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Ready-signal effects as a function of experimental design in simple reaction time*

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In the between-S design, 20 Ss had a visual ready signal presented on each trial; for another 20 Ss, the ready signal was always absent. The within-S design consisted of 40 Ss that experienced both ready-signal conditions in semirandom order. Two intensities of a 1,000-Hz tone were used as the response signals. Ready-signal manipulation had pronounced effects under the within-S but not the between-S design irrespective of response-signal intensity.

Although direct comparison of between-S and within-S experimental variables has to a large extent been neglected, the recent work on stimulus intensity effects attests to the usefulness of the combined design approach. Grice and Hunter (1964) conducted two experiments in which within-S and between-S stimulus intensity variables were directly compared for both eyelid conditioning and simple reaction time (RT). In both experiments, the effects of stimulus intensity, whether it was the conditioned stimulus or the response signal, were substantially greater under the within-S procedure. In addition to providing an innovative methodology, the Grice and Hunter findings had considerable theoretical value which led to a conceptual reorganization of stimulus intensity effects based on decision theory (Grice, 1968).

The ready signal in RT experiments has also been treated as an intensity variable and has been investigated within the context of the Grice decision model. Kohfeld (1969a, b) has shown that RT is an increasing function of the intensity of either auditory or visual ready signals. With few exceptions, little else can be actually said about the ready signal in RT experiments. It is often asserted that its presence is important for producing rapid RTs. In the light of eyelid conditioning studies that show conditioning to be poorer with a ready signal than without one (e.g., Turner, 1966), assumptions about ready-signal effects should not be entertained uncritically. It would, therefore, be worthwhile to determine whether the same relationships obtain when the ready signal is treated as both a between-S and a within-S variable. The present experiment allows for a direct comparison of between-S and within-S ready-signal (presence vs absence) conditions.

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METHOD

The Ss were 80 introductory psychology students who volunteered for extra course credit. In the between-S design, 20 Ss (Group P) always had the ready signal presented on each trial; for another 20 Ss (Group A) the ready signal was always absent. The within-S design consisted of 40 Ss (Group PA) that experienced both conditions of ready-signal manipulation in irregular order.

Two irregularly occurring 1,000-Hz tones of 40 and 90 dB (SPL) intensity generated by a Hewlett-Packard oscillator were used as the response signals. The tones, with a 25-msec rise time, were presented through calibrated earphones after attenuation. The ready signal was a 7-W jeweled light of 0.5 sec duration. Foreperiods of 2.0, 3.0, and 4.0 sec occurred in irregular order preceding the onset of the tones, which were of 1.5 sec duration. The ITI from response-signal offset to ready-signal onset was 9.5 sec. Recurring temporal parameters were controlled by BRS solid-state circuitry. A Beckman accumulator recorded RTs in milliseconds.

The Ss were seated in a sound-treated room at a small table holding a conventional telegraph key and ready-signal panel. To preclude the possibility of extraneous noises coming from adjoining rooms, a Grayson-Stadler noise generator was placed 8 ft behind S and measured at 48 dB SPL (Scale A). Conventional RT instructions and 20 warm-up trials appropriate to the experimental condition were given. There was a total of 160 regular RT trials, 80 at each response-signal level. A 3-min rest period was given halfway through the series.

RESULTS

In order to perform the analysis suggested by Grice and Hunter, the within-S group (PA) was subdivided into two independent groups. The data for one group came from only those trials where the ready signal was absent (PA-A); the data for the other group came from only those trials where it was present (PA-P). The data for the two between-S groups (P and A) came from those trials that corresponded with the same within-S condition.

