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REPORT NO. 763

INTENSITY OF THE RT READY-SIGNAL AS A DETERMINANT OF ADAPTATION LEVEL

(Interim Report)

by

Captain David L. Kohfeld, MSC

29 January 1968

UNITED STATES ARMY
MEDICAL RESEARCH AND DEVELOPMENT COMMAND

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ABSTRACT

INTENSITY OF THE RT READY-SIGNAL AS A DETERMINANT OF ADAPTATION LEVEL

OBJECTIVE

To study the role of auditory adaptation effects in simple reaction time (RT) to a range of ready- and response-signal intensities.

METHOD

Forty male subjects were given an RT test with four ready-signal conditions, ten subjects in each condition. A fifth group of twelve subjects received all four ready-signal conditions in a counterbalanced order on consecutive days.

SUMMARY

The results indicated that a 90-db ready-signal produced the slowest mean RT, 30-db the fastest, 60-db intermediate, while a random combination of ready-signals with a mean of 60-db also produced intermediate RTs. These results also held true for the subjects who were given each ready-signal condition on consecutive days. Trial to trial analyses revealed that intensity effects were stable even when ready- and response-signal intensities were presented at random within an RT session.

CONCLUSIONS

The ready-signal served as a reference stimulus against which the response-signals were perceived, a finding which was consistent with the implications of adaptation-level (AL) theory. There is a qualitative difference between ALs which involve a modification of sensory processes and those which can more appropriately be classified as response processes. The adaptation effects presently found belong in this latter category.

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INTRODUCTION

Recent research has shown that stimulus intensity effects in simple reaction time (RT) depend not only upon the absolute values of the stimuli, but also upon their difference from some subjective reference level. At least two experimental approaches have proved useful in clarifying these relationsnips. First, as pointed out by Grice and Hunter (5), within-Ss designs produce larger differences in RT to varying signal intensities than when each response-signal is presented to separate groups. They suggested that adaptation level (AL) theory (7) provides a reasonable interpretation of the contrast effect found in within-S designs. Secondly, Murray and Kohfeld (11) and Kohfeld (10) demonstrated that when Ss listened to brief presentations of a tone just prior to participation in an RT experiment, the resulting response-signal functions were displaced in the direction of the preadaptation stimulus. Clearly, the context of stimuli in which an RT signal is presented is a significant factor in determining the speed of response.

Although the inverse relationship between response-signal intensity and RT is well documented (12, 13), it has recently been shown that ready-signal intensity also effects RT. Behar and Adams (3) and Adams and Behar (1) found that RT to visual response-signals showed a systematic decrease with a corresponding increase in the intensity of auditory ready-signals. In contrast with these results, Baumeister, Dugas, and Erdberg (2), employing auditory ready- and response-signals, found that increases in ready-signal intensity produced reliable increases in RT. Apparently whether the ready- and response-signals are presented in the same or in two different modalities is critical to the direction of the effect on RT.

Of more immediate concern here is the possibility that the ready-signal can serve as a reference stimulus against which the response-signal is compared. It was hypothesized that variations in ready-signal intensity would produce corresponding changes in RT. In accordance with the preadaptation work of Murray and Kohfeld (11) and Kohfeld (10), it was expected that the highest ready-signal intensities would provide the slowest mean RT when the response-signal intensities were all at or below AL, and that ready-signal intensities of lowest intensity should produce the fastest mean RT when the test signals were at or above AL.

METHOD

Apparatus. The stimuli for both the ready- and response-signals were 1000-cycle tones ranging in intensity from 30- to 90-db, SPL. The tones were produced by a Krohn-Hite audio oscillator and presented through calibrated earphones. One Grason-Stadler electronic switch, having a rise and decay time of 100 msec, presented the ready-signal, while a second switch with a rise and decay time of 10 msec delivered the response-signal. The rise and decay times were set at this level in order to avoid click transients. The experiment was conducted in a double-wall, sound-treated chamber. S sat in a chair with a conventional telegraph key clamped on its arm.

Subjects and Procedure. The Ss were 52 soldiers (average age of 20 years) who were assigned to the laboratory after completion of basic training. Each S was given conventional RT instructions before beginning the experiment. It was emphasized that S should press the key as fast as he could to the second of two successive tones. A total of 96 scored trials per session was presented. Fifteen unscored practice trials were given before the first session in order to familiarize S with responding to the second of two tones.

