Crossmodal attention influences auditory contrast sensitivity

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BACKGROUND

Attending to a visual stimulus has been found to increase perceived contrast and has been shown to alter the auditory contrast response function via a mechanism of increasing contrast gain, as found for sustained visual attention, or via a combination of response gain and contrast gain, as found for transient visual attention (see Carrasco 2006 for a review). It is unclear whether or not attention can alter the sensitivity to auditory contrast via attentional mechanisms found to be important for visual processing.

Here we investigate

(1) How auditory contrast sensitivity varies with attention and how such attention effects compare to the effects of visual attention on visual contrast

(2) How crossmodal attention effects auditory processing: how varying the difficulty of a competing visual task (attentional load) alter auditory performance

(3) How practice, time on task, crossmodal attention effects

METHODS

To determine if varying attentional load can influence the detectability of an auditory stimulus, we used a two interval forced choice paradigm (2IFC) to obtain auditory contrast detection thresholds under two different attention conditions. We varied attention load across blocks of trials by varying the difficulty of a simultaneous visual task. Either the visual task was less demanding or more demanding.

Subjects completed 10 blocks (1125 trials) of each of two attention conditions demanding or more demanding.

Subjects completed 10 blocks (1125 trials) of each of two attention conditions over several days, within a 2 week window. Each session lasted between 1-2 hours.

Stimuli

Auditory stimuli: a white noise were presented binaurally on headphones in two intervals, only one of which had a sinusoidally amplitude modulated sound. The frequency range was 500-2000Hz. The ISI time was 100ms.

Visual stimuli: a series of stimuli were presented simultaneously in an interval on one ear and had to be ignored in the other ear.

Analysis

Auditory contrast threshold was computed as the ratio of the threshold for each condition with a reference condition.

Amplitude Modulation Frequency 1Hz

The mean auditory threshold ratio (hard/easy) is greater than 1, suggesting that auditory sensitivity is higher for the less demanding visual condition compared to the more demanding visual condition.

Amplitude Modulation Frequency 5Hz

The mean auditory threshold ratio (hard/easy) is greater than 1, suggesting that auditory sensitivity is higher for the less demanding visual condition compared to the more demanding visual condition.

Amplitude Modulation Frequency 10Hz

The mean auditory threshold ratio (hard/easy) is greater than 1, suggesting that auditory sensitivity is higher for the less demanding visual condition compared to the more demanding visual condition.

CONCLUSIONS

We found that subjects required a greater degree of amplitude modulation in the auditory stimulus when attention to visual contrast was more demanding. Future work will explore these effects in more detail.

Our results suggest that (1) Attention effects in the auditory domain can be similar to effects found in the visual domain. Our covert attention manipulation suggests that attention acts on auditory contrast via a mechanism of contrast gain, shifting the contrast response to the left when the visual task is more demanding. Future work will explore these effects in more detail.

(2) Attention can be a limited resource across modalities, such that devoting more attention to a concurrent visual task can result in a deterioration in auditory processing.

(3) The effects of crossmodal attention on auditory contrast sensitivity diminish with practice, or time on task.

REFERENCES

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