Effects of information feedback and reference tones on signal detection[1]

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In an auditory signal detection study feedback and no-feedback conditions were compared and the effect of introducing anchor or reference tones during the intertrial interval was investigated. Feedback increased the proportion of correct detections as did the presence of a strong anchor. The latter condition was also associated with a reduction of false alarms.

Several investigators have reported that information feedback increases the probability of correct responses in auditory signal detection (Gundy, 1961; Atkinson, Carterette, & Kinchla, 1964; Annette & Paterson, 1967). This finding accords with the more general observation that knowledge of results improves performance in monitoring situations (Weidenfeller, Baker, & Ware, 1962; Hardesty, Trumbo, & Bevan, 1963).

The similarity of the monitoring situation and the signal detection task is marked; indeed, the latter may be considered a special case of the former, one in which "noise" is made explicit. In both, S exerts essentially a judgmental function, and it is possible that contextual stimuli affect his performance in the same way as that exemplified in frame-of-reference psychophysics studies.

For these reasons, the present study compared the effects of three auditory anchor conditions, with and without feedback, on performance in signal detection. It was felt that the presence of feedback and anchor tones would facilitate performance.

One of the anchor conditions involved the presentation during the intertrial interval of a tone defined conventionally as "subthreshold." The rationale for its inclusion derived from the demonstrable effects of weak energy anchors in such studies as Black & Bevan (1960) and Bevan & Pritchard (1963) and the desire to see if such effects would modify performance in a related but not identical area.

In the present study signal strength was determined separately for each S relative to his own response threshold. This aspect of the present study was intentionally different from the methodologies of previous studies where a constant signal intensity was used for all Ss. Ss are known to differ in auditory sensitivity and response biases. By determining signal intensities that resulted in similar correctness of responding prior to the Ss' group assignment, it was hoped that the response variability within the experimental conditions would be reduced, thereby increasing the sensitivity of the experiment. Two conditions of feedback were used. In the F0 condition S was given no feedback about the correctness of his response. In the F1 condition S was told after each trial whether his response was correct or incorrect. After each trial in the detection series S was required to report whether he judged the signal to be present or absent. During the intertrial interval S was exposed to one of three anchor conditions: (1) in the A0 condition no anchor was present; (2) in the A1 condition a previously determined weak (subthreshold) anchor was presented; (3) in the A2 condition a strong (supra-threshold) anchor was presented.

METHOD

The S was seated in a sound-attenuated chamber with a chin rest and head clamp orienting him toward a response console under which was mounted an 8-in. speaker. To determine the appropriate intensity of the anchor tone, S's response threshold in the minimal audible field for a constant unmasked sinusoid tone of 1500 cps was determined by the method of limits. This value was then used as a base to set the intensity level of the intertrial anchor tone. Thirty college students with normal hearing were assigned at random to one of the three anchor conditions (10 Ss per condition). Ss in A0 represented the control condition and received no anchor stimulus between trials although their response thresholds to the unmasked anchor tone were also estimated. Ss in A1 were exposed between detection trials for 1 sec to an intertrial tone of 1500 cps that was attenuated 20 dB below the response threshold described above. Ss in A2 were exposed between detection trials to the same anchor tone and duration at an intensity level 20 dB above their indicated thresholds.

Before beginning the experimental trials, a Grason-Stadler, Model 455C white noise generator was turned on and a practice series of detection trials were run for each S with no feedback or anchor tone to determine the signal intensity to be used for that S in the later detection task. A tape programmer presented a 2-sec burst of white noise at 50 dB power level every 8 sec. For these practice trials a 1500-cps tone was superimposed by the programmer over the noise burst in a random sequence with the probability of occurrence on any trial equal to 0.5. S was instructed to respond after each burst of noise by pressing one of the two buttons on the response console marked "signal present" or "signal absent." The signal strength was varied to find an intensity that would produce approximately 60% correct responding over a block of 20 trials. This intensity level then defined the signal strength to be used in the detection task for that particular S.

In the principal test sessions, Ss in the A2 group were told that a reference tone, identical in pitch but of a greater intensity than the tone they were trying to detect, would be presented on each trial after they made their response. No mention of a reference tone was made to Ss in the A0 or A1 groups. Each trial was initiated by a 2-sec burst of noise (with or without signal), followed by S's response, followed by the appropriate anchor stimulus. A new trial commenced every 8 sec. Under the F1 condition a white light flashed on above the response console whenever a correct response was made. The signal was presented in a random order of occurrence on exactly 100 of the 200 trials under each feedback condition.

