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Classical Conditioning of Cognitive States

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Abstract

Classical conditioning has been a fundamental concept and practice throughout the history of psychology. While classical conditioning traditionally seeks to elicit target behaviors in correlation to specific stimuli, we sought to do the same with cognitive states in place of behaviors. Specifically, we wanted to determine the effectiveness of conditioning states of arousal and relaxation in human participants in conjunction with cues presented in a designed learning paradigm. By presenting participants with cognitive tasks designed to elicit either arousal or relaxation, we aimed to create associations with these induced states and the neutral cues presented throughout the conditioning. By recording pupil dilation via eye tracking technology as well as EEG data, we were able to determine the intensity of the induced cognitive states and the extent to which they persisted upon the removal of the cognitive tasks used to initiated them. Thus far we have been able to demonstrate the success of the learning paradigm in eliciting a state of arousal.

Introduction

Classical conditioning has been a corner stone of the school of behaviorism, and psychology in general, ever since it was first observed in Ivan Pavlov's dogs. Since then, countless associations have been shown to be possible using a wide verity of conditioned and unconditioned stimuli (US) to elicit numerous varying responses. Behaviorist experiments with classical conditioning such as the "little Albert experiments" done by John B. Watson have illustrated those emotional states could be conditioned in human participants. The goal of this research was to design an experiment in which it could be tested whether more complex cognitive states, as opposed to behaviors and emotional states, could be conditioned thorough traditional learning paradigms. Arousal and relaxation were chosen as the cognitive states of interest in this research because of the relative ease in eliciting these states in participants as well as their potential utility given successful conditioning.

While most classical conditioning is approached though a behavioral lens, we sought to focus primarily on the cognitive aspect of the conditioned state of the subjects and its effect on performance of cognitive tasks. Behaviorists argue that classical conditioning targets behaviors including conditioning of emotions, such as fear, cognitive states often have similar neurological origins as these types of emotions. For instance, fear response arises primarily though sympathetic nervous system activation while arousal and relaxation are also related to changes in sympathetic nervous system functioning. Since emotional conditioning related to sympathetic nervous system functioning have already been demonstrated, we hypothesized that conditioning of cognitive states would be plausible as well considering cognition and emotion are both influenced by sympathetic nervous system function. While emotion and cognition both have subjective aspects cognitive states in particular could be observed and measured though performance on cognitive tasks. We decided to measure cognitive state through a combination of pupil dilation, EEG data, performance on cognitive tasks, and self-report. Pupil dilation has already been demonstrated to be elicited by arousing stimuli through means of sympathetic nervous system activation [1]. By measuring variation in pupil size, we can determine if participants are relaxed and or aroused throughout conditioning and if these cognitive states are maintained in the absence of the unconditioned stimulus. Attentiveness and relaxation can also be determined by observing the ratio between alpha and beta waves in the brain [2]. By collecting EEG data from participants, we have another measure to examine when determining the cognitive state of participants during testing. By pairing this data with performance on cognitive tasks, we are able to determine the cognitive benefit of the induced cognitive state. More aroused and attentive participants should perform better on more difficult cognitive tasks while more relaxed participants should perform better on relatively easy cognitive tasks. By combining all these metrics with info obtained from self-report questionnaires on levels of relaxation and arousal throughout the study, we can determine if any observed changes in cognitive state are noticeable by participants and if they are consistent with what the participants are experiencing. If conditioning of these cognitive states is successful, it could prove beneficial for a multitude of applications for both clinical and personal use. Success in conditioning cognitive states through traditional learning paradigms could open up a world of applications particularly in the field of cognitive behavioral therapy.

Method

Three participants came in for three testing sessions over the summer for preliminary testing with the conditioning task. They each completed a demographic questionnaire which included questions about gender, race, and conditions that may affect their ability to relax or pay attention. The Tobii eye tracking software was utilized to measure pupil dilation as well as the Biopac MP36 EEG machine to look for brainwave data indicative of the cognitive states of interest. In designing a conditioning task that would allow for multiple interchangeable unconditioned stimulus, a task was created involving an open fixation point, closed red fixation point, and video portion that serves as either the arousing US or relaxing US dependent on the instructions give. In the Tobii eye tracking software, the subjects were presented with instructions followed by four pretest segments consisting of the open fixation point followed by the red closed fixation point and then a video containing the open fixation along with a sequence of four tones of varying low, medium, and high pitches. The subjects were instructed to press the arrow keys on the keyboard to indicate whether the current tone is higher, lower, or the same pitch as the previous tone. This tone pitching task served as the arousing US as it required the subjects to maintain attention on the tones in hopes to elicit a state or arousal or excitation as opposed to passive listening. A version of this task was also created that instructs participants to listen to the tones with no feedback required to serve as a relaxing US, but this version was not used during the preliminary testing this summer. After the pretest portion, subjects were presented with the same sequences again, but this time they were instructed to complete a letter number sequencing task following the tone pitching task wherein they are presented with a set of numbers and letters and are asked to repeat them in numerical order and then alphabetical order. Three letter number sequences of each four, five, six, and seven digits were presented during the second portion of the learning task. During the learning task, subjects were also monitored through the Biopac MP36 EEG machine which monitored brainwaves throughout the duration of the task. Pupil size data was exported from the Tobii eye tracking software, and averages of the pupil size consisting of the first ten and last ten readings from each portion of interest were taken and compiled in a separate spread sheet. Data was taken from all four sequences in the pretest and the second of the three sequences for each digit length in the letter number sequencing portion of the learning task. A version of the learning task was created that utilized a rapid visual information processing task where a sequence of numbers is presented, and subjects are instructed to press the space bar every time a sequence of three odd or three even numbers are presented in a row, in place of the pitching task in order to see if a visual US yields differing results than an auditory US, although this learning task was not utilized in the preliminary testing over the summer.

