

Revision History

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Perception and evaluation of Haptic Stimulation generated by a New Actuator - 'Haptic Bar'

Introduction

This experiment is a first attempt to investigate systematically the perception of tactile feedback provided by a new haptic device called 'haptic bar'. In the device a rotating screw thread metal bar is used to provide friction based tactile sensations, for example, to fingertips. By varying three parameters of the bar, i.e. 1) rotation duration, 2) rotation direction, and 3) pauses between rotations, it is possible to create diverse haptic stimuli (see Figure 1). In haptic interfaces these kinds of identifiable stimuli can be used, for example, as icons in order to present information packed into a small and economical size.

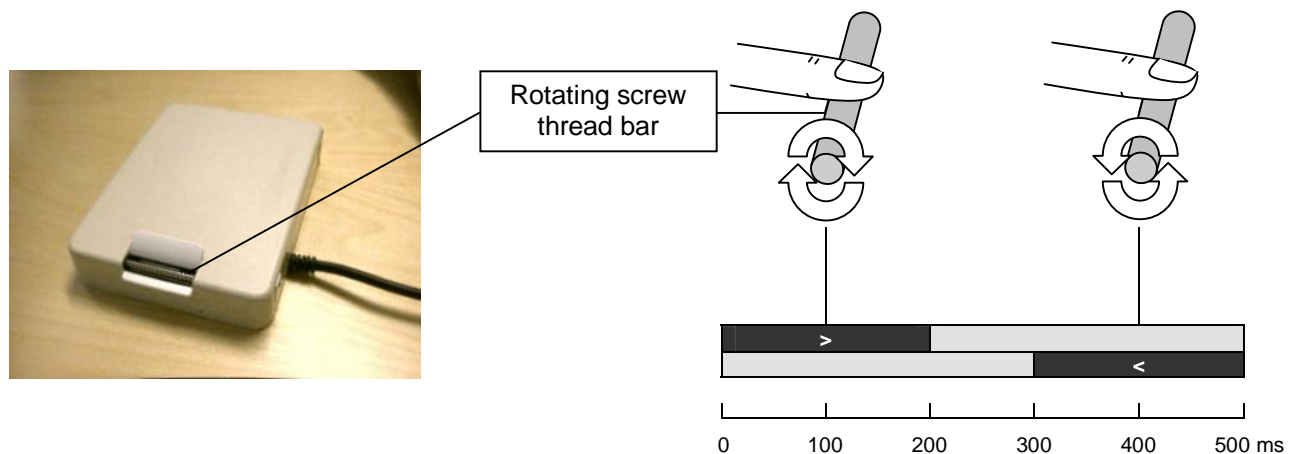


Figure 1: An example of a stimulus where the bar is rotating 200 ms forward, pauses for 100 ms and rotates backwards for 200 ms.

The aim of the experiment is to study how accurately and how fast it is possible to distinguish different haptic stimuli provided by the new device. Another goal is to measure emotionally related reactions to the stimuli. This is done by measuring facial electromyographic (EMG) responses evoked by the stimuli. Spontaneous electromyographic activation of two facial muscles, i.e., *corrugator supercilii* and *zygomaticus major* are recorded during the experiment. The former muscle is activated while frowning (e.g., during anger or annoyance) and the latter muscle is activated while smiling. In addition to that, subjects are requested to indicate emotion related responses and action tendencies (i.e. pleasantness, arousal, dominance, and approach-withdrawal tendency) evoked by the stimuli in a post-experimental questionnaire.

Stimuli

A total of twelve stimuli of a length of an average of 500 ms were created in an informal pilot testing (see Figure 2).

