3	4.47	0.59
Anger/Frustration	Pre	57	9.28	4.11	0.54
	Post	57	10.23	4.46	0.59
Success Mot.	Pre	57	15.89	5.74	0.76
	Post	57	***13.37**	5.73	0.76
Intrinsic Mot.	Pre	57	13.58	4.85	0.64
	Post	57	***11.46**	5.39	0.71
Overall Mot.	Pre	57	2.25	1.06	0.14
	Post	57	***1.67**	1.06	0.14
Self-Focused Thinking	Pre	57	12.12	6.85	0.91
	Post	57	***8.28**	8.1	1.07
Self-Esteem	Pre	57	17.49	6.99	0.93
	Post	57	***21.75**	7.12	0.94
Concentration	Pre	57	18.25	7.67	1.02
	Post	57	18.91	7.8	1.03
Control & Confidence	Pre	57	19.7	6.06	0.8
	Post	57	19.68	5.46	0.72
Task-Related Interference	Pre	53	22.11	6.26	0.86
	Post	53	***20.04**	7.32	1.01
Task-Irrelevant Interference	Pre	53	17.13	7.57	1.04
	Post	53	***12.98**	5.38	0.74

**Significant at the .01 level*

Table 4

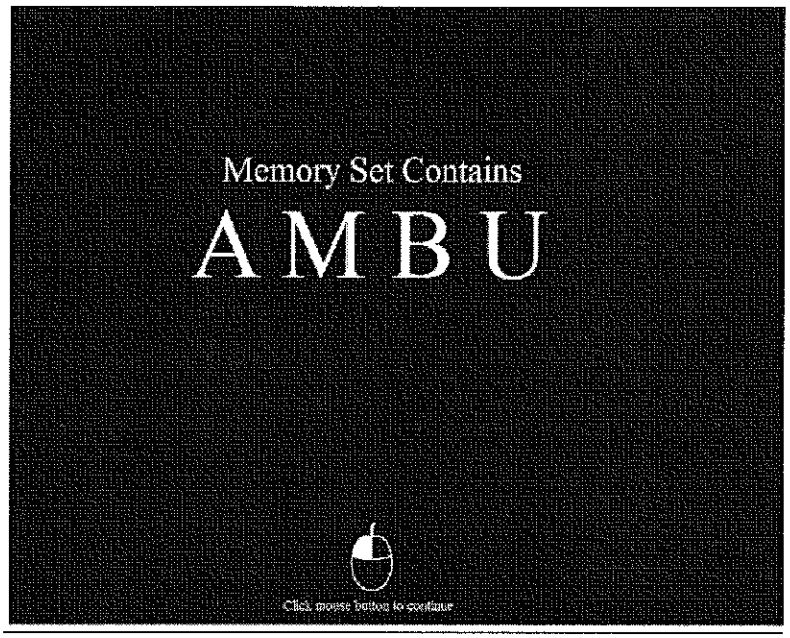
Means and Standard Deviations of Pre- and Post-Subjective Stress States for the Lo-High Shift Condition

Subjective Stress States		N	Mean	Std. Deviation	Std. Error Mean
Energetic Arousal	Pre	57	17..88	5.13	0.68
	Post	57	19.14	5.09	0.67
Tense Arousal	Pre	57	16.56	4.87	0.65
	Post	57	17.63	5.06	0.67
Hedonic Arousal	Pre	57	23.63	4.53	0.6
	Post	57	23.58	4.62	0.61
Anger/Frustration	Pre	57	10.26	4.02	0.53
	Post	57	10.11	3.94	0.52
Success Mot.	Pre	57	14.89	6.81	0.9
	Post	57	13.67	7.41	0.98
Intrinsic Mot.	Pre	57	14.95	4.93	0.65
	Post	57	13.86	5.41	0.72
Overall Mot.	Pre	57	2.14	1.25	0.16
	Post	57	2.12	1.07	0.14
Self-Focused	Pre	57	14	5.77	0.76
Thinking	Post	57	***9.61**	7.68	1.02
Self-Esteem	Pre	57	17.35	7.04	0.93
	Post	57	***20.28**	7.31	0.97
Concentration	Pre	57	17.21	7.05	0.93
	Post	57	18.96	7.04	0.93
Control &	Pre	57	18.25	6.78	0.9
Confidence	Post	57	19.3	6.77	0.9
Task-Related	Pre	51	23.92	5.72	0.8
Interference	Post	51	***20.94**	6.6	0.92
Task-Irrelevant	Pre	51	18.57	7.01	0.98
Interference	Post	51	***14.86**	7.21	1.01

