Appendix N

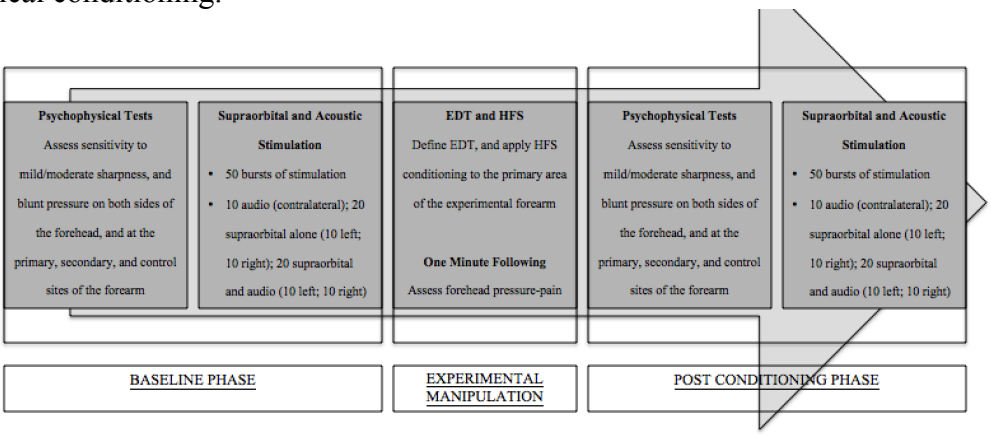
Project Summary

The main aim of the current study was to explore the effects of sympathetic arousal on a healthy individual's experience of pain, and how the presence of central sensitization effects this interaction. Central sensitization is the process by which nerves carrying sensory information in the body become increasingly responsive, causing otherwise innocuous stimuli to evoke pain. It is believed this disrupted mechanism is one of the contributing factors to the maintenance of chronic pain conditions.

Research suggests that heightened sympathetic arousal is associated with decreased pain tolerance, and higher ratings of pain in chronic pain patients. To understand the possible association between central sensitization, arousal and pain it is important to first understand how arousal affects the experience of pain in healthy participants. This provides a baseline by which to compare abnormal pain mechanisms. Researchers have been able to mimic the effects of central sensitization in healthy humans using techniques such as high frequency electrical stimulation (HFS). HFS involves a series of high intensity electrical pulses, applied to the forearm of a healthy human. Such methods allow researchers to investigate the role of central sensitization in the association between pain and arousal.

Method

The study used a repeated measures design, consisting of a baseline and post-HFS phase. During the baseline phase, participants underwent a series of tests to measure initial sensitivity to blunt-pressure, and mechanical stimuli on the forearm and each side of the forehead. This was followed by a series of electric shocks applied to an area of the forehead, some of which were paired with an acoustic stimulus (intended to evoke arousal). After introducing the experimental manipulation (i.e. HFS) these procedures were repeated, and the results compared to assess the impact of the electrical conditioning.



Participants reported feelings of pain and sharpness along a scale of zero to ten, after the presentation of each stimulus. If they received concurrent acoustic stimulation, they also reported loudness and discomfort. During the forehead shocks physiological data was also measured, pertaining to the strength of the protective blink reflex. Verbal ratings of pain and physiological data were compared using a two-way analysis of variance (ANOVA) in order to test for any significant differences in data between the baseline and post-HFS phase.

Results

During the baseline phase, arousal was significantly associated with higher ratings of pain and sharpness, and greater amplitude and shorter onset of the protective blink reflex. Following HFS, audio was still significantly associated with higher sensitivity and shorter onset of blink reflexes. However, these results did not differ significantly from baseline, suggesting HFS did not result in higher sensitivity to harmful stimuli during sympathetic arousal. The amplitude of the blink reflex decreased significantly following HFS, but was still higher for trials involving audio than those without.

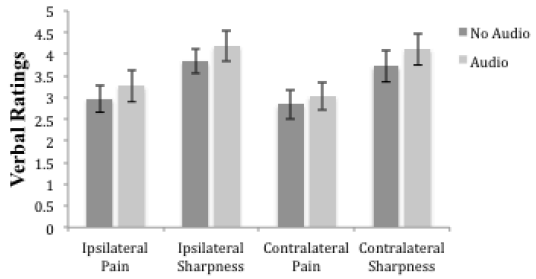


Figure 1. Mean ratings of pain and sharpness for supraorbital stimulus presented to the ipsilateral or contralateral (to HFS) forehead alone, or with concurrent audio stimulation, at baseline (prior to HFS). Error bars denote standard error.

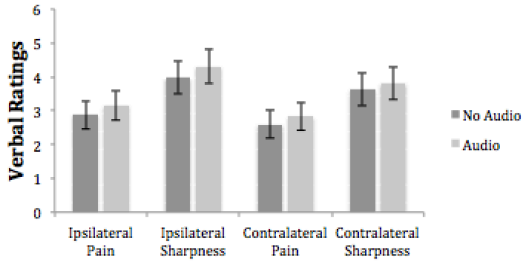


Figure 2. Mean ratings of pain and sharpness for supraorbital stimulus presented to the ipsilateral or contralateral (to HFS) forehead alone, or with concurrent audio stimulation, following electrical conditioning. Error bars denote standard error.

Discussion

Hypothesis: Effects of Arousal on Pain Perception Prior to HFS

It was hypothesized that arousal would lead to a decrease in sensitivity to harmful stimuli and dampen the protective blink reflex prior to HFS. This hypothesis was not supported as arousal was associated with higher ratings of pain and sharpness, and more pronounced blink reflexes. It is proposed that a differentiation between high-intensity imminent threats, which lead to pain inhibition, and unpredictable anxiety-provoking threats, which may result in pain facilitation may have accounted for this discrepancy. According to this theory, an environment containing unpredictable, moderately aversive threats would be expected to enhance an individual's experience of pain. During the current study participants were unaware of the order of presentation of the aversive stimuli, meaning that they were unsure whether they would receive an acoustic or electrical stimulation alone, or both concurrently. Therefore, the unpredictability of the moderately aversive stimuli could have resulted in pain facilitation.

Hypothesis: Effects of Arousal on Pain Perception Following HFS

It was hypothesized that following HFS, arousal would lead to higher levels of sensitivity to harmful stimuli and more pronounced blink reflexes relative to baseline. This hypothesis was not supported. HFS had no impact on subjective ratings of pain or onset latencies relative to baseline. However, it did lead to a decrease in the amplitude of the protective blink reflex. As acoustic stimulation was associated with higher ratings of pain and more pronounced blink reflexes relative to conditions without acoustic stimulation across both the baseline, and post-HFS conditions, it is thought that a different mechanism than the one proposed mediates the association between arousal and heightened sensitivity to harmful stimuli.