Auditory redundancy gain

Hannes Schröter, Rolf Ulrich, and Jeff Miller
hannes.schroeter@uni-tuebingen.de

Eberhard Karls Universität Tübingen
Cognitive and Biological Psychology
University of Otago
Department of Psychology

Introduction

When participants are required to respond as quickly as possible to the onset of any stimulus, they usually respond faster when two stimuli are presented than when only one stimulus is presented. This gain in RT has been termed the redundant signals effect (RSE). Miller (1982) showed that the RSE often violates the race model inequality (RMI) and hence cannot be explained by mere statistical facilitation. Therefore, coactivation processes seem to facilitate information processing in the redundant condition.

A number of studies report evidence for redundancy gains and coactivation in both unimodal visual and bimodal experiments. However, there are no studies that have assessed potential coactivation processes within the auditory modality. As two dichotically presented stimuli can fuse into a single percept, redundancy gains within the auditory modality may depend crucially on whether the redundant stimuli fuse into a single percept or not.

Method

Experiments 1 and 2 used a simple RT task and consisted of 300 trials. In each experiment, 20 participants were asked to make a key-press as soon as they detected an auditory stimulus, irrespective of its identity and location. In Experiment 1, pure tones of different frequencies (500, 700-Hz) stimulated the left and the right ears via headphones. In Experiment 2, the 700-Hz tone was replaced by white noise. The probability of presenting a stimulus was .6 for each ear. The assignment of stimulus to ear and the response hand were counterbalanced across participants.

Experiment 3 used an 2-AFC localization task with no restriction of RT. Twelve participants were asked to localize the 500-Hz tone, the 700-Hz tone, and the white noise in separate blocks of trials. In each trial, the relevant stimulus was presented randomly to one ear and one of the two other stimuli was presented concurrently to the other ear.

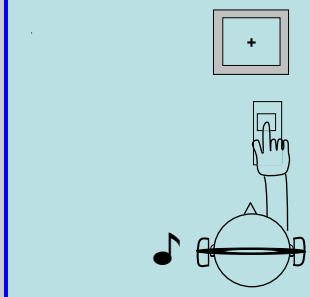
Results

In Experiment 1, RT did not differ between the redundant condition and the faster single stimulus condition, $t(19)=0.75$, $p>.05$. There was no violation of the RMI which was assessed using the algorithm of Ulrich, Miller, and Schröter (in press).

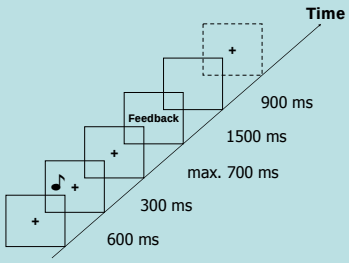
In Experiment 2, however, RT was 22 ms shorter in the redundant than in the faster single stimulus condition, $t(19)=6.43$, $p<.001$. Furthermore, the RMI was violated at the 15th ($p<.05$) and the 25th percentile ($p=.055$).

In Experiment 3, localization performance was just above chance level in the Tone+Tone condition (61% correct, RT: 1,006 ms). Participants, however, were almost perfect in localizing the relevant stimulus in the Tone+Noise condition (95% correct, RT: 601 ms). This difference was significant both for localization performance, $t(11)=9.43$, $p<.001$, and RT, $t(11)=4.71$, $p<.01$.

Experiment 1 and 2: Simple RT-Task

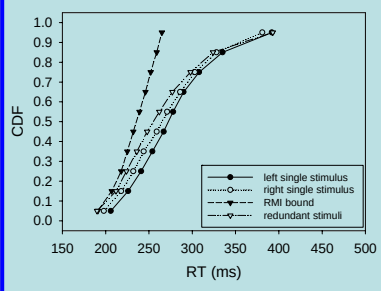


Trial Scheme



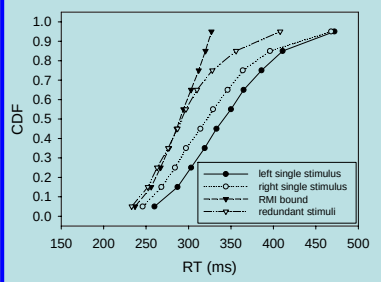
Experiment 1: Design

Experiment 1: Results

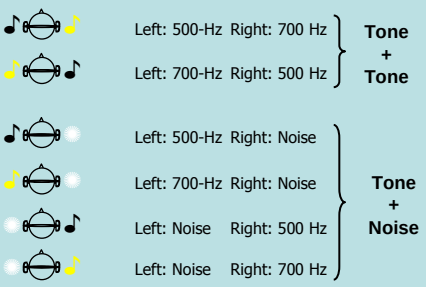


Experiment 2: Design

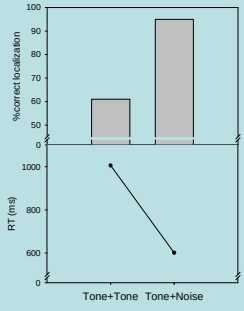
Experiment 2: Results



Experiment 3: 2-AFC Localization Task



Experiment 3: Results



Discussion

The observation of an RSE in Experiment 2 provides further evidence that redundancy gains are a very general phenomenon. Furthermore, the violation of the RMI suggests that responses in the redundant condition seem to be triggered by the combined activation of the two stimuli. As no RSE was observed in Experiment 1, its results suggest that a single percept was formed by the two pure tones when presented concurrently. This conclusion is strongly supported by the near-chance discrimination performance in the Tone+Tone condition in Experiment 3.

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References

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