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Effect of Task Difficulty on Physiological Measure of Arousal, Metacognition and Affect

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Abstract

According to Eysenck and Calvo (1992) performance on difficult tasks especially under test conditions is often impaired by anxiety (p. 409). Anxiety and its effects on test taking abilities have been researched extensively and the one thing that has been determined is that anxiety does play a role in an individual's ability to perform on a test. Therefore we had two hypotheses for this study. Our first hypothesis was that as task difficulty increased anxiety as measured by physiological and self-report measures would increase. Our second hypothesis was that as task difficulty decrease anxiety measured by physiological and self-report measures of anxiety would decrease.

Effect of Task Difficulty on Physiological Measure of Arousal, Metacognition and Affect

According to Eysenck and Calvo (1992) performance on difficult tasks especially under test conditions is often impaired by anxiety (p. 409). This paper will explore if task difficulty affects physiological measures of arousal, metacognition, and affect. We tested anxiety through manipulation of task difficulty as well as through self-report measures of anxiety and physiological measures of anxiety. We had two hypotheses for this study. We hypothesized that as task difficulty increased anxiety as measured by physiological and self-report measures would increase. Our second hypothesis was that as task difficulty decreased anxiety measured by physiological and self-report measures of anxiety would decrease.

Anxiety

Anxiety and its effects on test taking abilities had been researched extensively and it is clear that anxiety does play a role in an individual's ability to perform on a test. Anxiety is defined as "an unpleasant emotional reaction that results from the perception or appraisal of a particular situation as threatening" (Van der Ploeg, Schwarzer, & Spielberger, p. 3, 1982). Anxiety has been broken down into two types: state anxiety and trait anxiety. State anxiety is defined as the anxiety that is felt through the autonomic nervous system that is transitory and emotional and therefore is subject to change (Van der Ploeg, Schwarzer, & Spielberger, 1982). Trait anxiety refers to the consistent individualistic characteristics of people that determine how they will react to state anxiety (Van der Ploeg, Schwarzer, & Spielberger, 1982).

According to the processing efficiency theory by Eysenck and Calvo (1992) state anxiety is determined by situational stress, threat or its interaction with trait anxiety. The

rule of thumb used to study anxiety is by making the distinction between worry and emotionality (Sarason, 1986). Emotionality is defined as peoples awareness of the arousal and tension levels in their own body (Sarason, 1986). Worry is defined further as the preoccupation of self, a concern over evaluation of one's work, and concern of one's level of performance (Eysenck & Calvo, 1992). Worry is thought to form the cognitive part of state anxiety (Sarason, 1986). Worry affects task performance through its impact on the working memory system (Eysenck & Calvo, 1992).

Working Memory System

Working memory system is the construct that is in charge of the processing of information as well as the area for transient storage of this information (Eysenck & Calvo, 1992). The working memory system is comprised of three parts. The first part is known to manipulate and store speech based information and is called the phonological loop. The second part manipulates and stores visual and spatial information and is therefore called the visuospatial sketchpad. The third part, which is the central executive, has two purposes. The first is to regulate the phonological loop and the visuospatial sketchpad. The second is to serve as the control system for attention (Baddeley & Hitch, 1994). The part of the working memory system that is affected by worry is this central executive (Eysenck & Calvo, 1992).

Worry and its effects on the Working Memory System

The worry component can be separated into three parts, which are the person's expectations of the task, their concern over their performance, and their own negative

self-evaluations (Ikeda, Iwanaga, & Seiwa, 1996). These three components of worry can have either a negative or positive effects on task performance.

Worry affects the central executive negatively by impeding some of the resources needed for processing and storage (Eysenck & Calvo, 1992). Furthermore, state anxiety will produce adverse affects on task performance if the task places high demand on the working memory system. Worry affects working memory positively by allocating more processing resources which is defined as effort as well as providing strategies that could improve task performance (Eysenck & Calvo, 1992). This is best understood in terms of the Yerkes-Dodson law of arousal, which states that high arousal on easy tasks improves performance and low arousal on difficult task improves performance.

Therefore we hypothesized that as task difficulty increased levels of physiological measures of anxiety as well as self-report measures of anxiety would increase. In addition we hypothesized that as task difficulty decreased levels of physiological measures of anxiety as well as self-report measures of anxiety would decrease.