Results

Data was exported from the Tobii eye tracking software, and average pupil sizes were calculated using the first ten and last ten readings during the portions of interest in the learning test. Averages of pupil sizes recorded during presentation of the fixation point, the red neutral stimulus, and the tone pitching task were taken from readings during all four series in the pretest and four series from the second portion of the test, which included the letter number sequencing, one from each level of the letter number sequencing task.

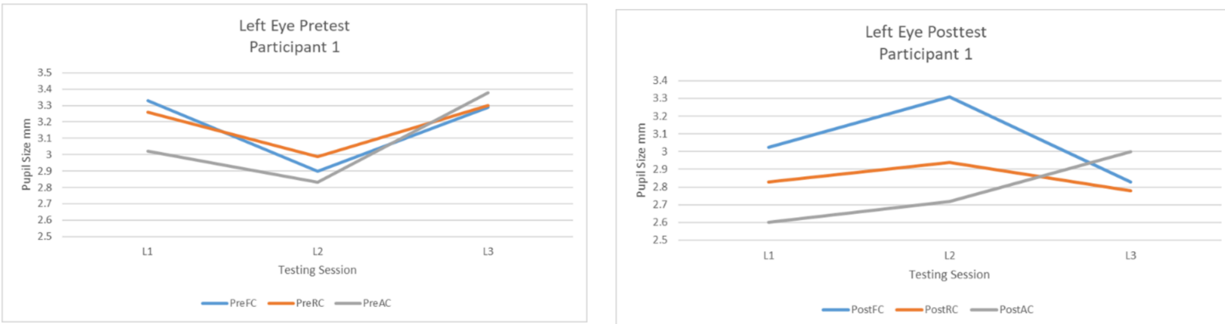

Figure 1. General trends in pupil size were seen between testing sessions within both the pretest and posttest, which suggest consistencies with pupil dilation within each portion of the test. Initial decreases in pupil size, while indicative of increased relaxation, may be due to participants becoming more acclimated to the testing environment and not being as nervous as they were when first coming in for testing.

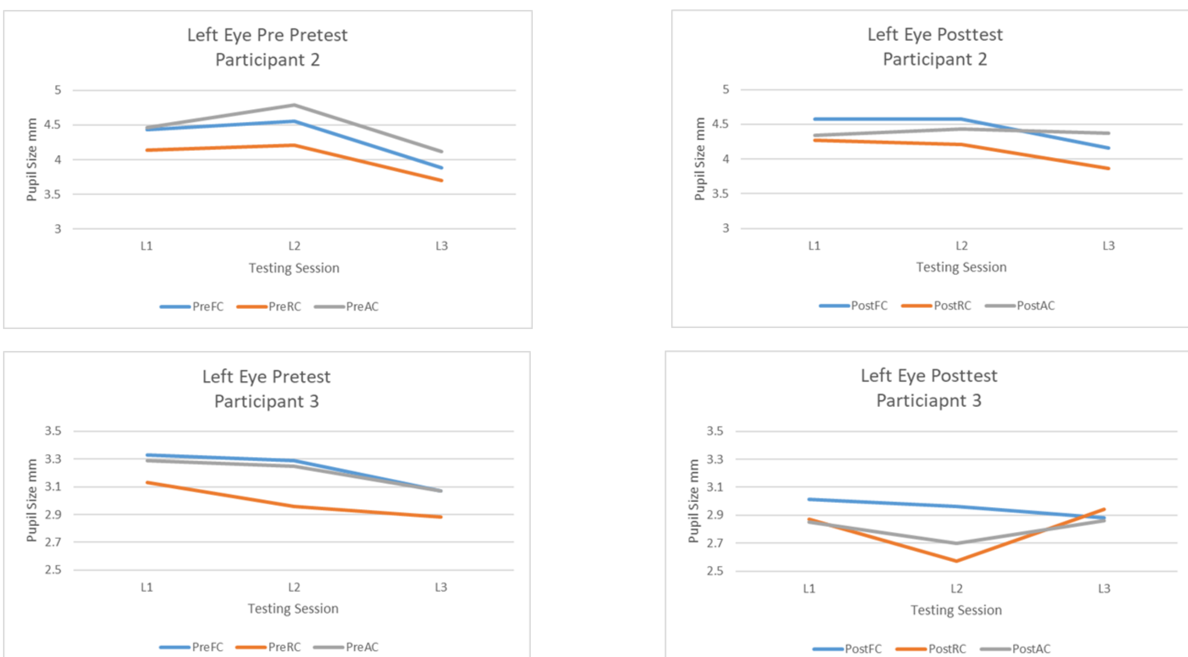

Figure 2. Differences were seen in trends between the pretest and posttest suggesting that the posttest has some level of effect on pupil dilation that the pretest does not. This may suggest that the letter

number sequencing task has some effect on pupil dilation. Differences in levels of effect and types of effect on pupil size were seen between participants suggesting some participants are more or less receptive to the effect of the learning test and classifying participants into categories based on the type and level of effect that is seen may be necessary in further testing.

Discussion

Because of the small number of participants over the preliminary summer testing, more data is required to determine any significance in the effect of the learning task. The EEG data that was collected will also be analyzed and matched with pupil dilation data in order to determine if there are consistencies with the markers of cognitive state. Going forward, success rates on the letter number sequencing will also be examined to determine if the conditioning has any effect on the success rate on this cognitive task. Self-report questionnaires will also be analyzed to see if participants observe any changes in their own level of arousal or relaxation.

References

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