Reaction time to "tone-off"

J. BROWN GRIER

NORTHERN ILLINOIS UNIVERSITY

Fifteen college students gave reactions to both the onset and end of a 1000 cps tone. After a few initial trials in which the Ss seemed to be adjusting to the novelty of responding at a signal's end, reaction times were significantly shorter to the end of the tone than to its onset.

Several lines of evidence indicate that people should be able to respond more quickly to the end of an auditory signal than to its beginning. First, the response of the ear to intensity changes is not instantaneous; it takes a short time for the sensation to build up or decay and measurement shows that the decay process is much faster than the build-up. Stevens & Davis (1938) report a decay time of about 140 msec., while Munson (1947) found that the rise time for sensation to a pure tone is about 250 msec. Since the change in sensation is gradual, it is also possible that some Ss will start to respond as soon as they notice a change and before the rise or decay is complete. The fact that the difference threshold is smaller in loud sounds implies that these people should more readily detect a decrement in a loud sound going off than an increment in a low sound whose sensation is just beginning to rise. Therefore, responses to "tone-off" should be faster both because the decay of sensation is faster and because a jnd is smaller.

Contrary to the expectation, at least two researchers have reported no difference in reaction times to the onset and end of auditory stimuli. Woodrow (1915) had Ss respond at the beginning and end of a complex tone, but gave a distinctive warning signal just before the tone came on. The beginning of the auditory signal itself was the warning signal for "tone-off." This distinctive warning may have facilitated the responses to "tone-on," thereby accounting for his results. In another experiment, Woodworth & Schlosberg (1954) report that Cochole found no differences in reactions to increases and decreases in the intensity of a sound. The reason for this negative finding is not clear, but if the upward and downward intensity changes were made very quickly, the Ss may have been responding to the spread of energy along the frequency spectrum rather than to the intensity change (cf., Stevens, 1951, p. 998). The following experiment was done to investigate reaction time to the onset and end of a pure tone, using a refined experimental procedure.

Method

The Ss were 15 Introductory Psychology students selected on the basis of available time from the classes at Northern Illinois University. The Ss were run in a dark windowless room with only a small red spotlight illuminating a telegraph key fastened to a desk top.

The auditory signal was a 1000 cps tone which was alternately on and off for periods varying from 4 to 10 sec., and averaging 7 sec. The variation was to prevent the development of exact temporal expectancies. Both the onset and end of the tones were controlled by a Grayson-Stadler electronic switch set to give rise and decay times of 100 msec. This time was selected because it was just shorter than the reported decay time of the ear (140 msec.), yet long enough to give relatively distortion-free intensity changes in the tone. The signal was presented to the Ss via earphones against a low background of white noise. The noise was set 40 db above the average threshold of three laboratory assistants and the signal set 50 db above threshold in the noise background. The signal was very distinctive and easily detectable, so the task had none of the characteristics of signal detection. The noise background was to cover up random lab sounds, and as a partial control for any auditory adaptation that may have occurred to the tone alone.

Each S listened to the tone several times and then was instructed to press the telegraph key as quickly as possible every time he heard the tone come on or go off. Four practice responses were permitted before data collection was started. Each S gave 100 consecutive responses (50 to "tone-on" and 50 to "tone-off"). The response time was measured from the beginning of the rise (or decay) to the press of the telegraph key.

Results

For each S the 100 responses were divided into blocks of 20 and the median response time to "tone-on" and "tone-off" determined in each block. The average of these medians is presented in Table 1 along with the significance level of a "t" test between the 15 median "on" response times and the 15 median "off" response times in each block.

Discussion

The last three blocks of trials show clearly that the reaction time to a tone going off is shorter than to the onset of the same tone. The small difference during the first few responses probably results from the novelty of responding to a tone going off. During the early trials

Table 1. Average of the median reaction times (in msec.) and significance of the differences (P).

Tone	Trials				
	1-20	21-40	41-60	61-80	81-100
On	326	324	324	325	317
Off	326	316	310	308	302
P	—	.25	.05	.005	.025

Ss sometimes forgot to respond to the tone going off until several seconds after its end (these long response times were included in the analysis).

The difference in median response time to "on" and "off" was much smaller (about 15 msec.) than what would be expected if Ss did not start their responses until the complete intensity change had taken place (about 90 msec.). It seems likely that responses are started as soon as the Ss notice a change in the stimulus, and that the different reaction time can be accounted for by the difference in the jnd of loud and low sounds. However, another explanation is possible. Galambos (in Rasmussen & Windle, 1960) has described some recordings from single nerve units in the auditory cortex of cats. In the sample of units recorded he found about 2% more fibers that responded to "tone-off" than

responded to "tone-on." It is possible that the results could be partly accounted for by the magnitude of the cortical response, and not by the jnd alone.

References

- Munson, W. A. The growth of auditory sensation. *J. Acoust. Soc. Am.*, 1947, 19, 584.
- Rasmussen, G. L., & Windle, W. F. *Neural mechanisms of the auditory and vestibular systems*. Springfield, Illinois: Charles C. Thomas, 1960.
- Stevens, S. S. *Handbook of experimental psychology*. New York: Wiley & Sons, 1951.
- Woodrow, H. Reactions to the cessation of stimuli and their nervous mechanisms. *Psych. Rev.*, 1915, 22, 423-452.

Note

1. This research was supported in part by Grant No. 54005-118 from the Northern Illinois University Dean's Fund.