Method

Participants

There were 96 participants recruited through a research pool amongst the undergraduate student population of Psychology, Sociology, Anthropology, and Social Work 101 classes at a public Northeast College. There were 27 male participants and 69 female participants. Participants needed to be 18 years or older and could not have participated in any previous studies conducted by the Biofeedback laboratory.

Apparatus

Instruments used in this study were the Spielberger State Trait Anxiety Inventory Test (1983) (STAI), Galvanic Skin Response Apparatus, the Raven's Progressive Matrices (1938) a non-verbal intelligence test, and a cognitive/affective questionnaire created by the lab.

The first instrument used was the Spielberger State Trait Anxiety Inventory. The STAI is one of the most frequently used devices for self-report measures of anxiety. There are 20 questions to assess state anxiety on a scale from 1 to 4, 4 being the emotion that the participant currently feels the most. There were also 20 questions to assess trait anxiety on a scale from 1 to 4. 4 being the emotion the participant generally feels the most. State anxiety is defined as the anxiety that is felt through the autonomic nervous system that is transitory and emotional and therefore is subject to change (Van der Ploeg, Schwarzer, & Spielberger, 1982). In simple terms state anxiety is measured on how the participant feels right now at the current moment. Trait anxiety is the consistent individualistic characteristics of a person that determine how they will react to state anxiety (Van der Ploeg, Schwarzer, & Spielberger, 1982). Therefore, trait anxiety is measured on how a participant generally feels. Two scores are derived from this inventory. If participants are given only the State portion of the inventory during both times of administration the weighted scores of the twenty questions must be added which will yield a raw score. The raw score will then be translated to a percentile score and a standard score, which are both, derived from the Percentile Rank and Standard Score Rank tables for students provided by the STAI. The same is done if the participant was given only the Trait portion of the inventory during both times of administration.

The second instrument used in this study was the Galvanic skin response apparatus (GSR). The GSR is also used as the biofeedback monitor. For this study we used the GSR electrodes to screen blood volume pulse, galvanic skin response for both internal and surface skin temperature, and electromyography for muscle contraction in the forearm

The third instrument used in this study was the Raven's Progressive Matrices. The Raven's Progressive Matrices is one of the widely used non-verbal intelligence tests that measure a person's ability to form perceptual relationships. The test is a set of black and white puzzles with a missing piece. Below each puzzle are either six choices (for puzzle sets A-B) or eight choices (for puzzle sets C-E) that are used to solve the puzzle. Seventeen of the sixty puzzles were used in this study. There were five sets of puzzles (A-E) with three puzzles in each set in increasing difficulty.

The fourth instrument used in this study was the cognitive/affective questionnaire created by our Biofeedback laboratory. The questionnaire was designed to measure the participant's perception of their cognition and their affect changes based on changes in anxiety, effort, comfort, and frustration levels after each puzzle set was completed. There were twelve questions in the questionnaire. The questions were divided up to measure either cognition or affect as follows: questions 1-4 and question 11 measured participants' cognitions on their anxiety, effort, comfort, and frustration during the tasks on a scale from 1-10, 10 being the most negative cognition. Questions 5-10 measured participants' affective perceptions of their anxiety, effort, comfort, and frustration during the tasks on a reverse scale of 10-1, 1 being the most negative affect.

Procedure

Participants were brought into a lab room individually and were given an initial briefing of what would be done during the study. The consent form was read, discussed, and signed by both the researcher and participant.

The galvanic skin response electrodes were placed on the participants' non-dominant hand and the initial portion of the State Trait Anxiety Inventory (STAI) was presented. The STAI instructions were read out to the participant and after its completion participants were asked a few demographic questions. The demographic questions were of age, gender, native language, major, year in school, how many credits each participant had currently completed and handedness (which hand was dominant).

Participants were initially presented with two sample puzzles so they can get an idea of what they will be doing during the study. After the two samples are presented and answered the sets of puzzles began. There were 5 sets of puzzles with three puzzles in each set and they were either presented A through E (Forwards group [increased difficulty], n = 44) or E through A (Backwards group [decreased difficulty], n = 52) depending on the grouping of the participant. Participants were presented with one puzzle at a time. Each time a puzzle was presented the researcher gave instructions to the participant to pick out of the six (puzzle sets A-B) or eight choices (puzzle sets C-E) one choice that best completed the puzzle. Participant's responses were recorded and after each set the galvanic skin response meter was recalibrated while the participant answered the cognitive/affective questionnaire.

