Masking and temporal integration with a multi-finger tactual display

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Recently, a multi-finger tactual display (the Tactuator) was developed to provide stimulation along a continuum from kinesthetic movements to cutaneous vibrations. The display is capable of delivering arbitrary waveforms to three digits (thumb, index, and middle finger) within an amplitude range from absolute threshold to about 50 dB sensation level, and a frequency range from DC to above 300 Hz.

The information transmission capabilities with the Tactuator were assessed through a series of absolute identification experiments with human observers. It was found that subjects could naturally categorize motions over the entire frequency range into three perceptually distinctive groups: slow motion (e.g., 4 Hz), a rough sensation (e.g., 30 Hz), and smooth vibration (e.g., 300 Hz). Multi-component stimuli were formed by simultaneously stimulating multilple fingers with waveforms containing sinusoids (varying in both frequency and amplitude) from the three frequency regions. Stimulation was applied either to one of the three digits or to all three digits simultaneously. For signal durations ranging ranging from 125 to 500 msec, static information transfer was estimated at roughly 5.6 to 6.5 bits and dynamic information transfer (based on experiments where the stimulus to be identified was preceded and followed by randomly selcted signals from the stimulus set) at roughly 12 bits/sec.

The current study was designed to investigate further the effects of various types of masking on the identification of multidimensional signals presented through the Tactuator. Specifically, the goals of the current study are (1) to measure the effects of motional, rough, and vibrational signals using typical forward- and backward-masking paradigms, (2) to invetigate the temporal integration properties of the signals employed in the stimulus set (e.g. a rough signal followed by a vibration may be perceived as a combination of the two), and (3) to establish the relationship between performance with simple masking paradigms and that with the identification paradigm used for estimating information-transfer rate in the previous study.

The current experiments were carried out using a set of seven signals at two different durations (125 or 250 msec) presented to the index finger of the left hand. In the forward- and backward-masking paradigms, subjects were presented with two signals (separated by interstimulus intervals - ISI - which varied from 0 to 640 msec) and asked to identify either the second signal (in the forward-masking conditions) or the first signal (in the backward-masking conditions). In a third paradigm, subjects were presented with three successive stimuli (again using interstimulus intervals in the range of 0 to 320 msec) and asked to identify the middle signal. Results are

summarized in terms of percent-correct scores as a function of ISI and signal duration. In addition, error trials are analyzed to gain insight into the masking process.

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