**Significant at the .01 level*

Figure 1

Screenshots of ANAM4™ Memory Search Test



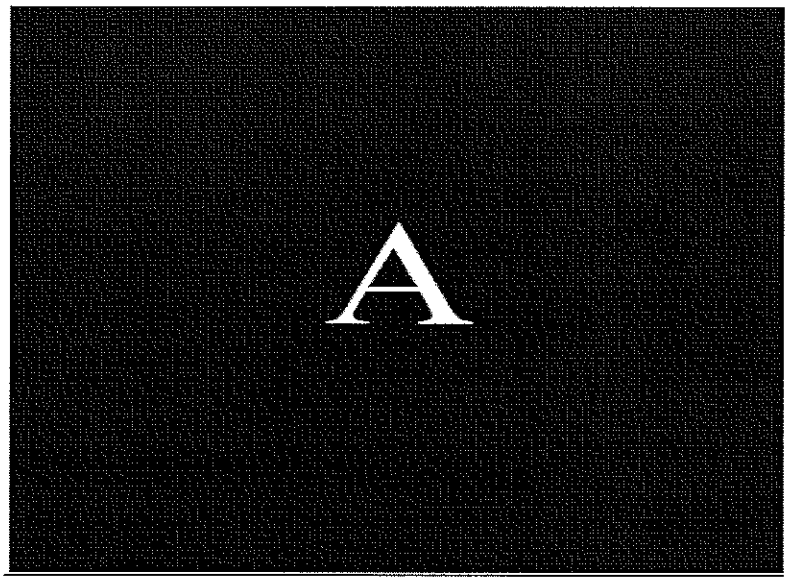


Figure 2

Mean Intrinsic Motivation For Pre- and Post-Testing By Instruction Condition for the Lo-High Shift Condition