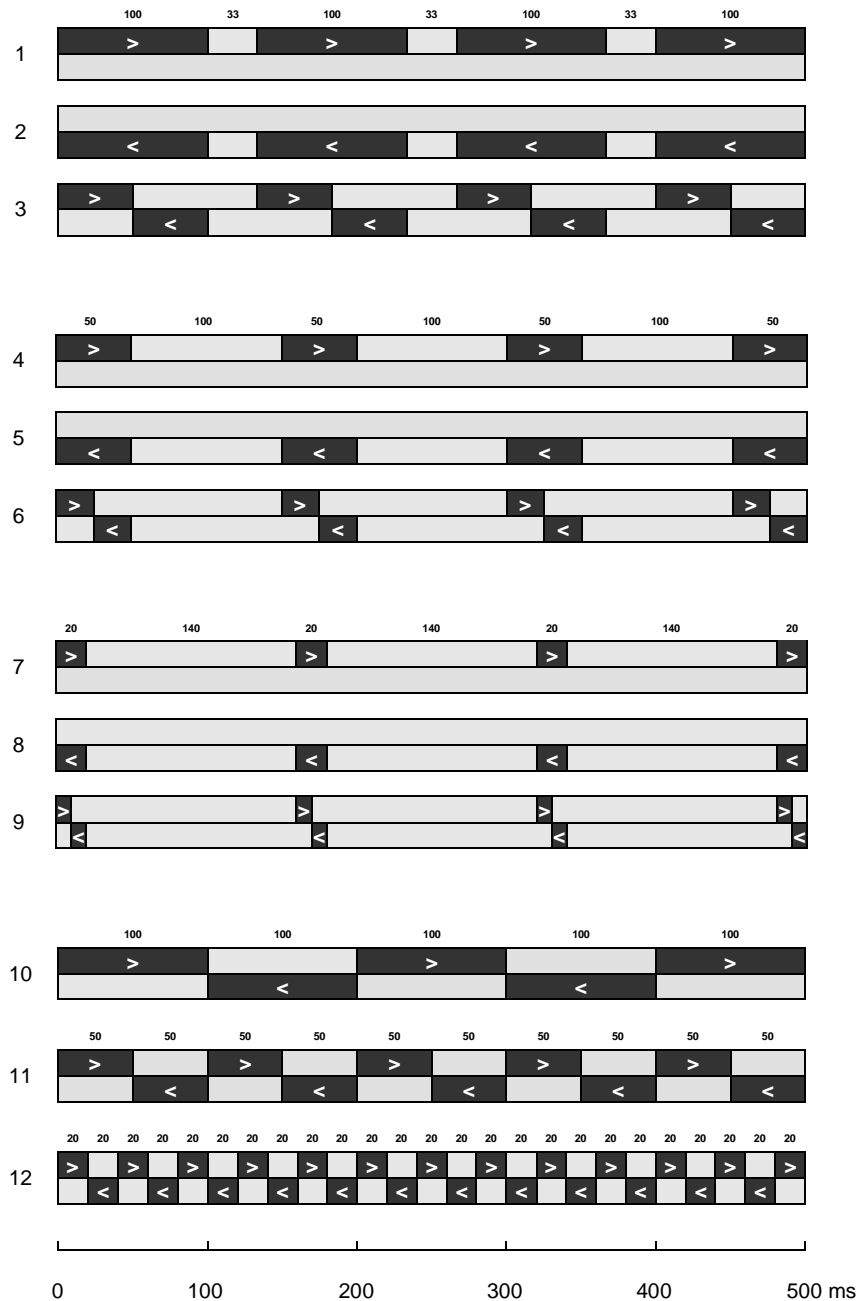


Figure 2: Patterns of the stimuli used in the experiment. Bar above the horizontal axis [>] represents forward rotation and bar below the axis [<] describes backward rotation.

Discontinuous stimuli:

Stimuli 1-9 consist of four bursts which are varied by rotation duration (100 ms / 50 ms / 20 ms) and rotation direction (forward / backward). The length of the pauses between the bursts is also varied (33 ms / 100 ms / 140 ms). The rotation direction of the burst is forward in stimuli 1, 4, and 7 and backward in stimuli 2, 5, and 8. In stimuli 3, 6, and 9 the rotating direction changes from forward to backward during a burst.

Continuous stimuli:

In stimuli 10, 11, and 12 the rotating direction is changing from forward to backward in turns, and there are no pauses between the rotations.

Experiment

All possible combinations of the twelve stimuli are used to form stimulus pairs. 132 of the pairs consist of two different stimuli and 12 pairs consist of same stimuli. The proportion of the same pairs is weighted so that there are 132 same pair trials as well. A total of 264 stimulus pairs are presented in randomised order to the subject. A forced choice design is used in giving the response. In each trial two stimuli separated by 1000 ms inter stimulus interval (ISI) are presented to the tip of subject's non-dominant hand index finger. Subject's task is to decide as quickly as possible whether the presented stimuli were the same or different by pushing either "same" or "different" labelled button in the response box with their dominant hand's index finger. The order of the response buttons is counter balanced between the subjects. In order to block the noise of the stimuli the subjects are listening pink noise with hearing protector headset. Spontaneous electromyographic activation of facial muscles is recorded during the experiment with NeuroScan SynAmps² system. Subjects perform two 264 stimulus blocks with short resting period between the blocks.