The two panels of Fig. 1 show mean RTs of the ready-signal conditions under the two types of experimental design for both soft and loud response-signal intensity. Most noticeable and of primary interest in the two panels are the interactions. The effects of the ready-signal manipulation clearly depend

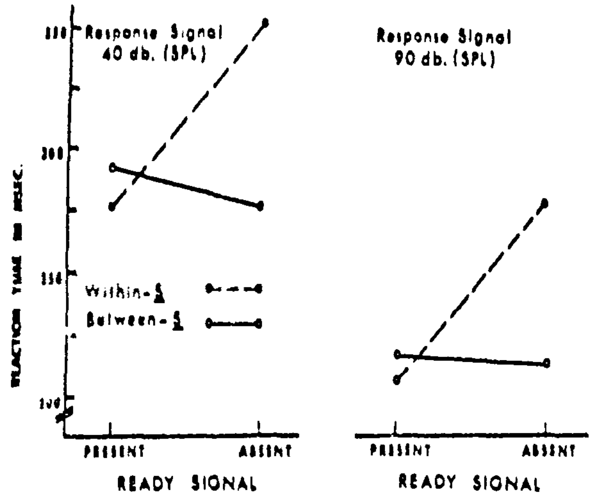

Fig. 1. Reaction time to ready-signal conditions as a function of experimental design for soft and loud response-signal intensities.

upon the type of experimental design irrespective of response-signal intensity. Further inspection of Fig. 1 reveals overall effects for ready-signal condition, design, and response-signal intensity. These conclusions were supported by a Ready-Signal Conditions by Design by Response-Signal Intensities analysis of variance. All three main effects yielded significant sources of variation: ready-signal conditions ($F = 11.52$, $df = 1/76$, $p < .005$), design ($F = 9.12$, $df = 1/76$, $p < .005$), and response-signal intensities ($F = 917.96$, $df = 1/76$, $p < .001$). The large within-S response-signal effect is already well established and is not surprising here. The Ready-Signal Conditions by Design interaction was highly significant ($F = 19.30$, $df = 1/76$, $p < .001$). The nonsignificance of the second-order interaction, Ready-Signal Conditions by Design by Response-Signal Intensities ($F = 1.66$, $df = 1/76$), indicates that the significant first-order interaction was not affected by the third variable, response-signal intensity. Individual group comparisons of interest found no difference between ready-signal conditions for the between-S groups regardless of soft or loud response-signal intensity ($F = 1.47$, $df = 1/76$; $F = .04$, $df = 1/76$). For the within-S groups, however, under both soft and loud intensity conditions, individual comparisons between presence and absence of ready signal yielded sizeable differences ($F = 29.91$, $df = 1/76$, $p < .001$; $F = 30.75$, $df = 1/76$, $p < .001$).

DISCUSSION

Traditionally, the ready signal has been assumed to maximize the S's state of readiness and thus lower the threshold for responding. The results reported here indicate that one has to consider the type of experimental design before such an assumption is accepted. In the between-S design, ready signal does not seem to be an effective variable. Its presence is important only to those Ss that have also, within the same session, experienced its absence. One possible explanation for the lack of a between-S effect would be the preceding response signal serving the function of an effective ready signal for the group that never received the ready signal. In effect, this group would have a considerably longer foreperiod, and although evidence is incomplete on long foreperiod effects, earlier work by Woodrow (1914) would lead one to expect detrimental effects. Such was not the case in the present experiment.

It is noteworthy that presence vs absence ready-signal findings are quite dissimilar to findings obtained when ready-signal intensity is manipulated. Ready-signal intensity bore a direct relation with RT in the Kohfeld (1969a, b) experiments when it was treated as a between-S variable and also when intensities were presented to the same Ss in counterbalanced order on consecutive days. However, when ready-signal intensity was manipulated randomly within a RT session (analogous to the presence vs absence procedure), no effect was obtained. Clearly, the absence of a ready signal cannot be conceived as the limiting case at the lower end of the intensity continuum. The most plausible interpretation of the large within-S effect would be the drastic trial-to-trial changes in ready-signal conditions. In decision theory terms, the elevated RTs that occurred when ready signal was absent may have stemmed from the abrupt raising of the S's response criterion after experiencing the ready signal on the preceding trial.

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