The Role of Stimulus Amplitude and Frequency on Movement-related Tactile Attenuation*

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I. Introduction

Somatosensory events generated by our own actions are perceived as less intense than comparable events of external origin, a phenomenon known as tactile attenuation [1]. Attenuation stems from an internal model that predicts and down-regulates the sensory consequences of the movement [1]. When manually interacting with external stimuli through voluntary movements, the sensorimotor system also predicts the sensations associated with the stimulus; however, only when predictions associated with the self-generated sensations can be accurately estimated from the context [2]. Despite extensive work on the role of motor prediction on tactile attenuation [1], the influence of stimulus properties on the strength of attenuation is still unclear. While stimulus amplitude may provide information on surface roughness [3], stimulus frequency is used to extract spatial features of dynamic events (object contact or slip) [4]. In a psychophysical experiment, we investigated the role of stimulus amplitude and frequency of self-generated tactile events on tactile attenuation.

II. Methods

Twenty participants performed a tactile discrimination task involving two vibrotactile stimuli delivered to the distal phalange of the left index finger via a piezotactor (EAI_PTL_08, Engineering Acoustics, Casselberry, FL). There were three within-subject factors: *movement type* defined whether a movement had to be performed (rest or move); *amplitude* defined the standard stimulus amplitude as peak-to-peak displacement of the tactor (low=0.114 or high=0.133mm); *frequency* defined stimulus frequency of the standard and the comparison stimulus (40Hz or 250Hz). Each stimulus pair was repeated six times per condition. Participants received the first vibrotactile stimulus, that was generated by a movement of their right finger or while resting. Upon receiving the second stimulus while resting, they judged which stimulus was more intense (tactile discrimination task).

III. Results And Discussion

We compared the point-of-subjective equality (PSE) across conditions and found tactile attenuation for high amplitude stimuli ($p<.001$). This is in line with previous findings showing amplitude-dependent changes in the perception of self-generated auditory stimuli, in which high, but not low amplitude stimuli are attenuated [5]. Our results show no significant differences in tactile attenuation across the different frequencies ($p>.05$). Given that these frequencies are implicated in different touch experiences [4], it can be argued that humans can flexibly generate internal models for various stimulus frequencies when interacting with an external stimulus. Future studies should investigate potential reasons for the differential processing of amplitude and frequency during voluntary movements, i.e., conveying information on dynamic and static object properties. Understanding the role of peripheral feedback properties on attenuation potentially contributes to object manipulation tasks.

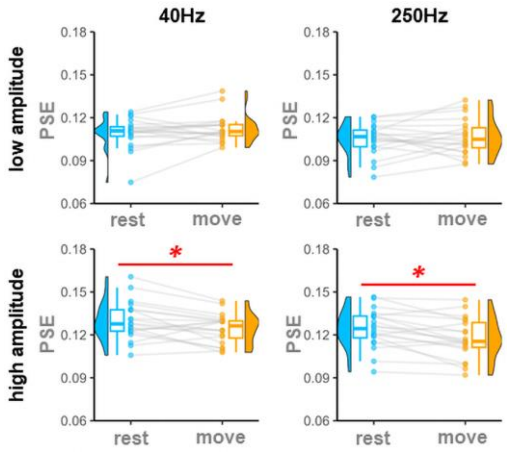

Figure 1. PSEs across conditions. Bold asterisks depict significant interaction of movement and amplitude. Dots show individual data points.

References

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