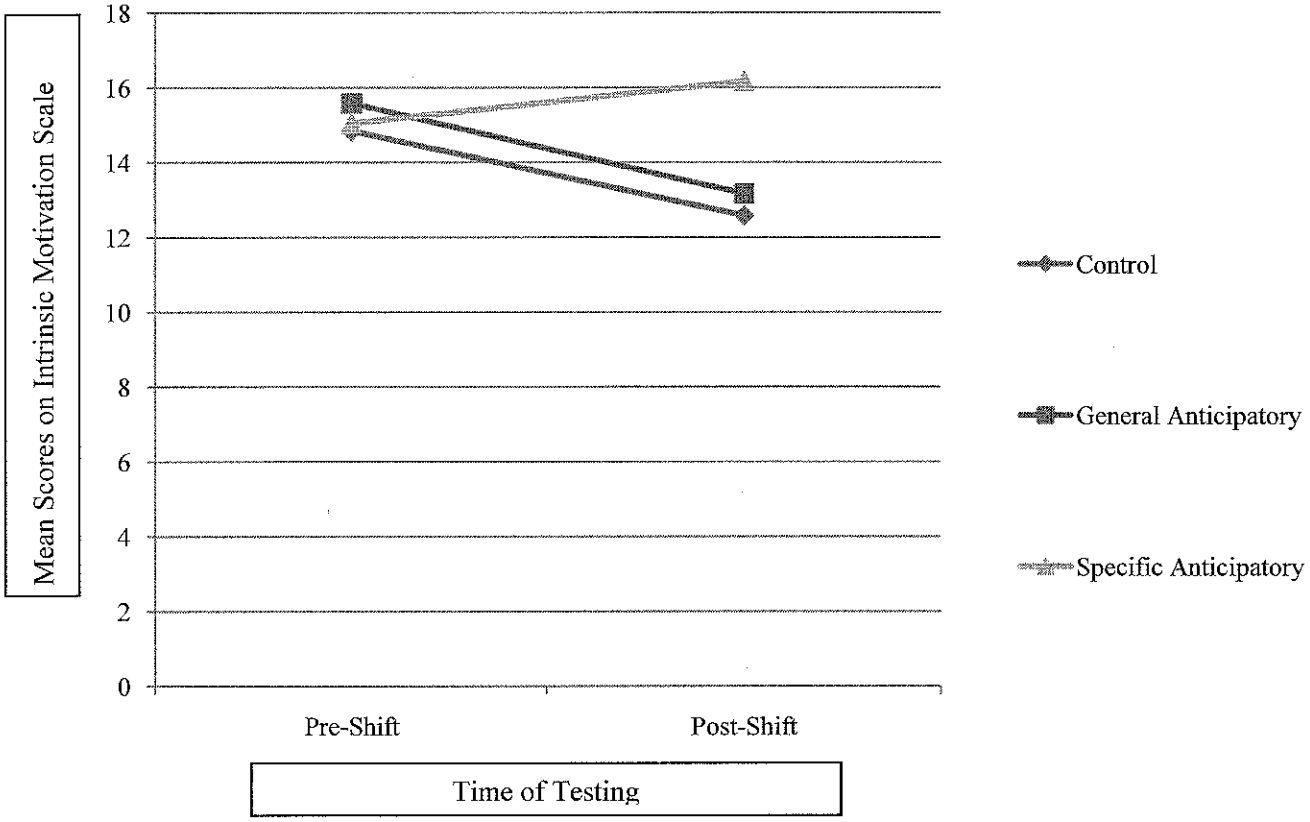


Table 5

Means and Standard Deviations of Intrinsic Motivation States by Instruction Condition for the Lo-High Shift Condition

Instruction	Condition	N	Mean	Std. Deviation	Std. Error Mean
Control	Pre	19	14.84	3.96	0.91
	Post	19	12.58	4.57	1.05
General Anticipatory	Pre	19	15.58	4.95	1.14
	Post	19	13.16	6.05	1.39
Specific Anticipatory	Pre	19	15.05	5.08	1.17
	Post	19	16.16	4.15	0.95

Appendix B

Dundee State Stress Questionnaire

Pre. General Instructions. This questionnaire is concerned with your feelings and thoughts at the moment. We would like to build up a detailed picture of your current state of mind, so there are quite a few questions, divided into four sections. Please answer **every** question, even if you find it difficult. Answer, as honestly as you can, what is true of **you**. Please do not choose a reply just because it seems like the 'right thing to say'. Your answers will be kept entirely confidential. Also, be sure to answer according to how you feel **AT THE MOMENT**. Don't just put down how you usually feel. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

Before you start, please provide some general information about yourself.

Age..... (years) Sex. M F (Circle one)
Occupation.....
If student, state your major.....
Date today..... Time of day now.....

1. MOOD STATE

First, there is a list of words which describe people's moods or feelings. Please indicate how well each word describes how you feel **AT THE MOMENT**. For each word, circle the answer from 1 to 4 which best describes your mood.

	Definitely	Slightly	Slightly Not	Definitely Not
1. Happy	1	2	3	4
2. Dissatisfied	1	2	3	4
3. Energetic	1	2	3	4
4. Relaxed	1	2	3	4
5. Alert	1	2	3	4
6. Nervous	1	2	3	4
7. Passive	1	2	3	4
8. Cheerful	1	2	3	4
9. Tense	1	2	3	4
10. Jittery	1	2	3	4
11. Sluggish	1	2	3	4
12. Sorry	1	2	3	4
13. Composed	1	2	3	4
14. Depressed	1	2	3	4
15. Restful	1	2	3	4
16. Vigorous	1	2	3	4

17. Anxious	1	2	3	4
18. Satisfied	1	2	3	4
19. Unenterprising	1	2	3	4
20. Sad	1	2	3	4
21. Calm	1	2	3	4
22. Active	1	2	3	4
23. Contented	1	2	3	4
24. Tired	1	2	3	4
25. Impatient	1	2	3	4
26. Annoyed	1	2	3	4
27. Angry	1	2	3	4
28. Irritated	1	2	3	4
29. Grouchy	1	2	3	4

2. MOTIVATION

Please answer some questions about your attitude to the task you are about to do. Rate your agreement with the following statements by circling one of the following answers:

Extremely = 4 Very much = 3 Somewhat = 2 A little bit = 1 Not at all = 0

1. I expect the content of the task will be interesting

   0 1 2 3 4

2. The only reason to do the task is to get an external reward (e.g. payment)

   0 1 2 3 4

3. I would rather spend the time doing the task on something else

   0 1 2 3 4

4. I am concerned about not doing as well as I can

   0 1 2 3 4

5. I want to perform better than most people do

   0 1 2 3 4

6. I will become fed up with the task

   0 1 2 3 4

7. I am eager to do well

   0 1 2 3 4

8. I would be disappointed if I failed to do well on the task

   0 1 2 3 4

9. I am committed to attaining my performance goals

0 1 2 3 4

10. Doing the task is worthwhile

0 1 2 3 4

11. I expect to find the task boring

0 1 2 3 4

12. I feel apathetic about my performance

0 1 2 3 4

13. I want to succeed on the task

0 1 2 3 4

14. The task will bring out my competitive drives

0 1 2 3 4

15. I am motivated to do the task

0 1 2 3 4

3. THINKING STYLE

In this section, we are concerned with your thoughts about yourself: how your mind is working, how confident you feel, and how well you expect to perform on the task. Below are some statements which may describe your style of thought **RIGHT NOW**. Read each one carefully and indicate how true each statement is of your thoughts **AT THE MOMENT**. To answer, circle one of the following answers:

Extremely = 4 Very much = 3 Somewhat = 2 A little bit = 1 Not at all = 0

1. I'm trying to figure myself out.

   0 1 2 3 4

2. I'm very aware of myself.

   0 1 2 3 4

3. I'm reflecting about myself.

   0 1 2 3 4

4. I'm daydreaming about myself.

   0 1 2 3 4

5. I'm thinking deeply about myself.

   0 1 2 3 4

6. I'm attending to my inner feelings.

   0 1 2 3 4

7. I'm examining my motives.

   0 1 2 3 4

8. I feel that I'm off somewhere watching myself.

   0 1 2 3 4

9. I feel confident about my abilities.

   0 1 2 3 4

10. I am worried about whether I am regarded as a success or failure.

    0 1 2 3 4

11. I feel self-conscious.

    0 1 2 3 4

12. I feel as smart as others.

    0 1 2 3 4

13. I am worried about what other people think of me.

    0 1 2 3 4

14. I feel confident that I understand things.

    0 1 2 3 4

15. I feel inferior to others at this moment.

    0 1 2 3 4

16. I feel concerned about the impression I am making.

    0 1 2 3 4

17. I feel that I have less scholastic ability right now than others.

    0 1 2 3 4

18. I am worried about looking foolish.

    0 1 2 3 4

19. My attention is directed towards things other than the task.

    0 1 2 3 4

20. I am finding physical sensations such as muscular tension distracting.

    0 1 2 3 4

21. I expect my performance will be impaired by thoughts irrelevant to the task.

    0 1 2 3 4

22. I have too much to think about to be able to concentrate on the task.

    0 1 2 3 4

23. My thinking is generally clear and sharp.

    0 1 2 3 4

24. I will find it hard to maintain my concentration for more than a short time.

    0 1 2 3 4

25. My mind is wandering a great deal.

    0 1 2 3 4

26. My thoughts are confused and difficult to control.

    0 1 2 3 4

27. I expect to perform proficiently on this task.

    0 1 2 3 4

28. Generally, I feel in control of things.

    0 1 2 3 4

29. I can handle any difficulties I encounter

    0 1 2 3 4

30. I consider myself skillful at the task

    0 1 2 3 4

4. THINKING CONTENT

This set of questions concerns the kinds of thoughts that go through people's heads at particular times, for example while they are doing some task or activity. Below is a list of thoughts, some of which you might have had recently. Please indicate roughly how often you had each thought **DURING THE LAST TEN MINUTES** or so, by circling a number from the list below.