After all puzzle sets were presented and completed the galvanic skin response electrodes were removed from the participants' hand. The final portion of the State Trait

Anxiety Inventory (STAI) was then given. As before the directions were read out to participants before they filled out the STAI again.

Results

All data except for STAI data were analyzed with ANOVA's. STAI data was analyzed with t-tests comparing before puzzle administration and after puzzle administration results.

Results showed that as task difficulty increased, surface skin temperature also increased ($F[1,4] = 4.7$, $p < .01$), in cognitive self-report measures of frustration ($F[1,4] = 4.73$, $p < .005$), difficulty ($F[1,4] = 10.41$, $p < .001$), attention ($F[1,4] = 2.51$, $p < .05$), and stress ($F[1,4] = 3.07$, $p < .05$). Results also showed that as task difficulty increased there was an increase in affective self-report measures of worry ($F[1,4] = 2.93$, $p < .05$), annoyance ($F[1,4] = 2.64$, $p < .05$), anger ($F[1,4] = 2.43$, $p < .05$), anxiousness ($F[1,4] = 3.38$, $p < .01$), and sadness ($F[1,4] = 3.01$, $p < .01$).

When task difficulty decreased there was a decrease in surface skin temperature ($F[1,4] = 22.7$, $p < .001$), in cognitive self-report measures of frustration ($F[1,4] = 2.17$, $p < .05$), difficulty ($F[1,4] = 3.84$, $p < .005$), attention ($F[1,4] = 2.64$, $p < .05$), and stress ($F[1,4] = 2.40$, $p < .05$). Results also showed that as task difficulty decreased there was a decrease in affective self-report measures of worry ($F[1,4] = 2.73$, $p < .05$), and anxiousness ($F[1,4] = 2.92$, $p < .01$).

In regards to gender there was a significant difference found in the four physiological measures of anxiety. Males showed an increase in internal temperature, pulse and muscle contraction in comparison to females ($p < .05$) regardless of which group they were in, increasing or decreasing difficulty of task. Females showed an

increase in surface skin temperature in comparison to males ($p < .05$) regardless of which group they were in, increasing or decreasing difficulty of task.

Discussion

This study showed that as task difficulty increased skin temperature increased. Furthermore as task difficulty increased there was an increase in self-report measures of affect in regards to worry, annoyance, anxiousness, anger and sadness. In addition, as task difficulty increased there was an increase in self-report measures of cognition in regards to frustration, difficulty, stress, and attention. There was also an increase in the STAI from the first to the second administration. This study showed that as task difficult increased, there was no increase in internal temperature. There was also no change in pulse, muscle contraction, or self-report measures of comfort.

As task difficulty decreased there was a decrease surface skin temperature. Furthermore, as task difficulty decreased there was a decrease in self-report measures of affect in regards to worry and anxiousness. In addition, as task difficulty decreased there was a decrease in cognition in regards to frustration, difficulty, attention, and stress. This study showed that as task difficulty decreased there were no changes in muscle contraction, internal temperature, pulse and self-report measure of comfort.

This study showed differences in gender regardless of task difficulty. Males showed a higher degree of pulse, muscle contraction, and internal temperature. Females showed a higher degree of surface skin temperature.

Our findings are important because it proves our hypotheses that an increase or decrease of task difficulty would have an effect on physiological measures of anxiety as well as self-report measures of anxiety. These findings can help further understand how

task difficulty effect levels of anxiety and how this in turn affects cognitions and affect which then translate to task performance. Recommendations for future research would be to evaluate how both physiological and self-report measures of anxiety affect participants' number of correct and incorrect responses. Furthermore, future research should look at the amount of time it took for participants to complete the tasks as well as how long they felt it took for them to complete the tasks.

