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Spatial Localization for Transient and Intransient Tactile Stimulus

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Abstract - When the hand is stimulated during hand movements, humans can localize the stimulated position even without visual guidance. This is because the sensorimotor system integrates internal information of the hand's locat ion and perceived temporal information of the stimulus. It is reported that when *transient* (6 ms) tactile stimulation was presented before, during or after hand movements, the stimulus was systematically mislocalized [1]. The mislocalization was interpreted as a result of mismatch between internal information and the physical location of the hand. However, typical environments exhibit a high degree of spatiotemporal coherence, and a different spatial localization strategy may be more adaptive to the continuous case. Here, we examine the time courses of localization for both *transient* and *intransient* vibration stimuli, to gain further insight into the spatial localization mechanism of the hand.

Keywords: *Hand movement, Spatial localization, Somatosensory system, Internal spatial representation*

Experiment

Apparatus & Procedure:

Three naive male subjects participated in three experiments. A small vibration motor was mounted on the forefinger of each subject's right hand for delivering vibration. The subject closed his eyes and made a rapid horizontal hand movement along the aluminum bar, as shown in Fig. 1.

Figure 2 describes the experimental time chart. At the beginning of each trial, each subject was cued by an audio signal to make an immediate hand movement. The latency and duration of the hand movement were about 200 and 400 ms, respectively. In Exp. 1, a *transient* vibration (duration 20 ms, frequency 130 Hz) was presented at a random time from 50 ms to 700 ms after the audio signal. This timing ranged from about 150 ms before to about 500 ms after the onset of the hand movement. The subject was asked to indicate the perceived location of the vibration by his forefinger. The position of the subject's forefinger was measured by a laser sensor (Keyence Corp. LK-500).

In Exp. 2 and 3, the same procedure was performed except for the duration of the vibration. An *intransient* vibration (duration 300 ms) was presented, instead of 20 ms. The subject was asked to indicate the perceived starting position of the vibration in Exp. 2 and, the ending position in Exp. 3

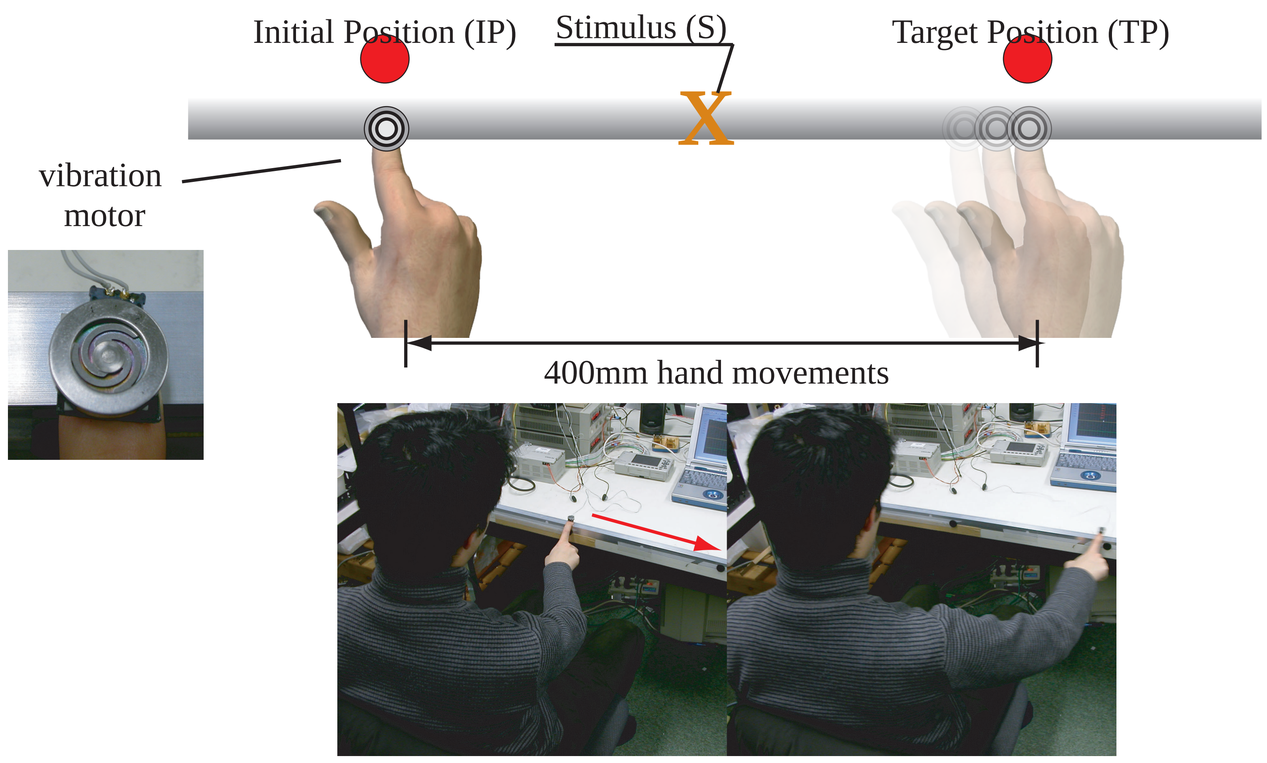

Fig. 1 Spatial arrangement of experiments

Result:

Perceived positions for the *transient* vibration in Exp. 1 are shown in Fig. 3. The horizontal axis represents the temporal difference between the vibration time and the hand movement onset time. The vertical axis represents the localization error of the indicated position for the physically presented position of the vibration (the distance between the indicated position minus the presented position from IP). When the subject moves his hand from Left to Right, a positive value indicates the vibration is localized in the hand movement direction, while a negative value indicates the mislocalization is in the opposite direction. When the subject moves his hand from Right to Left, a positive value indicates the vibration is localized in the opposite hand movement direction. Blue (Red) dots are the perceived positions when the right hand moves from Left to Right (from Right to Left). Blue dots have positive values, and Red dots have negative values in the period from -100ms to 400 ms. These data suggest that the vibration is mislocalized during hand movement in the same direction as the hand movement, despite the direction of the movement.

Perceived positions for *intransient* (300 ms) vibration in Exp. 2 & 3 are shown in Fig. 4. Blue (Red) dots indicate perceived positions of the Start Position (End Position) of the vibration. If the Start and End Positions of 300 ms vibration are localized in the same way as the 20ms *transient* vibration, time courses of both perceived positions should coincide with the time course for the *transient* vibration. Although a similar tendency was observed in the time course for the Start Position, the time course for the End Position is clearly different [2].