1= Never 2= Once 3= A few times 4= Often 5= Very often

1. I thought about how I should work more carefully.

   1 2 3 4 5

2. I thought about how much time I had left.

   1 2 3 4 5

3. I thought about how others have done on this task.

   1 2 3 4 5

4. I thought about the difficulty of the problems.

   1 2 3 4 5

5. I thought about my level of ability.

   1 2 3 4 5

6. I thought about the purpose of the experiment.

   1 2 3 4 5

7. I thought about how I would feel if I were told how I performed.

   1 2 3 4 5

8. I thought about how often I get confused.

   1 2 3 4 5

9. I thought about members of my family.

   1 2 3 4 5

10. I thought about something that made me feel guilty.

    1 2 3 4 5

11. I thought about personal worries.

    1 2 3 4 5

12. I thought about something that made me feel angry.

    1 2 3 4 5

13. I thought about something that happened earlier today.

    1 2 3 4 5

14. I thought about something that happened in the recent past

    1 2 3 4 5

    (last few days, but not today).

15. I thought about something that happened in the distant past

    1 2 3 4 5

16. I thought about something that might happen in the future.

    1 2 3 4 5

Post. General Instructions

This questionnaire is concerned with your feelings and thoughts while you were performing the task. We would like to build up a detailed picture of your current state of mind, so there are quite a few questions, divided into four sections. Please answer every question, even if you find it difficult. Answer, as honestly as you can, what is true of you. Please do not choose a reply just because it seems like the 'right thing to say'. Your answers will be kept entirely confidential. Also, be sure to answer according to how you felt **WHILE PERFORMING THE TASK**. Don't just put down how you usually feel. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

1. MOOD STATE

First, there is a list of words which describe people's moods or feelings. Please indicate how well each word describes how you felt **WHILE PERFORMING THE TASK**. For each word, circle the answer from 1 to 4 which best describes your mood.

	Definitely	Slightly	Slightly Not	Definitely Not
1. Happy	1	2	3	4
2. Dissatisfied	1	2	3	4
3. Energetic	1	2	3	4
4. Relaxed	1	2	3	4
5. Alert	1	2	3	4
6. Nervous	1	2	3	4
7. Passive	1	2	3	4
8. Cheerful	1	2	3	4
9. Tense	1	2	3	4
10. Jittery	1	2	3	4
11. Sluggish	1	2	3	4
12. Sorry	1	2	3	4
13. Composed	1	2	3	4
14. Depressed	1	2	3	4
15. Restful	1	2	3	4
16. Vigorous	1	2	3	4
17. Anxious	1	2	3	4
18. Satisfied	1	2	3	4
19. Unenterprising	1	2	3	4
20. Sad	1	2	3	4
21. Calm	1	2	3	4
22. Active	1	2	3	4
23. Contented	1	2	3	4
24. Tired	1	2	3	4
25. Impatient	1	2	3	4
26. Annoyed	1	2	3	4

27. Angry	1	2	3	4
28. Irritated	1	2	3	4
29. Grouchy	1	2	3	4

2. MOTIVATION

Please answer the following questions about your attitude **to the task you have just done**. Rate your agreement with the following statements by circling one of the following answers:

Extremely = 4 Very much = 3 Somewhat = 2 A little bit = 1 Not at all = 0

1. The content of the task was interesting

   0 1 2 3 4
2. The only reason to do the task is to get an external reward (e.g. payment)

   0 1 2 3 4
3. I would rather have spent the time doing the task on something else

   0 1 2 3 4
4. I was concerned about not doing as well as I can

   0 1 2 3 4
5. I wanted to perform better than most people do

   0 1 2 3 4
6. I became fed up with the task

   0 1 2 3 4
7. I was eager to do well

   0 1 2 3 4
8. I would be disappointed if I failed to do well on this task

   0 1 2 3 4
9. I was committed to attaining my performance goals

   0 1 2 3 4
10. Doing the task was worthwhile

    0 1 2 3 4
11. I found the task boring

    0 1 2 3 4
12. I felt apathetic about my performance

    0 1 2 3 4
13. I wanted to succeed on the task

    0 1 2 3 4
14. The task brought out my competitive drives

    0 1 2 3 4
15. I was motivated to do the task

    0 1 2 3 4

3. THINKING STYLE

In this section, we are concerned with your thoughts about yourself: how your mind is working, how confident you feel, and how well you believed you performed on the task. Below are some statements which may describe your style of thought during task performance. Read each one carefully and indicate how true each statement was of your thoughts **WHILE PERFORMING THE TASK**. To answer circle one of the following answers: Extremely = 4 Very much = 3 Somewhat = 2 A little bit = 1 Not at all = 0

