# Modulation of Attentional Control in Sustained Pain

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# Abstract

# 1. Introduction

The present study investigates attentional control and its associated alpha EEG activity in a model of acute sustained cutaneous pain. Attentional control allows for the filtering of distracting or irrelevant stimuli in order to support goal directed behaviour. Current theories describe attentional control operating by both inhibiting distracting, but also by facilitating relevant information. The processes that achieve effective attentional control are strongly associated with Alpha activity in the human electroencephalogram (EEG). Oscillations between 8-13Hz are the most prominent activity in the human EEG (Bazanova & Vernon, 2014) and are consistently found to be modulated by sensory processing and attention more generally. Through the functional inhibition of specific input streams, it is thought that processes responsible for the ability to filter out distraction are indexed by alpha EEG activity. In this study, we explore whether attentional mechanisms and their associated EEG oscillatory activity.

## 1.1. Attentional Control

## Attentional control is important and allows individuals to maintain performance and focus on a given task in the face of multiple, possibly distracting stimuli. Attention tasks examine the ability to direct attention by presenting a target stimulus among distracting or irrelevant stimuli (e.g., REF). Improved performance is often reported through reduced reaction times and error rates when informative cues describe attributes of the upcoming target (e.g., spatial location or modality). This suggests that individuals can use top-down attentional control to facilitate the processing of an upcoming stimulus. Alongside this, attention can also be used to maintain goal-direct performance, through the inhibition of distracting, or irrelevant stimuli. Trials in which distractors are present often have increases in errors and slower RT compared to trials in which the target is presented alone (REF)Determining whether performance improvements when targets are cued and/or presented along are due to facilitation of targets, or inhibition of distractors is difficult (van Diepen et al., 2019). One such method that has progressed our understanding of the differences in these two components of attention is analysis of electroencephalography (EEG) data. 1.2. Alpha Oscillations

Oscillatory activity in the alpha band (8-12Hz) has been shown to control the flow of relevant and distracting information (for a review, see van Diepen et al., 2019). The modulation of alpha rhythms in response to voluntary attentional control provides some of the strongest evidence for separating attentional control into facilitation and inhibition. For example, when attention is directed to a particular visual field, alpha power is commonly found to decreased in the contralateral hemisphere and simultaneously increased in the ipsilateral hemisphere (Green & McDonald, 2010; Worden et al., 2000; Thut et al., 2006; Kelly et al., 2006; Handel et al., 2011; Capilla et al., 2014; Marshall et al., 2015). This modulation of alpha activity would suggest that the facilitation of information processing is reflected in decreases in actvitiy, while inhibition of information is reflected in increases to oscillatory power.

However, this is not simply constrained to the processing of visual information. For example, in cross-modal attention tasks alpha activity has been found to be decreased in visual areas associated with a target, while increased in areas associated with an auditory distractor (REF), and vice versa. In sum alpha activity is EEG is strongly related to the ability to both actively select targets, but also filter out distraction. This study will utilise a cross-modal cued target paradigm with a distraction to probe selective attention and the associated oscillatory activity. By separately presenting visual auditory stimuli as either targets or distractors we aim to show whether this

Therefore, this ability to focus on stimuli and inhibit distractors appears to be an overarching process, which in turn may influence more than simple sensory cues.

## 1.3. Theta and Cognitive Control

There is also strong evidence linking the ability to proactively

## 1.4. Present Study

We believe that the attention-related pattern of posterior cortical alpha reduction and its inverse correlation with frontal cortical theta activity reflects the electrophysiological signs of attentional control. Moreover, the absence of these oscillatory patterns reflects a disconnection between frontal cortical control and sensory processing systems. We suspect that in chronic pain, patients have a similar deficit in top-down attentional control, which could explain some of the cognitive deficits in patients, as well as contribute to the chronic pain symptomatology. **We therefore hypothesize that in healthy subjects, ongoing pain will cause a deficit in top-down attentional control reflected in a disconnection of frontal theta and posterior alpha oscillations.**

# References

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