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EFFECT OF MASKING TONE DURATION ON PREPERCEPTUAL AUDITORY IMAGES[1]

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The *S*s identified the pitch of a 20-msec. test tone as high or low. The test tone was followed by a masking tone after a variable silent intertone interval. Pitch identification performance improved with increases in the silent intertone interval indicating that an auditory image remains for processing after a short tone is presented. Presentation of the masking tone precludes perceptual processing of the auditory image of the test tone. The present results also indicate that the interference produced by the masking tone was independent of its duration. This result supports the hypothesis that the onset of the masking tone interferes with or overwrites the auditory image of the test tone directly.

In an earlier study (Massaro, 1970), *S*s identied the pitch of a 20-msec. test tone as high or low. The test tone was followed by a masking tone after a variable silent intertone interval. The results indicated that pitch identification performance improved with increases in the silent intertone interval. Furthermore, the amount of interference produced by the masking tone was relatively independent of the similarity of the test and masking tones, dichotic (contralateral) masking was as effective as the binaural case, and presenting the masking tone before the test tone did not disrupt pitch identification performance. The experiments were discussed in terms of the utility of a central auditory image that remains after a short tone burst is terminated. This image can be processed, while it lasts, in order to identify the stimulus that was presented.

The masking tone could preclude perceptual processing of the auditory image of the test tone in, at least, two ways. First, the masking tone could prevent perceptual processing without actually interfering with the auditory image. Even though the image remains, it might be very difficult for perceptual processing of the image to occur during the masking tone presentation. In this case, however, perceptual processing should occur after the masking tone terminates. Accordingly, for the duration of the image, perceptual processing after the masking tone presentation would improve pitch identification performance. Second, the masking tone could preclude perceptual processing by interfering with or overwriting the auditory image of the test tone. In this case, perceptual processing after the masking tone terminates would not improve pitch identification. Thus, the interference produced by the masking tone should be independent of its duration since any image remaining after the masking tone would not have perceptual features corresponding to the test-tone presentation.

With a silent retroactive interval, the auditory representation of the test tone persists for about 250 msec. This follows from the finding that identification of the test tone improved with increases in the silent intertone interval up to about 250 msec., whereas further increases in the silent interval from 250 to 500 msec. had no significant effect on pitch identification (Massaro, 1970). Since the duration of the masking tone was 500 msec. in these studies, they are inconclusive with respect to the nature of the interference effects of the masking tone. That is, the image of the test tone would have decayed by the end of the masking tone presentation even if the masking tone did not interfere with the auditory image.

The present study varies the duration of the masking tone to test, whether the masking tone interferes with the auditory image directly or simply prevents perceptual processing during the masking tone presentation. As noted above, if the masking tone simply prevents perceptual processing and ends within 250 msec. of the test tone, further perceptual processing after the masking tone presentation would improve identification performance. On the other hand, if the masking tone interferes with the auditory image, a short masking tone would be as effective as a long masking tone. This result would support the conjecture that the onset of the masking tone is the critical event that interferes wih the auditory representation of the test tone.

Method.—Two females and one male attending the University of California were employed in the present study. They were paid $1.88/hr for participation in the experiment.

The basic procedure has been described earlier (Massaro, 1970). The *S*s were required to identify the pitch of a test tone which was presented for 20 msec. On any trial, one of two test tones could be presented. The two tones were programmed to occur equally often. The *S*'s task was to identify the higher tone (840 Hz.) as "high" and the lower

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tone (800 Hz.) as "low." The masking tone (820 Hz.) followed the test tone after a variable silent intertone interval. The masking tone lasted 50, 100, 200, or 400 msec. The silent intertone interval lasted 0, 20, 40, 80, 160, 250, 350, or 500 msec. The loudness of the test and masking tones was 81 db.

The *S*s were tested simultaneously in a sound-insulated chamber (Industrial Acoustics). All experimental events were controlled by a PDP-8 computer. A digitally controlled oscillator (Wavetek Model 155) was used to produce the pure tones. The tones were presented binaurally over matched headphones (Grason-Stadler Model TDH-39). Each *S* recorded his "high" or "low" decision by pressing one of two switches labeled "high" and "low," respectively. Following the 2-sec. response period, feedback was given by illuminating a small light for 500 msec. above the correct response button. The intertrial interval was 2.5 sec.

On every trial, *S*s heard a test tone followed by a variable silent interval followed by a masking tone of variable duration. They identified the test tone as "high" or "low" and were then informed of the correct answer for that trial. The *S*s were practiced in this task for 3 days before the present study and did not respond to the first 5 trials in each session. All 64 (2 test tones × 4 masking tone durations × 8 intertone intervals) experimental conditions were completely random within a given session. A session consisted of 400 trials. The results consist of the data of two sessions per day for 4 days giving about 50 observations under each experimental condition for each *S*.