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FIG 1. Change in Skin Temperature

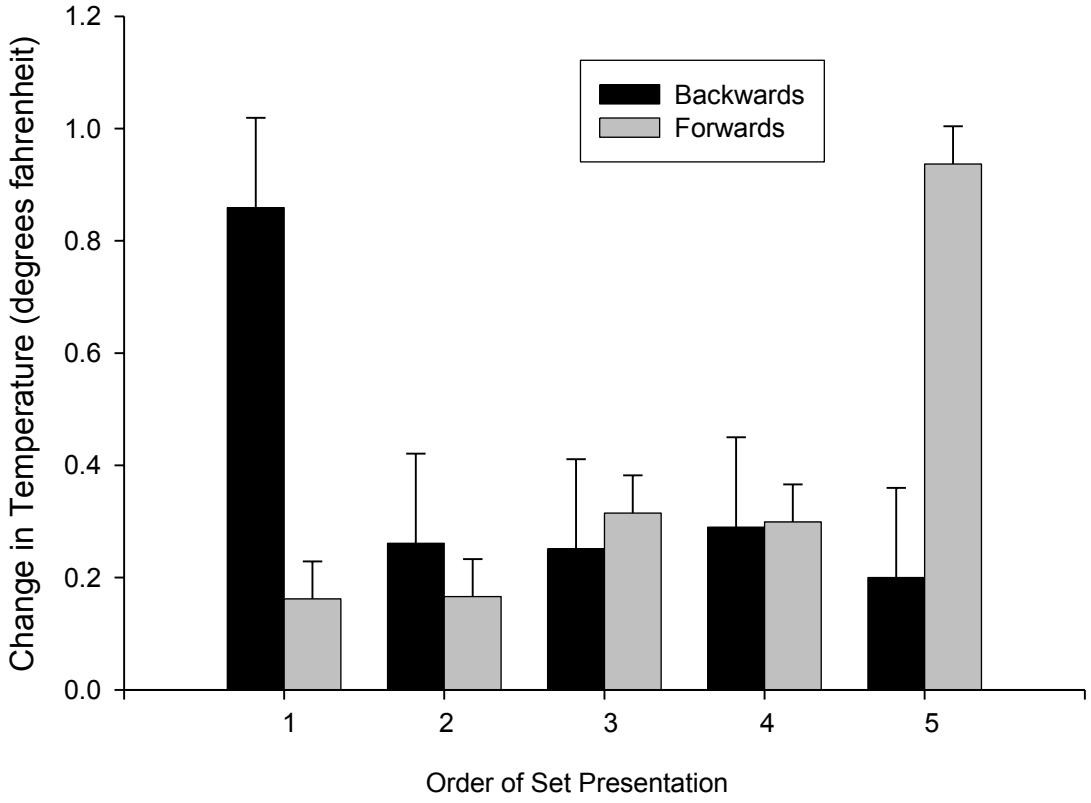


FIG 2. Gender Differences in Physiological Measures