1.	I tried to figure myself out.	0 1 2 3 4
2.	I was very aware of myself.	0 1 2 3 4
3.	I reflected about myself.	0 1 2 3 4
4.	I daydreamed about myself.	0 1 2 3 4
5.	I thought deeply about myself.	0 1 2 3 4
6.	I attended to my inner feelings.	0 1 2 3 4
7.	I examined my motives.	0 1 2 3 4
8.	I felt that I was off somewhere watching myself.	0 1 2 3 4
9.	I felt confident about my abilities.	0 1 2 3 4
10.	I was worried about whether I am regarded as a success or failure.	0 1 2 3 4
11.	I felt self-conscious.	0 1 2 3 4
12.	I felt as smart as others.	0 1 2 3 4
13.	I was worried about what other people think of me.	0 1 2 3 4
14.	I felt confident that I understood things.	0 1 2 3 4
15.	I felt inferior to others.	0 1 2 3 4
16.	I felt concerned about the impression I was making.	0 1 2 3 4
17.	I felt that I had less scholastic ability than others.	0 1 2 3 4
18.	I was worried about looking foolish.	0 1 2 3 4
19.	My attention was directed towards things other than the task.	0 1 2 3 4
20.	I found physical sensations such as muscular tension distracting.	0 1 2 3 4
21.	My performance was impaired by thoughts irrelevant to the task.	0 1 2 3 4
22.	I had too much to think about to be able to concentrate on the task.	0 1 2 3 4
23.	My thinking was generally clear and sharp.	0 1 2 3 4
24.	I found it hard to maintain my concentration for more than a short time.	0 1 2 3 4
25.	My mind wandered a great deal.	0 1 2 3 4
26.	My thoughts were confused and difficult to control	0 1 2 3 4

27.	I performed proficiently on this task.	0 1 2 3 4
28.	Generally, I felt in control of things.	0 1 2 3 4
29.	I was able to handle any difficulties I encountered	0 1 2 3 4
30.	I consider myself skillful at the task	0 1 2 3 4

4. THINKING CONTENT

This set of questions concerns the kinds of thoughts that go through people's heads at particular times, for example while they are doing some task or activity. Below is a list of thoughts, some of which you might have had recently. Please indicate roughly how often you had each thought during **THE LAST TEN MINUTES** (while performing the task), by circling a number from the list below.

1= Never 2= Once 3= A few times 4= Often 5= Very often

1.	I thought about how I should work more carefully.	1 2 3 4 5
2.	I thought about how much time I had left.	1 2 3 4 5
3.	I thought about how others have done on this task.	1 2 3 4 5
4.	I thought about the difficulty of the problems.	1 2 3 4 5
5.	I thought about my level of ability.	1 2 3 4 5
6.	I thought about the purpose of the experiment.	1 2 3 4 5
7.	I thought about how I would feel if I were told how I performed.	1 2 3 4 5
8.	I thought about how often I get confused.	1 2 3 4 5
9.	I thought about members of my family.	1 2 3 4 5
10.	I thought about something that made me feel guilty.	1 2 3 4 5
11.	I thought about personal worries.	1 2 3 4 5
12.	I thought about something that made me feel angry.	1 2 3 4 5
13.	I thought about something that happened earlier today.	1 2 3 4 5
14.	I thought about something that happened in the recent past (last few days, but not today).	1 2 3 4 5
15.	I thought about something that happened in the distant past	1 2 3 4 5
16.	I thought about something that might happen in the future.	1 2 3 4 5

Appendix C

Demographics Questionnaire

Before we begin, please provide some general information about yourself.

