Preferential Detection of Rising Versus Falling Intensity

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Abstract: An increase in intensity caused by the approach of a sound source can signal an ecological threat or opportunity, and therefore a potentially important event. A receding source produces a pattern of decreasing intensity change and a potentially less important event. Therefore, preferential responding by an organism to rising intensity stimuli may provide a selective advantage. To investigate the hypothesis that listeners respond preferentially to rising intensity stimuli, listeners were presented with white noise samples that either rose or fell dynamically 20 dB (SPL) in intensity. Stimulus duration ranged from 2s to 3s, and onset of intensity change ranged from 0s to 1s. In a speeded 2AFC task listeners had to determine whether intensity rose or fell. Results show that listeners detect increases in intensity more quickly than equivalent decreases. The findings are consistent with the interpretation that the auditory system processes some acoustic events according to a set of ecologically defined priorities.

INTRODUCTION

The most common methodology used in investigating loudness discrimination is that of comparing discrete static signals of different intensities. The results of such work, although informative, are generally not representative of listening conditions in a natural environment where most sounds change dynamically in intensity over time. Some work has examined dynamic loudness perception of pure tones (1,2,3,4). However, the thrust of this research has either been to determine dynamic difference limens, or to examine loudness adaptation phenomena.

Recent work has suggested a preferential status of dynamic rising intensity. Listeners are more influenced by rising intensity than falling intensity when tracking dynamic pitch change (5,6). It has also been shown that listeners can use the pattern of intensity change produced by an approaching sound source to make accurate estimates of arrival time of the source (7). A sound source approaching an organism produces an increasing pattern of intensity change. A source moving away from an organism produces a decreasing pattern of intensity change. Thus, in a natural listening environment, increasing intensity can represent a potential opportunity or threat and thus, may be more important than decreasing intensity. The current work directly examines the hypothesis that listeners detect dynamic rising intensity sooner than equivalent falling intensity.

FIGURE 1. Three onset latencies for intensity change are crossed with 2 directions of change for a total of six stimuli. Each stimulus was presented a total of 10 times. All 60 stimuli were presented in random order.
METHOD

Twenty listeners were presented with white noise samples that either rose or fell dynamically 20 dB (SPL) in intensity. All stimuli initiated at 60 dB and either began changing immediately or after a short delay. Thus, onset of intensity change began at either 0s, .5s, or 1s, and once initiated changed 10dB/s for 2s. The 3 rising intensity stimuli terminated at 80dB, and the 3 falling intensity stimuli terminated at 40dB (see Figure 1). In a speeded 2AFC task listeners had to determine whether intensity rose or fell. Listeners were instructed to indicate as quickly and as accurately as possible whether the stimuli were getting louder or quieter by pressing the appropriate key on a computer keyboard. Listeners heard the 6 different stimuli 10 times each in random order. Mean reaction times for each listener in each condition were recorded.

RESULTS AND DISCUSSION

A 3x2 (onset latency x direction of change) analysis of variance showed that rising intensity stimuli were detected significantly sooner than falling intensity stimuli ($F_{(1,19)} = 37.57, p<.001$). There was also a main effect for onset latency ($F_{(1,19)} = 303.98, p<.001$), that showed the sooner the onset of intensity change, the longer listeners took to respond (see Figure 2). Results confirm preferential detection of rising versus falling intensity in a range of stimulus change that could be encountered in a natural listening environment. The findings are consistent with the interpretation that the auditory system processes some acoustic events according to a set of ecologically defined priorities.

![Reaction Time to Rising and Falling Intensity Noise (10dB/s)](image)

**FIGURE 2.** Reaction time is faster to rising intensity stimuli and stimuli with a longer onset latency of intensity change.

REFERENCES