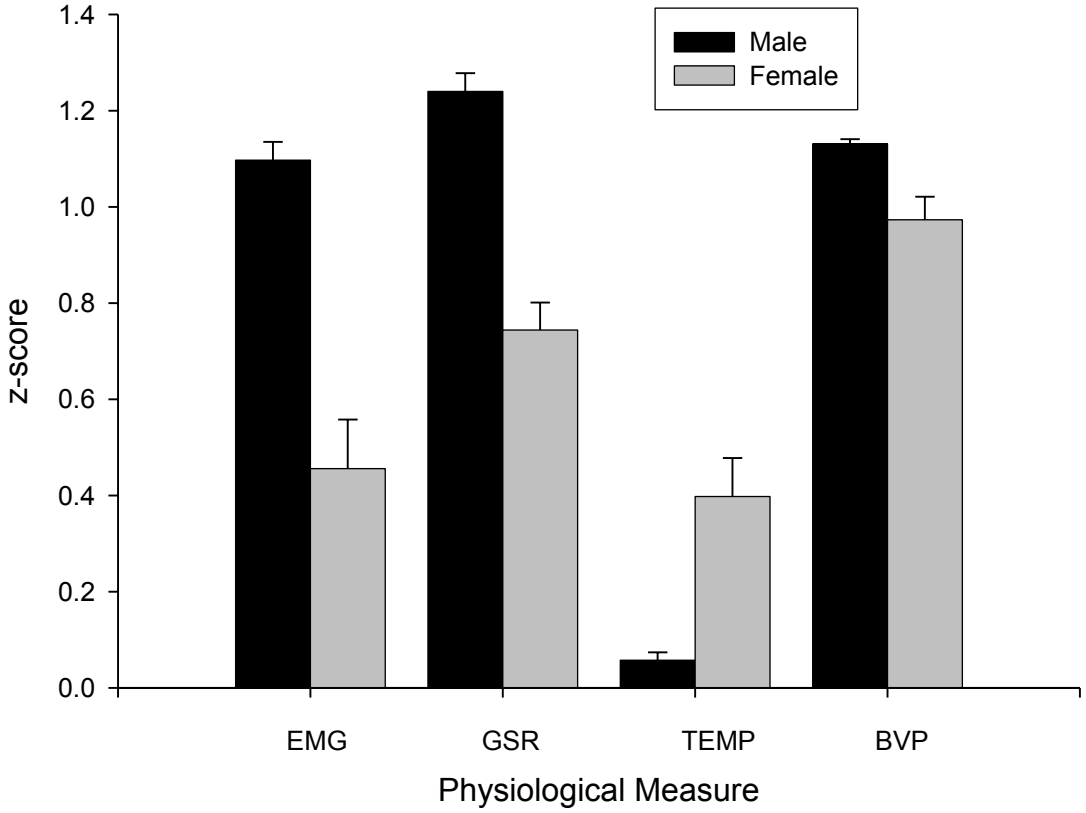


FIG 3. Cognitive Self-Report Questions for Forwards Group

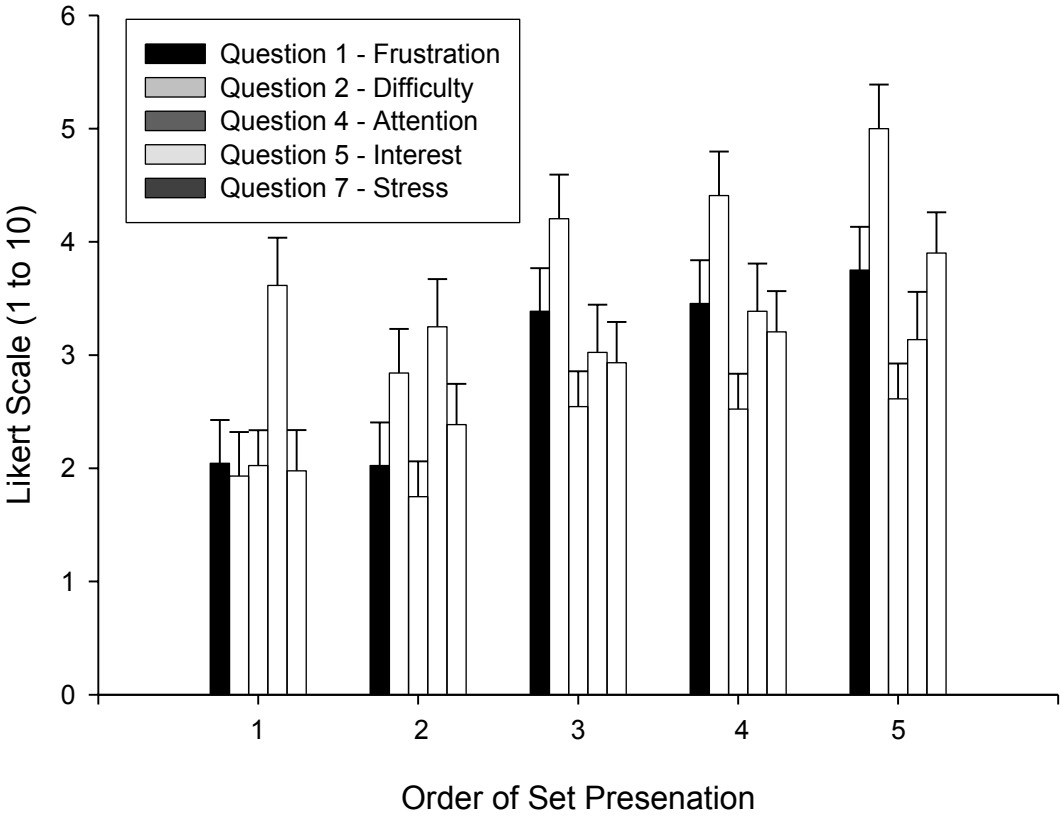


FIG 4. Cognitive Self-Report Questions for Backwards Group

