Measuring Point Localization Errors in Spatiotemporal Tactile Stimulus Patterns

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Abstract. In saltation, a tactile illusion, the subjective localization of a first stimulus is altered by a second one at a different site depending on its delay. The stimulus onset interval (SOA) and the amount of displacement are negatively correlated. In this study tactile point localization errors in the course of a saltation experiment were measured with 3D trackers (Polhemus Isotrak II and Fastrak). In experiment 1 we applied saltation patterns to the forearm. Beside the expected saltation effect our data show a constant distortion of the perceived body map. Spatial perception of stimuli was affected by their distance to the elbow. In experiment 2 we chose the abdomen as stimulus site, assuming that it is to a lesser extent influenced by anatomical landmarks. As in experiment 1, SOA affected the displacement of the successive stimuli. Contrary to experiment 1, no constant distortion of the perceived stimulated area occurred.

1 Introduction

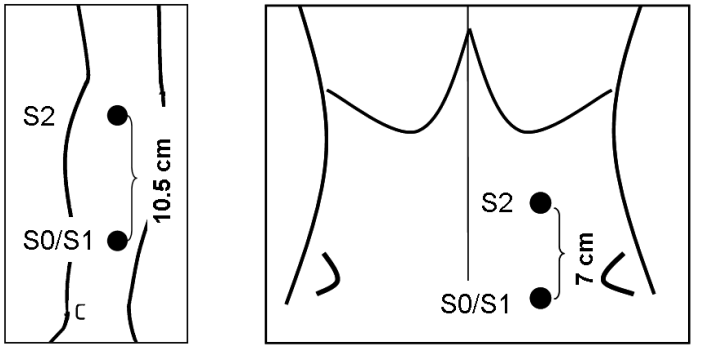
In sensory saltation [2], a tactile stimulus, followed by a second one closely in time, is perceptually displaced depending on the stimulus onset interval (SOA). The SOA and the amount of displacement are negatively correlated. This phenomenon has been investigated at different stimulus sites [3]. In the present study we focus for the first time on measuring the perceived displacement of the whole stimulus pattern on the body map. This gives us information about how spatiotemporal patterns are integrated in this map. The spatial perception of stimuli is affected by their distance to anatomical landmarks such as joints [1, 4]. Therefore we assumed that presenting saltation patterns on the forearm near the elbow should result in a constant distortion towards the elbow, whereas on the abdomen no such distortion should occur because of presumably less anatomical landmarks. Point localization errors were measured with 3D trackers (Polhemus Isotrak II and Fastrak).

2 Experiments

2.1 Method of Experiment 1

33 healthy subjects were examined. The pneumatically driven tactors were applied on the subjects' left forearm. The first tactor was placed 8 cm apart from

the wrist in proximal direction and the second tactor 10.5 cm apart from the first one towards the elbow (see Fig. 1a). The saltation patterns consisted of three stimuli (S0, S1, S2). Each single stimulus was a rectangular pressure pulse of 20 ms duration. S0 served as a warning stimulus. After a constant SOA of 1020 ms, S1 was presented at the same site. S1 was followed by S2 in a spatial distance d[phys] of 10.5 cm. The SOA between S1 and S2 varied in the range of 0–1020 ms.



a Arrangement of tactors in experiment 1.

b Arrangement of tactors in Experiment 2.

Fig. 1. Arrangements of tactors. a) In experiment 1 the two tactors were placed on the left forearm. b) In experiment 2 the two tactors were applied in vertical arrangement on the left side of the subjects' abdomen

2.2 Method of Experiment 2

29 healthy subjects were examined. The tactors were applied in a vertical arrangement to the left side of the subjects' abdomen (see Fig. 1b). One tactor was placed near the spina iliaca anterior superior, the other one in a distance of 7 cm near the costal arch. The saltation patterns consisted of three vibrating stimuli (S0, S1, S2) of 40 ms duration. S0 served as a warning stimulus. After a constant SOA of 700 ms, S1 was presented at the same site followed by S2 in a spatial distance d[phys] of 7 cm. The SOA between S1 and S2 varied in the range of 57–500 ms.

2.3 Results and Discussion

In both experiments a saltation effect could be elicited (see Fig. 2). The amount of displacement of S1 towards S2 increased with smaller SOAs (linear mixed model: exp. 1: $F = 412.05$; $p < 0.0001$; exp. 2: $F = 288.77$; $p < 0.0001$). Because of