Expecting the Unexpected: Cross-Modal Priming of Low-Probability Stimuli

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ABSTRACT

Performance on a visual odd-ball discrimination task was influenced by whether the visual stimulus was preceded by a high-probability or low-probability auditory stimulus. Hearing a high-probability sine wave speeded responses to the high-probability visual stimulus and slowed correct responses to the low-probability visual stimulus, relative to hearing a low-probability sine wave. These results demonstrate that encountering a high-probability stimulus in one domain can lead one to expect high-probability stimuli in other domains, or conversely, encountering a low-probability stimulus in one domain can lead one to expect low-probability stimuli in other domains. It is possible that the brain circuits implicated in monitoring probability utilize the level of predictability in one domain to calibrate the level of predictability generally.

INTRODUCTION

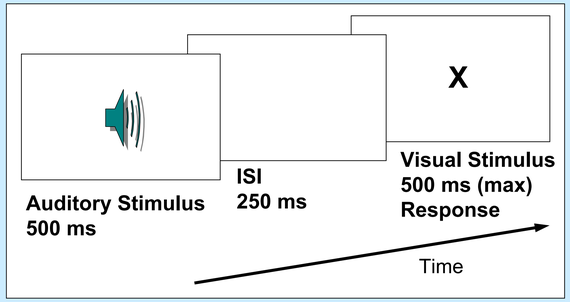
The brain is particularly sensitive to the probability that a stimulus will occur in a given context. Cortical regions that respond to low-probability stimuli across multiple sensory domains have been identified (e.g., Downar et al., 2002; Linden et al., 1999). Given that these cortical regions have access to probability information from multiple modalities, we examined whether probability information is processed interactively between sensory modalities.

By representing relationships and contingencies in a perceptual domain, the brain is able to use a context to anticipate events that typically occur in that context. We hypothesized that the contextual probability of events occurring in one domain would inform perception across modalities. Specifically, we hypothesized that encountering a low-probability auditory event would speed the response to a subsequently presented low-probability visual stimulus, relative to when that stimulus was preceded by a high-probability auditory event.

STIMULI

Auditory Stimuli:	Visual Stimuli:
261 Hz sine wave (70% of trials)	X (70% of trials)
522 Hz sine wave (30% of trials)	O (30% of trials)

TRIAL PARAMETERS



TRIAL TYPES

	X	O
Low pitch (261 Hz)	49%	21%
High pitch (522 Hz)	21%	9%

Percentage of total trials per type

EXPERIMENT 1: METHODS

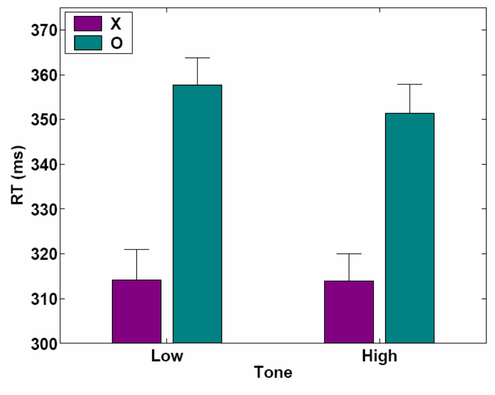
PARTICIPANTS

Thirty-two participants were recruited from the Dartmouth College community.

INSTRUCTIONS

Participants were told to attend to visual stimulus and to decide as fast and accurately as possible whether the letter was an "X" or an "O" by pressing a button on a keyboard. They were informed that they would hear beeps, but that the beeps were irrelevant to the task.

RESULTS

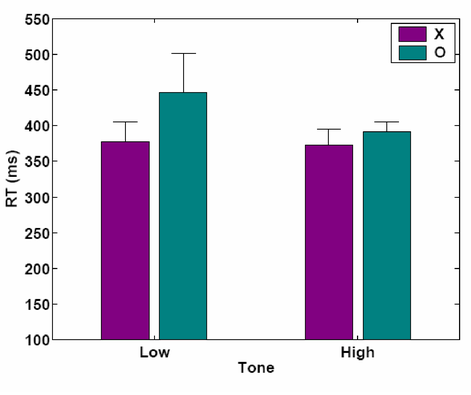


X was identified significantly faster than O [F(1,31)=133.07, p<.001].

There was a significant interaction between letter-type and sound-type, as illustrated above [F(1,31)=6.68, p=.015].

A paired-samples t-test revealed that O was identified significantly faster in the context of the high tone than in the context of the low tone [t(31)=3.23, P=.003].

RESULTS



X was identified significantly faster than O [F(1,16)=40.72, p<.001].

There was a significant interaction between letter-type and sound-type, as illustrated above. [F(1,16)=9.01, p=.008].

A paired-samples t-test revealed that O was identified significantly faster in the context of the high tone than in the context of the low tone [t(16)=3.01, p=.008].

EXPERIMENT 2: METHODS

MOTIVATION

To explore the possibility that the participants in Experiment 1 were using the different tones to predict the letter-type, we altered the instructions and ran a second experiment.

PARTICIPANTS

Eighteen participants were recruited from Tufts University. One subject was determined to be an outlier, and their data was discarded from analysis.

INSTRUCTIONS

Same as Experiment 1, but the subjects were told that they would hear two different types of beeps, and that the beeps were not predictive of the letter-type and their only task strategy should be to wait for the letter to appear, then respond.

CONCLUSIONS

The results of both experiments support the hypothesis that stimulus probability is processed interactively between the auditory and visual domains. These data suggest that upon encountering a low-probability auditory stimulus, the brain becomes calibrated to have higher expectations for encountering an unexpected visual stimulus.

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