The ready-signals were 30-, 60-, or 90-db tones of .5 sec duration. Forty Ss were randomly assigned to four ready-signal conditions of either 30-db, 60-db, 90-db, or a random combination of the three (30-60-90-db), 10 Ss in each condition. The 30-60-90-db combination provided for eight presentations of each ready-signal intensity in each block of 24 trials. The remaining 12 Ss were given all four ready-signal conditions in a counterbalanced order on consecutive days.

All Ss were administered the same order of 30-, 50-, 70-, and 90-db response-signals, presented in random order with the restriction that there were six presentations of each response-signal in each block of 24 trials. Foreperiods of 1, 2, or 3 sec were given in irregular order preceding the onset of the response-signal of 1.5 sec duration. The intertrial interval was set at 15 sec. Temporal parameters of events were controlled by Hunter timers operating in a repetitive sequence. RT was recorded in msec by a Hunter electronic timer.

RESULTS

The left panel in Figure 1 (next page) shows mean RT as a function of response-signal intensity for the four ready-signal conditions. An analysis of variance confirmed that mean RT was fastest for the

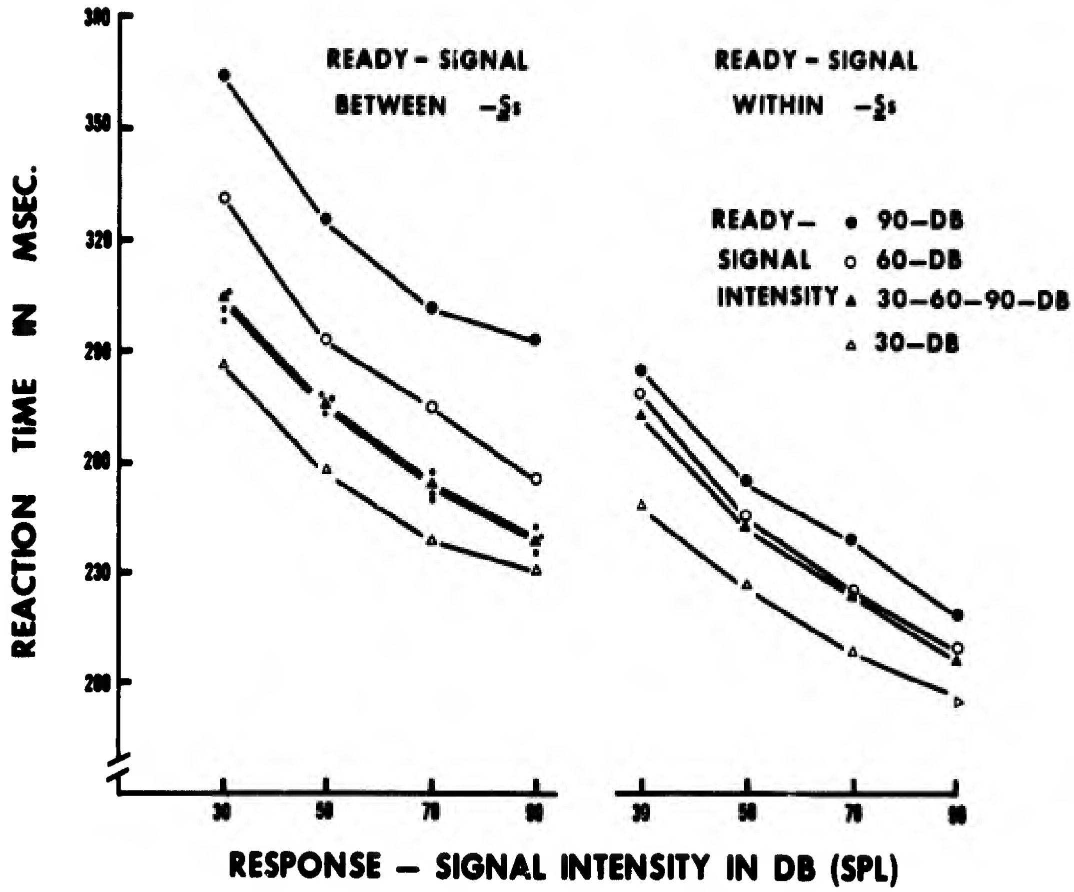

Fig. 1. Reaction time as a function of ready- and response-signal intensity. Dots around the between-Ss 30-60-90-db ready-signal means are plots of the separate 30-, 60-, and 90-db trial components.