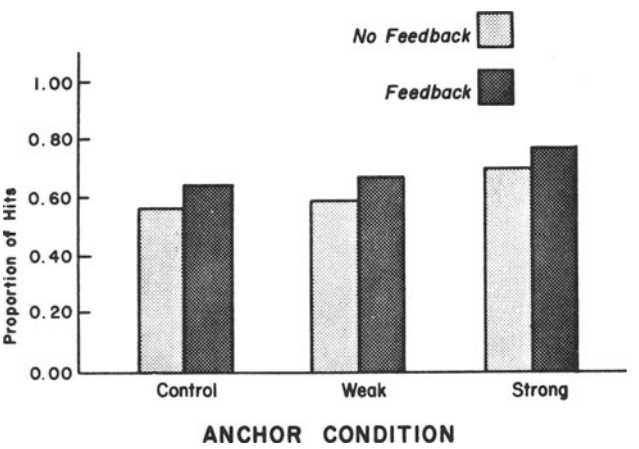

Fig. 1. Proportion of hits under feedback and anchor (reference tone) conditions.

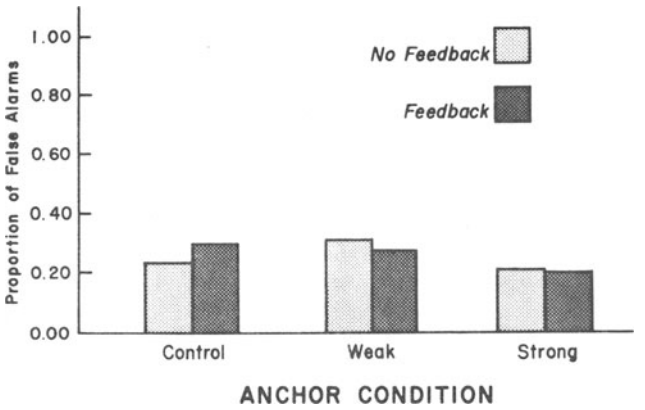

Fig. 2. Proportion of false alarms under feedback and anchor (reference tone) conditions.

RESULTS AND DISCUSSION

Figure 1 shows the mean proportions of hits (correct detections) made under the different feedback and anchor conditions. Feedback is seen to be consistently superior to the no-feedback condition. The performance of the strong anchor group is shown to exceed that of both the control and weak anchor groups which show similar performance. Since it is possible that a higher proportion of hits could be achieved by a simple tendency to give more "signal present" responses, the proportions of false alarms were computed and are shown in Fig. 2. Here it is seen that the tendency to give false alarms is unrelated to feedback condition and that the strong anchor group shows a lower false alarm rate than either the weak anchor or control groups.

While individual Ss differed widely in their reactions to the experimental conditions, it seems safe to conclude that information feedback and the presence of a distinct reference tone facilitate the correct detection of auditory signals. No evidence was found for a facilitating effect of a subthreshold anchor tone.

REFERENCES

ANNETT, J., & PATERSON, L. Training for auditory detection. Acta Psychologica, 1967, 27, 420-426.

ATKINSON, R., CARTERETTE, E., & KINCHLA, R. The effect of information feedback upon psychophysical judgments. Psychonomic Science, 1964, 1, 83-84.

BEVAN, W., & PRITCHARD, J. F. The effect of subliminal tones upon the judgment of loudness. Journal of Experimental Psychology, 1963, 66, 23-29.

BLACK, R. W., & BEVAN, W. The effect of subliminal shock upon the judged intensity of weak shock. American Journal of Psychology, 1960, 73, 262-267.

GUNDY, R. F. Auditory detection of an unspecified signal. In J. Swets (Ed.), *Signal detection and recognition by human observers.* New York: Wiley, 1964.

HARDESTY, D., TRUMBO, D., & BEVAN, W. Influence of knowledge of results on performance in a monitoring task. Perceptual & Motor Skills, 1963, 16, 629-634.

WEIDENFELLER, E. W., BAKER, R. A., & WARE, J. R. Effect of knowledge of results on vigilance performance. Perceptual & Motor Skills, 1962, 14, 211-215.

NOTE

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