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Review article

Non-informative vision enhances tactile acuity: A systematic review and meta-analysis

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ABSTRACT

Background: Individual experimental data suggest that visual input during tactile stimulation enhances tactile appreciation – whether this finding is replicated across studies and across body sites is unknown.
Objective: To determine the available evidence as to whether non-informative vision of the body has an effect on tactile acuity.
Methods: Studies that assessed tactile acuity with vision of the body, compared to vision of a neutral object or vision occluded, were systematically identified and reviewed. Seven relevant electronic databases were searched from their inception to April 2014. Risk of bias was assessed using adapted criteria from the Cochrane Handbook. Effect sizes were calculated using mean differences in a random effects model.
Results: Ten studies were included. All were randomized, within subject, controlled trials published in English (total $n=232$ participants), with low to moderate risk of bias. Despite the diversity of protocols and outcome measures used, eight of the studies reported improvements in tactile acuity when vision of the relevant body part (predominantly the hand) was available. Meta-analysis revealed statistically significant findings from grating orientation tests ($p=0.002$, *SMD* 3.31, 95% CI 1.24–5.39), demonstrating a positive effect of vision of the body. No significant effect was found for other sensory tests or for other body parts, such as the back, and statistical heterogeneity was high.
Conclusions: This review provides confirmatory evidence for a visual enhancement effect for tactile acuity for body parts where vision has a plausible functional linkage – further studies are required to elaborate on the mechanisms for multi-modal processing of sensory stimuli.

Contents

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1. Introduction

Perception is now considered the result of multimodal processing, rather than a direct read-out of tactile input (Halligan et al., 1997). Indeed, there has been sufficient investigation of this possibility in fundamental studies to lead to the idea of a "visual enhancement of touch" (VET) effect (Kennett et al., 2001; Taylor-Clarke et al., 2004; Cardini et al., 2011). The mechanisms behind VET in humans are still largely unknown, but animal studies have uncovered neurons in parietal and frontal cortex that have tactile receptive fields on the hand, and corresponding visual receptive fields in the space immediately adjacent to those tactile receptive fields (Rizzolatti et al., 1997). There are some behavioral and neuroimaging data that imply that a functionally analogous system may exist in humans (Taylor-Clarke et al., 2004; Sereno and Huang, 2006). Serino and Haggard (2010, p. 233) reviewed the phenomenon of VET concluding: "The neural correlates of this effect may involve activation of multimodal brain areas representing the body, which results in a modulation of neural activity in primary somatosensory cortex."

This systematic review aimed to determine the current state of evidence as to whether non-informative vision of the body has an effect on tactile acuity in humans. Vision was defined as non-informative in that there was vision of the body part being stimulated or tested, but no vision of the tactile stimulus being given.

2. Methods

2.1. Systematic search strategy

The electronic databases CINAHL, EMBASE, MEDLINE, PEDro, SCOPUS, TRIP and Web of Science were searched from their inception to November 2014. The search was conducted in each database using the following terms: "touch* OR tactile AND vision OR look* OR watch*" (Boolean operator * adapted as necessary for each database). Each search was restricted to the English language with no other publication restrictions imposed and participant type was limited to a healthy population of adults ($\geq$ 18 years). The intervention of interest was the use of vision during tactile acuity testing as compared to vision of a neutral object or occluded vision, with tactile acuity as the primary outcome.

Titles of the initial search were screened by one reviewer. Eligibility assessment of the abstracts of remaining studies was then undertaken independently by two reviewers, with studies progressed through this selection process using a yes/no/maybe format. Full-text papers were then assessed by both reviewers. Any disagreements between reviewers were to be resolved through discussion. Reference lists of included papers were also searched.

2.2. Critical appraisal

Methodological quality of the included studies was assessed for risk of bias based on an adaptation of the criteria recommended in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins et al., 2011). Risk of bias (also known as critical appraisal) offers a structured and repeatable method to evaluate the level of threat to the internal validity of included studies—a low risk of bias is interpreted as evidence that the results of the study are highly credible and unlikely to be confounded by poor study methods. Five criteria were established: randomising/counterbalancing, blinding, selective reporting, ethical considerations and sampling. Both reviewers independently assessed individual studies for risk of bias and then compared results, using three levels: low (yes, met criterion), potential (unclear if met criterion) or high risk of bias (no, did not meet criterion). Discrepancies were discussed and resolved by consensus.

2.3. Data extraction and analysis

A data extraction sheet was developed by both reviewers for details of study design, participant characteristics, intervention and comparison, and outcome measures. Where studies were sufficiently homogenous, meta-analyses would be performed; if this was not possible a descriptive synthesis of study results would then be undertaken. The primary measure of effect for both meta-analyses was the difference in means and standard deviations for the outcome of tactile acuity, using random effects to accommodate study heterogeneity (RevMan v5.2).

3. Results

3.1. Study selection

Ten studies were included in this review. The initial database search resulted in 432 citations. One reviewer then excluded 401 citations based on title and abstract. Thirty-one full text studies were assessed by both reviewers, resulting in exclusion of a further 25 studies. At this stage, six studies that assessed the effect of non-informative vision of the body vs. vision of a neutral object or vision occluded on tactile acuity were included. Subsequent pearling of the reference lists of these included papers yielded four additional studies, which were then assessed by both reviewers and included. Details of inclusion/exclusion criteria at each stage of the systematic review are detailed in Table 1. A flow diagram of

Table 1
Inclusion/exclusion criteria for each stage.

Assessment stage	Inclusion criteria	Exclusion criteria
Titles	Adults ($\geq$ 18 years)	Children ($<$ 18 years)
	Healthy population	Patient population
	English language	Non-English language papers
Abstracts	Undertook tactile sensory testing with a visual aspect	No visual aspect to sensory testing
	Outcome measure of tactile acuity	Tactile acuity not assessed (e.g. assessed a different sensory modality)
Full-text	Conditions of vision of the body, vs. vision occluded or vision of object	Illusion or reflected images of the body during tactile sensory testing