30-db ready signal, slowest for the 90-db ready-signal, and intermediate for the 60-db and 30-60-90-db conditions; F (3, 36) = 3.22, $p < .05$. The fact that the 60-db and 30-60-90-db groups performed at intermediate levels suggested that both groups had a reference level at the mean of the stimuli (60-db). A test for simple effects revealed that these two groups did not differ significantly, t (18) = 1.06. In order to determine whether the 30-60-90-db group responded differentially to the 30-, 60-, and 90-db ready-signal trials, each ready-signal was plotted separately in the left panel of Figure 1. The 30-, 60-, and 90-db trial components showed small and unsystematic departures from the group mean. It appears that Ss in this group adopted an AL at the mean of the ready-signal values and responded to this average on a trial to trial basis in spite of random ready-signal shifts around the value of 60-db.

In view of the apparent stability of Ss' AL within each experimental session, as evidenced by the trial to trial analysis of ready-signal components in the 30-60-90-db group, the four ready-signal conditions were presented to 12 Ss in a counterbalanced order to determine whether RT would change from day to day as a function of ready-signal intensity. The right panel of Figure 1 reveals that RT changed over days, as Ss were fastest on the 30-db day, slowest on the 90-db day, and intermediate on days where the 60-db and 30-60-90-db ready-signals were presented. An analysis of variance indicated that the within S ready-signal effect was significant, $F(3, 33) = 3.50$, $p < .025$. The 60-db and 30-60-90-db ready-signal conditions did not produce significant differences in RT, $t(11) = .39$, which confirms the prediction of similar response potential for the two groups. In addition, Figure 1 shows that the four within-S ready-signal conditions produced faster mean RTs than the between-S conditions, thus indicating a practice effect for the 12 Ss over successive days of performance.

It has been suggested (9) that trial to trial variations in response-signal intensity should displace Ss' AL toward the intensity of the response-signal on the preceding trial. In order to evaluate this assumption, Figure 2 presents RT to response-signal intensity on trial n as a

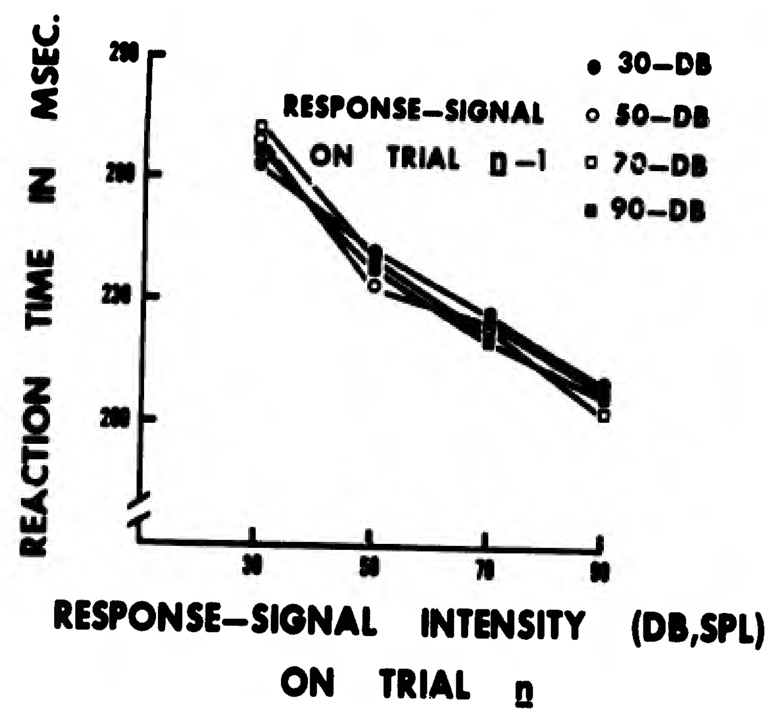

Fig. 2. Reaction time to response signal intensities on trial n as a function of the response-signal intensity presented on the previous trial (n-1).

function of response-signal intensity on trial n-1.* The data points represent mean RT averaged over ready-signal conditions for the 12 Ss in the within-S design. It is apparent from Figure 2 that RT on trial n could not be predicted on the basis of trial n-1 response-signal intensity. Supporting this conclusion were the results of an analysis of variance which indicated that the trial n-1 effect was not significant, $F(3, 33) = .33$. Moreover, the absence of this effect was consistent across ready-signal conditions, as evidenced by the lack of a Ready-signal x Trial n-1 interaction, $F(9, 99) = .81$. These results disagree with John's assumption that trial to trial changes in stimulus intensity produce corresponding shifts in AL.

