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Review

Quantitative assessment of pleasant touch

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ABSTRACT

The hedonic attributes of tactile stimulation are important to one's quality of life, yet they have rarely been studied scientifically. The earliest experimental investigations suggested soft and smooth materials as pleasant, those that were stiff, rough, or coarse as unpleasant. More recent studies conducted by the authors and described herein obtained ratings of pleasantness of different textured materials stroked across the skin of multiple body sites at controlled velocities and forces of application. Statistically significant interactions between materials, sites, velocities, forces and subject sex attest to the complexity of the percept. Less pleasant percepts arose from stimuli that were rougher. However, the difficulty in making further general statements regarding hedonic touch raises questions as to whether the body surface can be mapped affectively in a meaningful manner with a single stimulus and indeed whether pleasantness-to-touch can be viewed as a unidimensional construct.

Contents

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1. Introduction

The hedonic attributes of tactile stimulation (e.g., pleasantness-to-touch) make an important contribution to one's quality of life (Beebe-Center, 1932). For example, pleasant (and unpleasant) touch forms a cornerstone of social, affiliative behavior in humans and other primates (Björnsdotter et al., 2000; Montagu, 1986), and is critical in physical and cognitive development (Diamond and Amso, 2008; Harlow, 1958). More prosaically, we encounter the touch of clothing against our bodies every day, and this contact influences the comfort of the garments we wear (Cardello et al., 2003). Yet despite the importance of affect derived from touch, there is relatively little published empirical research on this topic. This review summarizes the limited knowledge available, followed by presentation of a new empirical study which aims to bridge some of the many gaps in knowledge we identify in the review. The study makes use of a novel, custom-engineered tactile stimulation device, designed to allow the investigation of the affective components of touch in a highly controlled manner.

A distinction is made throughout this manuscript between 'affective' and 'discriminative' touch. In short, affective touch refers to the emotional response to tactile stimulation, with particular emphasis on the pleasantness of such contact. Discriminative touch refers to perceptual attributes apart from the hedonic aspects of touch, attributes that might, in principle be linked rather closely to quantifiable physical aspects of the stimulus (e.g., perceived and instrumental roughness, see Bergmann Tiest and Kappers, 2006).

1.1. Stimulus parameters and pleasantness

A wide variety of stimulus parameters may be altered to provide an infinite variety of tactile stimuli. For example, a stimulus can be moved across the skin with a particular velocity and indenting force (i.e., force exerted normal to the skin at the point of contact with the stimulus). Velocity and force may vary periodically, and the surface of the stimulus itself may be textured. These parameters, and more besides, have been investigated extensively for discriminative aspects of touch, particularly in terms of determining absolute sensitivity of the sense of touch. Thus threshold data are available for the detection of light touch (Kenshalo, 1986) and the detection of vibration against the skin (Fagius and Wahren, 1981; Kenshalo, 1986). More complex discriminations have also been investigated, such as the perceived path of linear stimulus movement over the skin (Essick et al., 2002). There are also data available concerning the rating of discriminative perceptual attributes of touch, such as the extensive investigations of the attribute of roughness by Susan Lederman and colleagues (Lederman, 1974, 1981, 1983; Lederman and Taylor, 1972). However, stimulus parameters have been investigated in a far more limited way for affective touch. Thus, what can be detected via the tactile sense is well established, and to a lesser extent knowledge is available concerning how suprathreshold stimuli feel in terms of discriminative attributes, but there is very little data pertaining to how pleasant or unpleasant such stimuli feel.

In the affective domain, albeit of primarily historical interest, is the work of D.R. Major, who in 1895 obtained ratings of the pleasantness of 51 different textured fabric materials from three experienced participants (Major, 1895). The participants actively manipulated each material between the thumb and index finger for 2 s, then selected one of seven response categories from 'very pleasant' to 'very unpleasant' to characterize the affective quality of the tactile experience. Materials that were soft and smooth were unanimously reported as pleasant; those that were stiff, rough, or coarse were reported as unpleasant. Similar work to that of Major was carried out by Ripin and Lazarsfeld (1937), who obtained hedonic responses to silk and rayon fabrics, by way of a preferential choice procedure. Participants were asked to choose which member of a pair of fabrics they preferred and to give reasons for their preference. Based on the results, Ripin and Lazarsfeld suggested that 'relaxing' stimulus properties were preferred. The term 'relaxing' covered a wide range of stimulus properties, notably including smoothness and softness, consistent with the results of Major (1895).

In both of these studies, the manner in which, and the velocity at which, the fingers contacted the materials were not controlled. Moreover, in neither study was the force of stimulus contact (e.g., light versus heavy touch) controlled, possibly impacting the tactile experience and its rating. It has been demonstrated that stimulus velocity is important in ratings of discriminative, suprathreshold perceptual attributes such as the traverse length of a stimulus over the skin (Whitsel et al., 1986). In contrast, some attributes, such as perceived roughness, appear affected little by exploration velocity (Lederman, 1974).

More recently, Essick et al. (1999) demonstrated that valid and reliable pleasantness ratings could be made of different fabric materials (velvet, cotton, and plastic mesh), and confirmed the importance of velocity (0.5, 5 and 50 cm s^{-1}) in judgments of tactile pleasantness. A computer-interfaced motor passively delivered a fabric material across the ventral forearm or side of the face, after which the participant provided a numerical estimate of pleasantness- or unpleasantness-to-touch, Significant differences in pleasantness were detected for the two sites tested, the fabric materials used as stimuli, and the velocity of motion. On average, percepts were more pleasant on the face than on the forearm. Velvet and cotton were more pleasant than the plastic mesh, particularly on the forearm. Percepts evoked by stimuli moving at the lower velocities (0.5 and 5 cm s^{-1}) were judged as more pleasant than those evoked at 50 cm s^{-1}, particularly on the face; however, velvet was more pleasant at 5 cm s^{-1} than at either 50 or 0.5 cm s^{-1}. Estimates of pleasantness correlated negatively with estimates of unpleasantness obtained for the same stimuli, attesting to their validity. Moreover, the participants (all of whom were female) were reasonably consistent in their ratings upon repeated delivery of the same stimuli. These stimulus-related findings were generally replicated by Cascio et al. (2008), as part of a clinical study investigating sensory perception in autism. As in Essick et al. (1999), a plastic mesh stimulus was rated as relatively unpleasant, and a cosmetic brush as particularly pleasant in both control and autistic participant groups.

Similar to velocity, the importance of indenting force is well established for supratheshold tactile perception. For example, the perceived roughness of grooved plates increases as they are explored with greater indenting force (Lederman, 1974). In an extension to the affective domain, Cascio et al. (2008) delivered stimuli at three approximate force levels, finding that the lightest force led to the greatest pleasantness ratings. Unfortunately, the precise force magnitudes were not reported, or tightly controlled. An interaction was identified, whereby the ratings of relatively pleasant stimuli were affected minimally by indenting force, whereas relatively unpleasant stimuli were judged less pleasant as they were delivered with greater force.

1.2. Friction, roughness and pleasantness

There exists convincing evidence that pleasant stimuli are those that feel smooth (i.e., not rough) to touch (Ekman et al., 1965; Verrillo et al., 1999; Zampini et al., 2003). Intuitively, one might expect greater frictional forces at the skin–stimulus interface to be perceived as greater roughness, and thus tactile stimulation that leads to greater friction to feel less pleasant. Indeed, early work