Results.—Figure 1 presents the percent correct identifications for each *S* as a function of the duration of the masking tone and the silent intertone interval. In agreement with earlier results (Massaro, 1970), performance improved with increases in the silent intertone interval up to about 250 msec. The figure also shows no large differences in overall performance as a function of the duration of the masking tone. Furthermore, the improvement in identification performance with increases in the silent intertone interval seems independent of the duration of the masking tone.

An analysis of variance of *S*s, masking tone durations, and intertone intervals was performed on the percent correct identifications. The analysis indicated no differences in overall performance as a function of the duration of the masking tone, $F\ (3, 6) = 2.39$, $p > .1$. Also the Masking Tone Duration × Intertone Interval interaction was nonsignificant, $F < 1$. As expected, the improvement in performance as a function of the silent intertone interval was significant, $F\ (7, 14) = 15.17$, $p < .001$.

The results indicate that the duration of the retroactive masking tone was not a critical factor for terminating the perceptual processing of the test tone. This supports the hypothesis that the masking tone interferes with the auditory image directly rather than simply preventing perceptual processing.[3] That is, if the masking tone did not interfere with the auditory image, perceptual processing after short masking tones should have improved pitch identification at the short intertone intervals. Since this was not the case, the onset of the masking tone seems sufficient for overwriting the auditory image of the test tone.

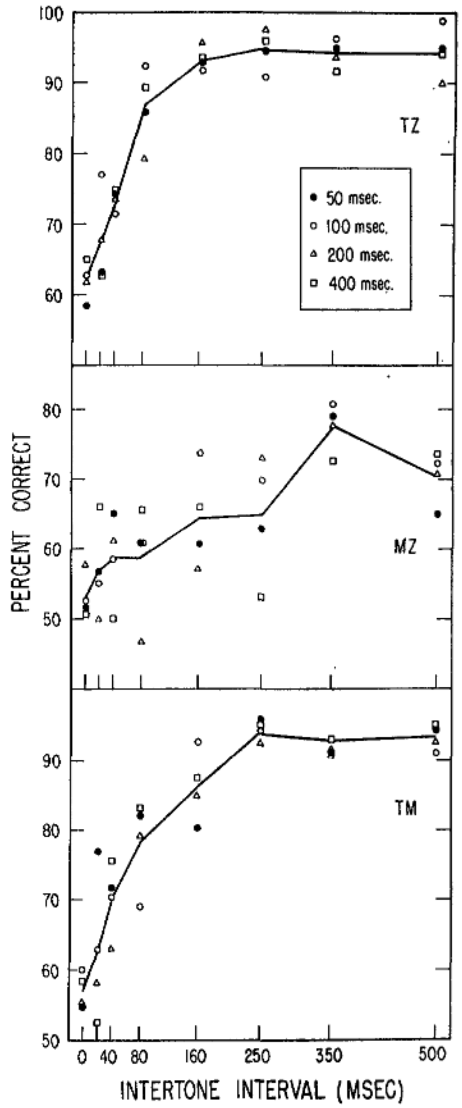

FIG. 1. Percent correct identifications of the test tone for *Ss*, TZ, MZ, and TM as a function of the duration of the masking tone and the silent intertone interval. (The continuous lines are means averaged over masking tone duration.)

Discussion.—The results indicate that the pitch identification of a short tone can be interfered with

[3] This conclusion is not weakened by the possibility that the duration of the masking tone might be important below 50 msec.

by a relatively short retroactive masking tone. Since the masking tone can be much shorter than the duration of the auditory image of the test tone, it follows that the onset of the masking tone interferes with the auditory image directly. Accordingly, the interference produced by the masking tone was independent of its duration in the present study.

These results of auditory processing are completely analogous to the information processing of visual stimuli (Averbach & Coriell, 1961; Haber, 1970; Neisser, 1967; Sperling, 1960). Haber states, "The new stimulus wipes out the iconic image of the old, so that the way is cleared for the processing of new material. [Given a short visual display,] the quarter-second occupied by the iconic image is not needed for seeing a display but for processing its content [p. 112]." Similarly for audition: In the pitch identification task, the 250 msec. after the test-tone presentation is not needed for hearing the tone, but for perceptual processing of the information in the auditory representation. The present results indicate that the onset of the masking tone overwrites the auditory image of the test tone destroying its information.

REFERENCES

AVERBACH, E., & CORIELL, A. S. Short-term memory in vision. *Bell System Technical Journal*, 1961, **40**, 309–328.

HABER, R. N. How we remember what we see. *Scientific American*, 1970, **222**, 104–112.

MASSARO, D. W. Preperceptual auditory images. *Journal of Experimental Psychology*, 1970, **85**, 411–417.

NEISSER, U. *Cognitive psychology*. New York: Appleton-Century-Crofts, 1967.

SPERLING, G. The information available in brief visual presentations. *Psychological Monographs*, 1960, **74**(11, Whole No. 498).

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