# Common Onset Masking of Vibrotactile Stimuli

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## Abstract

Two different forms of vibrotactile masking were explored:

- **Backwards (BW)**
- **Common Onset (CO)**

We used a two-channel setup, presenting stimuli to the middle and ring finger of the participants' right hand.

250-Hz sinusoidal stimuli were displayed in various combinations of duration (30 & 300 ms) and stimulus onset asynchrony (0 & 30 ms).

Our results indicate the existence of a statistically significant masking effect for both forms of haptic masking explored, with a larger effect observed for common-onset.

An analysis of levels of confidence in response (rated at 70%) shows no difference amongst two successful masking techniques.

## Stimulus Masking and Why it Matters

A perceivable stimulus is said to be **masked** when interference from a different stimulus prevents the recipient from identifying or localizing it.

### Two Types of Masking

**Central Masking:**

- *Main focus of our study*
- The masked stimulus reaches high levels of cognitive processing, but is prevented from reaching conscious perception
- Occurs in **Backward and Common-Onset Masking** and is attributed to interruption of the perceptual process

**Peripheral Masking:**

- Masked stimulus is blocked from perception at a low level
- Occurs in **Forward Masking** and is sometimes attributed to temporal integration

### Relevance to Haptic Design

Understanding masking for the haptic sense is important for user interface design from at least two perspectives:

- **Avoid inadvertent masking** when maximizing tactile transfer of information with stimuli that are closely spaced temporally
- **Explicitly mask** perceivable information-bearing tactile stimuli so the recipient can utilize them at a nonattentional level

## The Experiment

### Participants

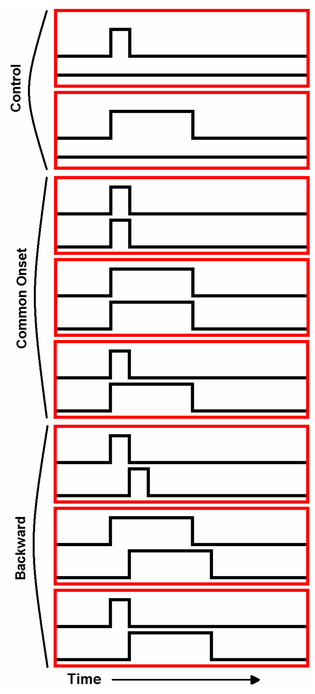
- Participants: 5 female / 6 male, aged 22-27

### Stimulus Set

- 14 stimuli with identical amplitudes and a frequency of 250 Hz (skin's peak sensitivity), chosen for conservativity
- Stimuli duration either short (30 or 50 ms) or long (150 or 300 ms)
- Variable SOA (0 or 30 ms)
- 10 repetitions from 11 subjects

### Experiment Task

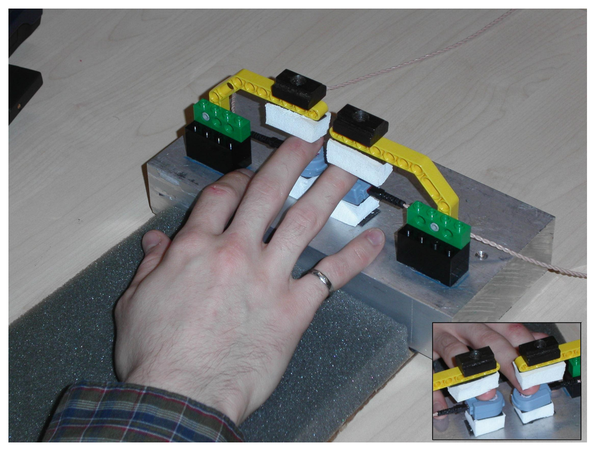
- Participants asked to report presence of stimuli on left, right or both fingers




## Hardware Setup

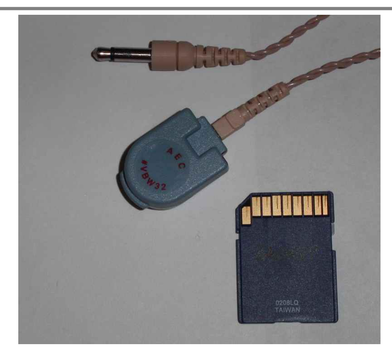
### Experiment Setup

- Two transducers mounted on aluminum plate using latex foam rubber for mechanical isolation
- Participant's hand rested on a foam pad
- Fingers held with a constant pressure against the transducers

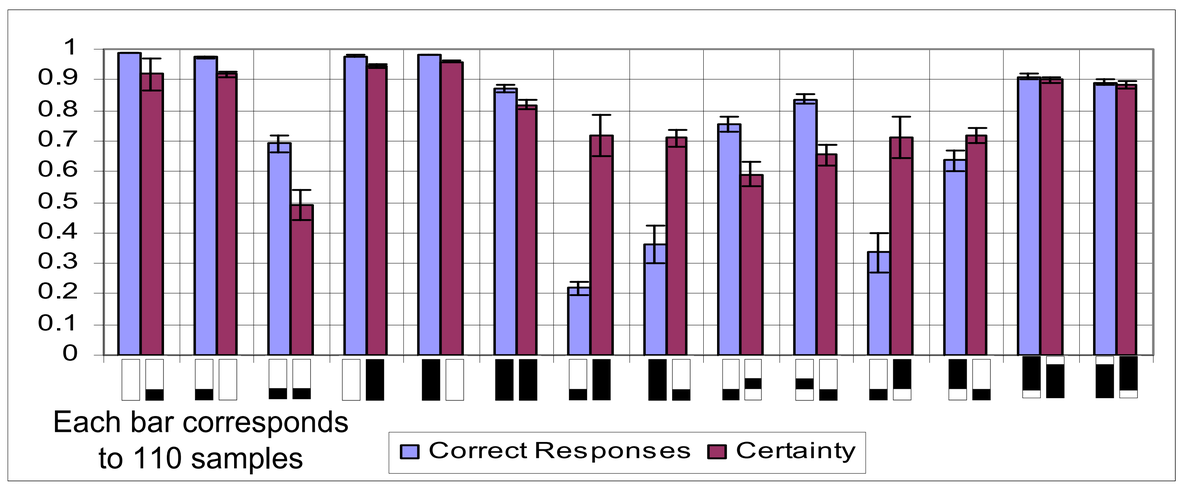


### Transducers

- Audiological Engineering model VBW32 skin transducer
- Voice coil produces precisely timed waveforms
- Independent control over both frequency and amplitude



## Results




**Performance**

- CO produced greatest masking, followed by BW
- 99.98% of incorrect responses involved responding with the mask rather than the target

**Confidence**

- Confidence similar for CO and BW masking, but lower than for the unmasked control trials
- Lowest confidence for simultaneous presentation of two short signals to both fingers

## Implications → New Questions Raised

The design of haptic interfaces using **simultaneous presentation** of stimuli should take these masking effects into consideration to ascertain that information **is not being masked inadvertently**.

Why does common-onset masking show the strongest masking effect among the set of masking paradigms we tested?

- We hypothesize that a brief delay between the presentation of two signals (on two fingers) increases the detection rate over simultaneous presentation, due to an induced sense of motion.
- Although further experimentation is required to confirm this, the phenomenon could allow designers to elicit more salient sensations by presenting a carefully timed series of milder stimuli.

**Notice:** This poster is associated with a Hands-On Demo