Participant Study ID _____

Age (years): _____

Occupation: _____

If student, state your major: _____

Sex (Circle one): M F

Ethnicity (Choose one):

_____African/African American
_____American Indian or Alaska Native
_____Asian/Asian American
_____Hispanic
_____Pacific Islander
_____White-Not of Hispanic Origin
_____Other

Have you had any caffeine today (if yes, please explain):

_____

Appendix D

Eysenck Personality Inventory

Directions: Here are some questions regarding the way you behave, feel, and act. Try and decide whether "Yes," or "No" represents your usual way of acting or feeling. Then blacken in the appropriate space on your scantron sheet. Use A = Yes/True and B = No/False. Work quickly and do not spend too much time over any question; we want your first reaction, not a long drawn out process. The whole questionnaire shouldn't take more than a few minutes. Be sure not to omit and questions. There are no right or wrong answers, and this is not a test of intelligence or ability, but simply a measure of the way you behave.

1. Do you often long for excitement?
2. Do you often need understanding friends to cheer you up?
3. Are you usually carefree?
4. Do you find it very hard to take no for an answer?
5. Do you stop and think things over before doing anything?
6. If you say you will do something do you always keep your promise, no matter how inconvenient it might be to do so?
7. Does your mood often go up and down?
8. Do you generally do and say things quickly without stopping to think?
9. Do you ever feel "just miserable" for no good reason?
10. Would you do almost anything for a dare?
11. Do you suddenly feel shy when you want to talk to an attractive stranger?
12. Once in awhile do you lose your temper and get angry?
13. Do you often do things on the spur of the moment?
14. Do you often worry about things you should not have done or said?
15. Generally do you prefer reading to meeting people?
16. Are your feelings rather easily hurt?
17. Do you like going out a lot?
18. Do you occasionally have thoughts and ideas that you would not like other people to know about?

19. Are you sometimes bubbling over with energy and sometimes very sluggish?
20. Do you prefer to have few but special friends?
21. Do you daydream a lot?
22. When people shout at you, do you shout back?
23. Are you often troubled about feelings of guilt?
24. Are all your habits good and desirable ones?
25. Can you usually let yourself go and enjoy yourself a lot at a party?
26. Would you call yourself tense or "high-strung"?
27. Do other people think of you as being very lively?
28. After you have done something important, do you often come away feeling you could have done better?
29. Are you mostly quiet when you are with other people?
30. Do you sometimes gossip?
31. Do ideas run through your head so that you cannot sleep?
32. If there is something you want to know about, would you rather look it up in a book than talk to someone about it?
33. Do you get palpitations or thumping in your heart?
34. Do you like the kind of work that you need to pay close attention to?
35. Do you get attacks of shaking or trembling?
36. Would you always declare everything at the customs, even if you knew that you could never be found out?
37. Do you hate being with a crowd who plays jokes on one another?
38. Are you an irritable person?
39. Do you like doing things in which you have to act quickly?
40. Do you worry about awful things that might happen?
41. Are you slow and unhurried in the way you move?
42. Have you ever been late for an appointment or work?
43. Do you have many nightmares?

44. Do you like talking to people so much that you would never miss a chance of talking to a stranger?
45. Are you troubled by aches and pains?
46. Would you be very unhappy if you could not see lots of people most of the time?
47. Would you call yourself a nervous person?
48. Of all the people you know are there some whom you definitely do not like?
49. Would you say you were fairly self-confident?
50. Are you easily hurt when people find fault with you or your work?
51. Do you find it hard to really enjoy yourself at a lively party?
52. Are you troubled with feelings of inferiority?
53. Can you easily get some life into a rather dull party?
54. Do you sometimes talk about things you know nothing about?
55. Do you worry about your health?
56. Do you like playing pranks on others?
57. Do you suffer from sleeplessness?

Appendix E

Performance Assessment Questionnaire

Participant Study Number: _____

Please read the following questions carefully. All information you provide will be kept strictly confidential.

1.
2. Please rate your level of effort expended on this task.

1	2	3	4	5	6	7	8	9
very little effort				average effort				high effort

3. Since the last (15-minute) break, rate your motivation to perform the task well.

1	2	3	4	5	6	7	8	9
poor motivation				average motivation				high motivation

4. Did you perceive any changes in workload level in the most recent task?

_____Yes _____No

5. If yes, please explain:

   a. What kind of change did you perceive?

   b. What effect did they have on you?

   c. How did you handle the changes (e.g. strategies employed)?

   d. Was your performance affected?

6. Do you have any additional comments you would like to make pertaining to the study?