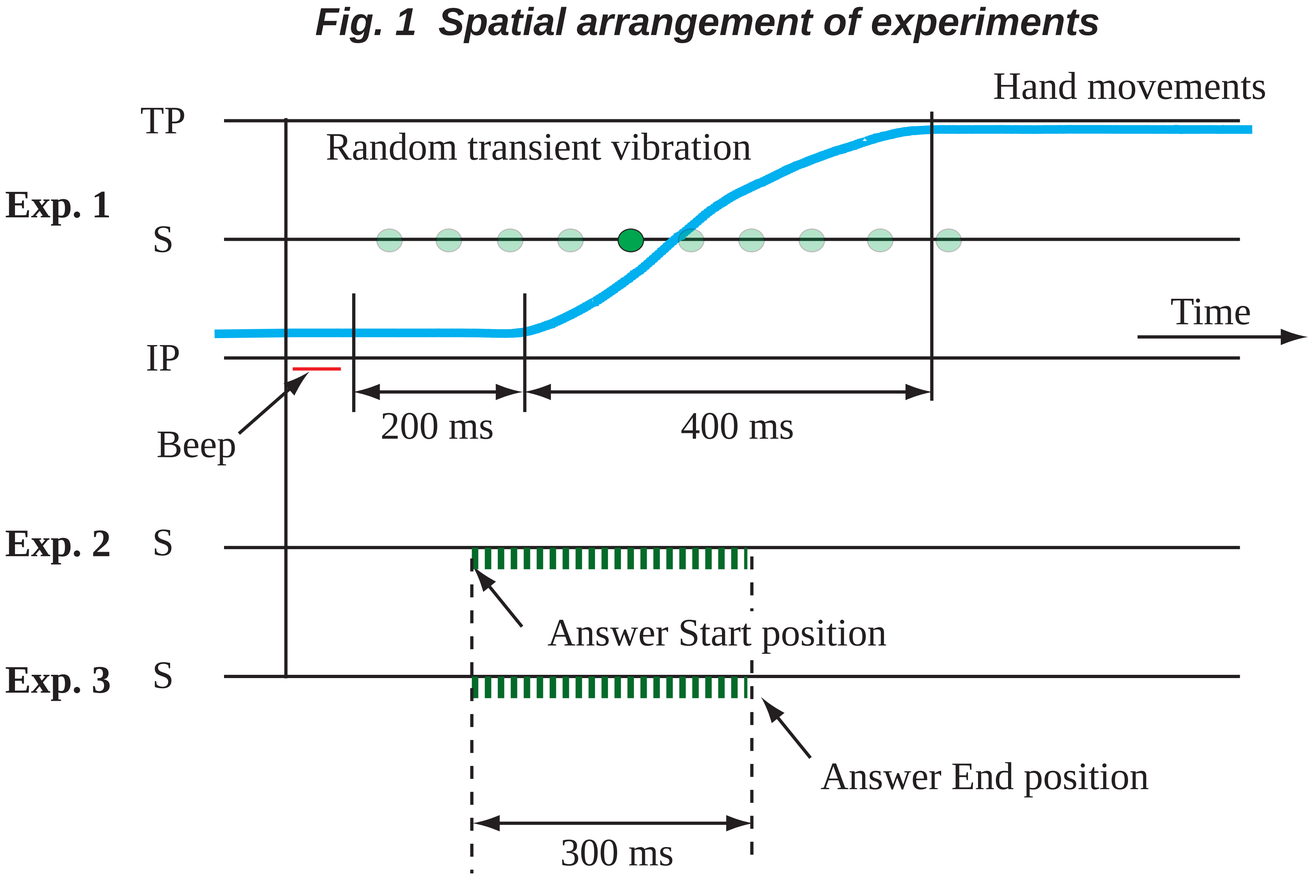

Fig. 2 Time chart of Exp.1, 2 and 3

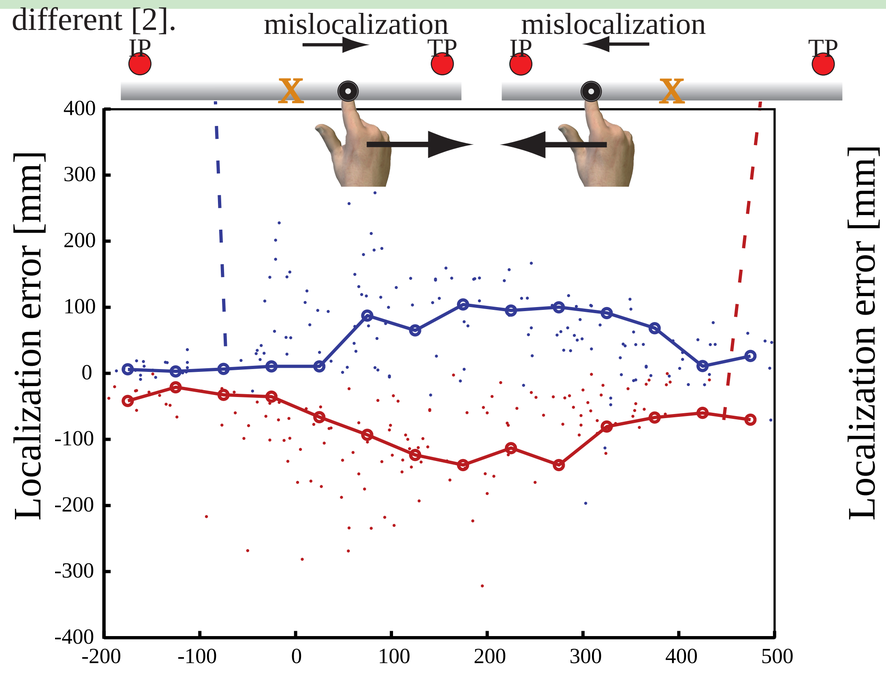

Fig. 3 Results of Experiment 1

Blue dots are obtained data when hand moved fromt Left to Right, and Red dots are when Right to Left. Circles mean the averaged value of the data in each 50 ms interval.

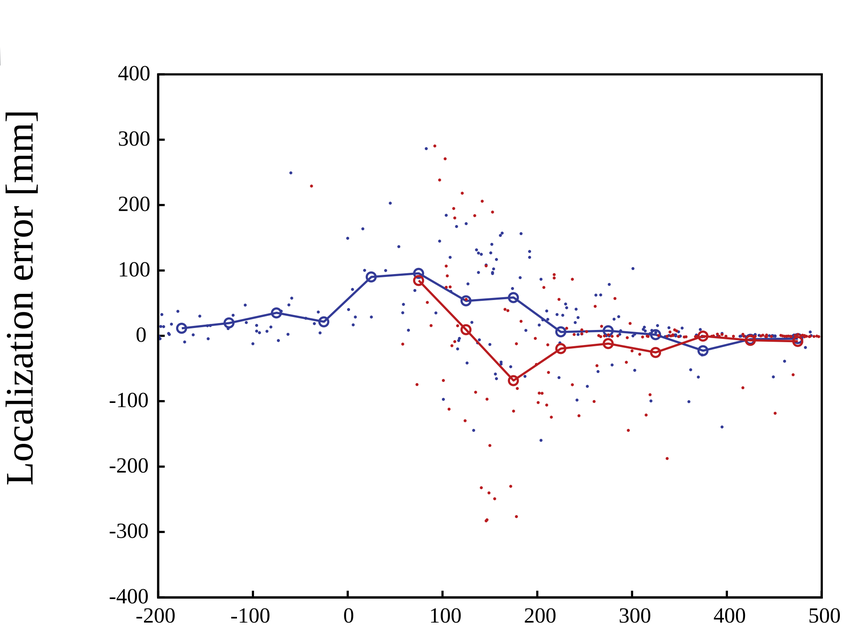

Fig. 4 Results of Experiment 2 & 3

Blue dots: subjects answered Start Position
Red dots: subjects answered End Position

Conclusion

Spatial localization of an *intransient* (300 ms) vibration shows a different trend, depending on which position is localized (stimulus Starts or Ends). The conventional localization theory, which assumes integration of internal hand position information and perceived vibration timing, cannot explain the difference between the Start and End Positions. As a reason of this difference, the temporal information of the End Position may be misjudged, or observations made with *transient* stimuli may not necessarily indicate inaccuracy of the internal information, as shown in several lines of visual perception studies [3].

References

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