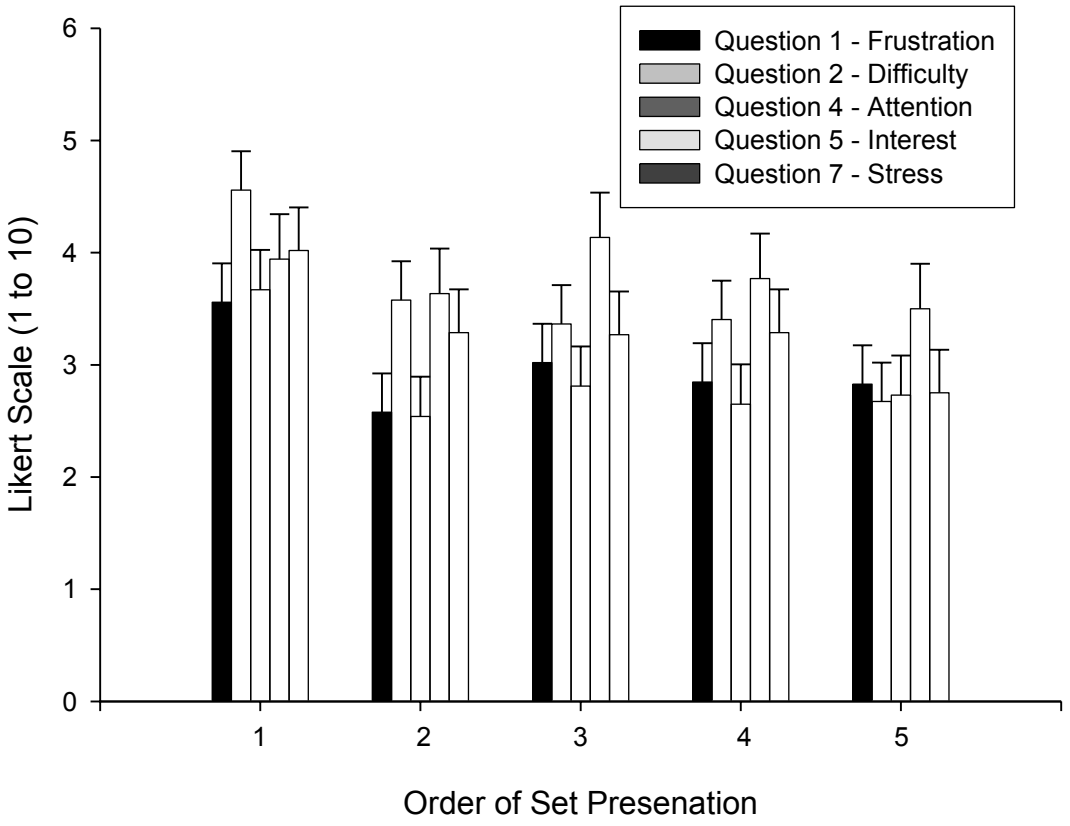


FIG 5. Affective Self-Report Measures for Forwards Group

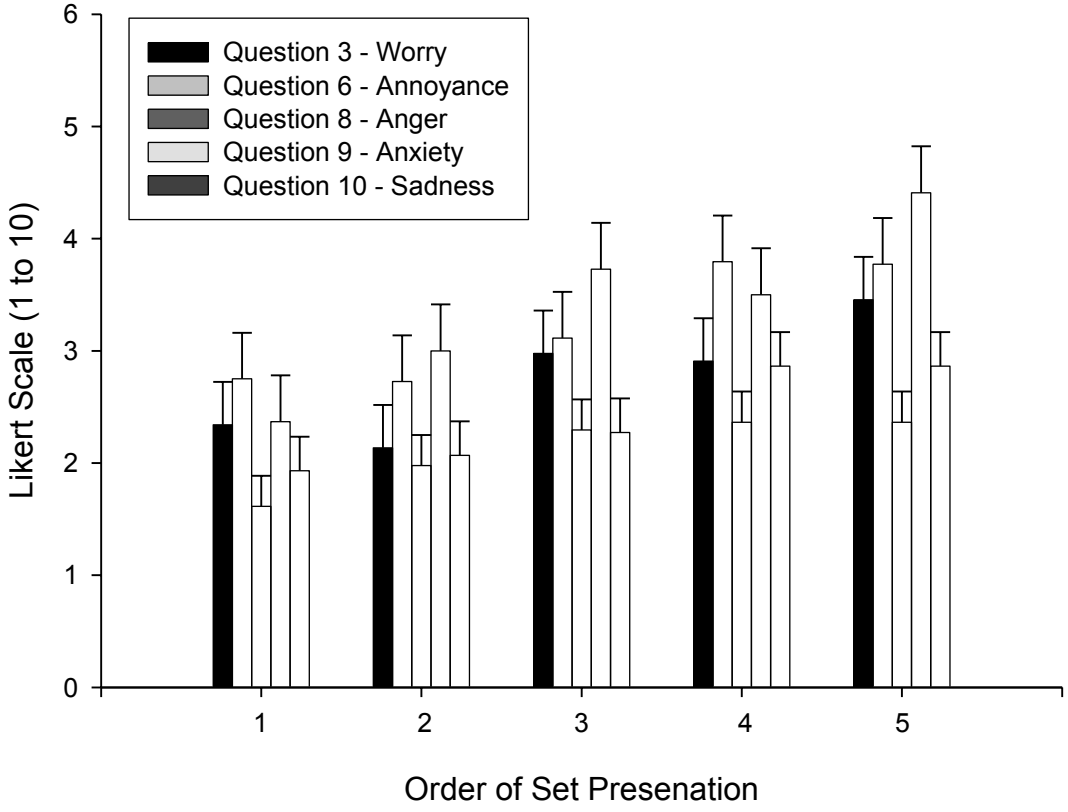
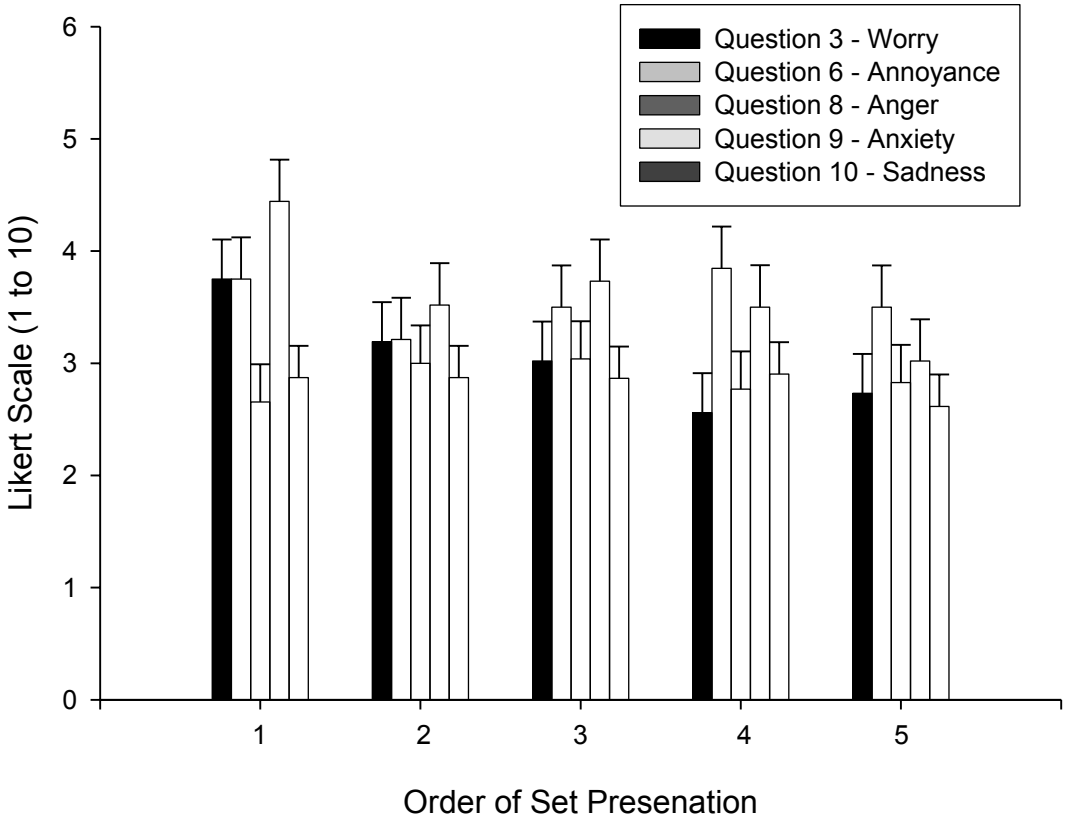


FIG 6. Affective Self-Report Measures for Backwards Group


Question 3 - Worry
Question 6 - Annoyance
Question 8 - Anger
Question 9 - Anxiety
Question 10 - Sadness
Likert Scale (1 to 10)
0
1
2
3
4
5
6
1
2
3
4
5
Order of Set Presenation