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Stroke me for longer this touch feels too short: The effect of pleasant touch on temporal perception

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ABSTRACT

Negative, painful, somatosensory stimulation lengthens the perceived duration of time. However, to date, no research has explored the influence of positive, pleasant, somatosensory stimulation on temporal perception. Here we asked whether gentle stroking touch influences perceptions of duration. Pleasant (gentle) and mildly unpleasant (rough) tactile stimulation was delivered whilst participants estimated the duration of a neutral visual stimulus. Pleasant touch resulted in shorter estimates of duration than unpleasant touch. There was no difference in duration perception in the unpleasant and control conditions. Taken together with the results of previous research (Ogden, Moore, Redfern, & McGlone, 2015), the results of this study suggest that pleasant and painful somatosensory stimulation have opposing effects on temporal perception, and additionally that pleasant touch can alter aspects of perceptual and attentional processing outside the purely affective domain.

1. Introduction

The ability to judge the passage of time in the range of seconds to minutes, termed interval timing, is a critical function that underlies a number of everyday behaviours such as crossing a road with oncoming traffic, or toasting bread under a grill (Wearden, 1999). Subjectively, the perceived duration of events can be distorted by the activities we perform and the concurrent emotions we experience. Research into the effects of emotion on time perception has mostly used visual or auditory stimuli as triggers, such as emotional facial expressions (Droit-Volet, Brunot, & Niedenthal, 2004), pictures (Angrilli, Cherubini, Pavese, & Manfredini, 1997) and sounds (Noulhiane, Mella, Samson, Ragot, & Pouthas, 2007). These are exteroceptive emotional triggers relating to stimuli that originate outside the body, but what is less understood is the effect of interoceptive stimuli on interval timing. Negative affective somatosensory stimulation (pain) has been shown to be effective in altering temporal perception (Hare, 1963; Ogden, Moore, Redfern, & McGlone, 2015), but to date no studies have explored whether positive somatosensory stimulation (pleasant touch) influences the perceived duration of time.

Pleasant touch is hypothesised to be coded by a system of recently identified unmyelinated peripheral nerves (the same class as nociceptors) called c-tactile afferents (CT) (McGlone, Wessberg, & Olausson, 2014). CT afferents are located around the vellus hair follicles found all over the hairy skin and are not present in glabrous skin (Vallbo, Olausson, & Wessberg, 1999). Maximal neural responding in these nerves occurs with tactile stimulation velocities of around 3 cm/s (Löken,

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Wessberg, Morrison, McGlone, & Olausson, 2009), which corresponds with the highest ratings of subjective pleasure to gentle touch (Essick et al., 2010). CTs project to the insular cortex (Olausson et al., 2002) and orbitofrontal cortex (Francis et al., 1999; Rolls et al., 2003) and they are purported to provide or support emotional, hormonal, and behavioural responses to skin-to-skin contact with conspecifics (Morrison, Loken, & Olausson, 2010). The insular cortex relays affective information to the frontal lobe (Craig, 2008) supporting the hypothesis that CTs code emotional rather than discriminative touch (Olausson et al., 2008). Stimulation, in a manner known to activate CT fibres (see Triscoli, Ackerley, & Sailer, 2014 for discussion), therefore offers a way to examine the effect of positive emotional touch on perceived duration, but we cannot rule out the contribution made by fast conducting myelinated touch nerves to the overall perception of touch.

The lengthening of perceived time with pain has been interpreted as a consequence of pain increasing arousal and amygdala activity, affecting the subsequent subcortical processing of duration (Gil & Droit-Volet, 2012). This results in increased output from the internal timing mechanism and a lengthening of subjective duration (Droit-Volet, 2013). An alternative explanation is that because both duration and self-representation are thought to be processed by the insular cortex (Craig, 2009; Wittman, 2009), concurrent activation of the insular cortex, both from temporal processing and self-representation, may distort perceived duration. The insular cortex continuously monitors homeostatic states, underpinning the neural processes involved in interoception by generating an "emotional moment in time" (Craig, 2002). It is therefore hypothesised that when timing a neutral stimulus, which does not evoke self-representation, anterior insular cortex activity may be limited to temporal processing and no distortion to time occurs. In contrast, when timing an interoceptive stimulus, such as the duration of a painful stimulus, the additional insular cortex activation produced by pain may lengthen perceived duration. Whilst this is theoretically plausible, it should be noted that it is yet to be confirmed empirically using neuroimaging.

Little is known about the way in which pleasant touch (i.e. that known to activate CT fibres i.e. low velocity/force) influences wider cognitive processing (Essick et al., 2010; Leonard, Talia Berkowitz, & Shusterman, 2014). Inferences can however be made about how perceived duration may be effected. Activation of the insular cortex (Olausson et al., 2002) and orbitofrontal cortex (Francis et al., 1999; Rolls et al., 2003) from touch known to stimulate CTs suggests that arousal may be increased, perhaps through an increase in positive affect. This may, therefore, lengthen perceived duration as with negative visual and auditory emotional triggers (Droit-Volet & Meck, 2007).

However, recent research exploring the effect of touch on delay-of-gratification in children suggests that the experience of friendly touch lengthens the amount of time that children are willing to wait to receive a reward (Leonard et al., 2014). The authors suggest that this is consistent with a touch-based distortion to time shortening the perceived wait-time i.e. children think that less time has passed than actually has and are therefore willing to wait for longer. Thus, pleasant touch may shorten perceived duration. This would be consistent with previous reports of shorter perceived durations for positively valenced visual stimuli than negatively valenced visual stimuli (for example Angrilli et al., 1997; Buetti & Lleras, 2012), and for positively valenced auditory stimuli than neutral stimuli (Droit-Volet, Ramos, Bueno, & Bigand, 2013). A shortening of perceived duration may be observed because attention capture by touch (Lloyd, Bolanowski, Howard, & McGlone, 1999) may reduce attention to time resulting in shorter, less accurate duration estimates (Zakay & Block, 1997).

1.1. The current study

The current study examined, for the first time, whether pleasant emotional tactile stimulation affects perceived duration. In doing so, it also offers one of the first examinations of whether stimulation known to activate CT afferents (amongst other myelinated afferents) can affect attentional and perceptual processing outside of a purely affective domain. Participants completed a verbal estimation of duration task whilst receiving pleasant, mildly unpleasant or no tactile stimulation (control). Of interest was the potential difference in duration estimates given whilst experiencing pleasant, unpleasant and no tactile stimulation. Based on the findings of Leonard et al. (2014) it was predicted that the experience of pleasant touch would result in shorter duration estimates than the experience of no touch or mildly unpleasant touch.

2. Method

2.1. Participants

Twenty Liverpool John Moores University female undergraduates participated (M_{age} 23.90 years, SD 5.37). A solely female sample was used to prevent gender differences in somatosensory perception affecting the findings (Fillingim, King, Ribeiro-Dasilva, Rahim-Williams, & Riley, 2009). All participants gave written consent. The experiment was approved by the Ethics Committee of Liverpool John Moores University and was conducted in accordance with the Declaration of Helsinki (2008).

2.2. Apparatus

2.2.1. Tactile stimulation

Throughout the experiment participants were seated comfortably in a dental chair, the height of which was adjusted to position their left volar forearm within reach of a rotary tactile stimulator (RTS), see Fig. 1. A vacuum bead bag was placed