DISCUSSION

The most noteworthy aspect of the present results was that the intensity of the ready-signal contributed to the formulation of an AL against which the response-signal was perceived. This finding is consistent with previous attempts to describe the departure of a stimulus from AL as an important source of response potential in the RT situation (5, 10, 11). A feature of the present design which deserves comment is that both the ready- and response-signal intensities were important in the formulation of an effective AL. Thus, pronounced within-S intensity effects were obtained for response-signals, a finding which supports the notion that an AL effect can be obtained when response-signal intensity is varied within a session. As to why the intensity of the ready-signal also produced an AL effect, it is argued that Ss have a tendency to attend closely to the ready-signal, thus giving it weighting power in the RT situation. Since the ready-signal serves to prepare S for the ensuing response, it follows that its properties should influence the formulation of an effective AL.

There were several aspects of the results which pointed to the conclusion that AL showed remarkable stability within an RT session. First, there were no fluctuations in RT as a function of the response-signal intensity presented on the previous trial. Secondly, when three ready-signal intensities were presented in irregular order, Ss apparently responded to the mean value and did not show trial to trial adjustments toward the prevailing ready-signal value. Finally, within-S changes in ready-signal effects were obtained only when the intensity values were varied on consecutive days of testing. While this latter

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*The author wishes to thank Harry G. Murray for suggesting this analysis.

result does not preclude the possibility that systematic changes of ready-signal intensity within a session might produce corresponding shifts in RT, there is other evidence to indicate that intensity effects remain stable within a session even when several intensity values are presented in regular order. For example, Jarl (8) reported little difference between regular (each stimulus presented alone for a block of trials) and irregular (all stimuli presented randomly within each block) methods of presentation in terms of the intensity effects obtained. A possible explanation for the above evidences of stability is based on the assumption that S was unable to modify his AL from trial to trial because the ready- and response-signal intensities were presented in an unpredictable order. As a consequence of this uncertainty, S chose an effective AL which was intermediate among the intensity values. On the other hand, when the intensity of the ready-signal was fixed for an entire session, and therefore predictable, S adjusted his AL toward that value. A useful test of this hypothesis would involve informing S regarding which ready-signal intensity to expect on each trial. Under these circumstances, he should be able to make an appropriate adjustment of his AL from trial to trial.

It should be noted that ready-signal effects were obtained in a situation where both the ready- and response-signals were tonal stimuli. In contrast, when the intensity of white noise ready-signals was varied with a visual response-signal, Behar and Adams (3) found ready-signal effects in the opposite direction of the present results. Furthermore, Kohfeld (10) obtained non-significant AL effects when white noise was utilized as adaptation-signals and tones were employed as response-signals, whereas highly significant effects in the direction of those reported here were noted when both the adaptation and test stimuli were tones. Behar and Warm (4) suggested that one of the difficulties in explaining ready-signal effects is that they may involve an interaction of arousal, intersensory, and conditioning effects. While the present data were interpreted in terms of AL theory, it appears that empirical support for this proposition is thus far restricted to RT designs where both the adaptation and test stimuli were in the same modality. Whether or not an AL interpretation of ready-signal effects can be applied to cross-modal RT research is a matter for future study.

The fact that adaptation effects were so persistent deserves a word of further comment in the context of AL theory. Since the theory predicts that every stimulus produces an adjustment of the prevailing level, the inability of Ss to modify their AL in the direction of the stimuli presented on each trial poses a theoretical problem. It appears that something more than sensory processes are reflected in RT measures.

Accordingly, Helson has suggested that AL is not a purely sensory phenomenon, but is also a factor in cases where motor responses reflect the prevalent AL.* Furthermore, Grice (6) has pointed out that there is a qualitative difference between ALs which involve a modification of sensory processes, and those which can more appropriately be classified as response processes. Grice's primary concern was to propose a decision model which deals with adaptation effects in this latter category. He notes that adaptation procedures which influence the response criterion can be quite persistent, an observation which is supported by the present data. Although the present results were interpreted in terms of AL theory, they also appear to be consistent with an approach where S's behavioral criterion is seen as an important variable in response evocation.

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13. ABSTRACT

Forty male Ss were given a simple reaction time (RT) test with four ready-signal conditions, 10 Ss in each condition. A fifth group of 12 Ss received all four ready-signal conditions in a counterbalanced order on consecutive days. The results indicated that a 90-db ready-signal produced the slowest mean RT, 30-db the fastest, 60-db intermediate, while a random combination of ready-signals with a mean of 60-db also produced intermediate RTs. It was concluded that the ready-signal served as an adaptation stimulus against which the response-signals were perceived. (U)

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