Stimulus selection as a function of stimulus duration and letter color in paired-associate learning[1]

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A PA list comprised of non-overlapping consonant trigram stimuli with numerals as responses was presented to six groups of Ss. For a given group, the stimulus duration was either 1 or 3 sec. and the letters in either the initial, medial, or final position of the trigrams were red. When the list had been learned to criterion, the individual letters were presented and the Ss were required to respond with the appropriate number. Stimulus duration affected the rate of PA learning, while red letter position influenced performance on the transfer test.

The major purpose of the present investigation was to determine if in paired-associate (PA) learning situations Ss' stimulus (St) selection behavior is influenced by St duration. In particular, the hypothesis tested was as St duration increases the functional St (St used by S to cue his response) and the nominal St (St presented to S) should become identical. In order to test this hypothesis, a PA task was chosen in which the functional and nominal stimuli were known to be different for a given St duration and a given stimulus-response (S-R) duration. Rabinowitz & Witte (in press) presented Ss with non-overlapping CCC trigrams with red letters appearing in either the initial, medial or final positions. Ss tended to utilize either the red letters, the first letters, or both as the functional stimuli. In this experiment, the St and S-R durations were both 1 sec.

A second purpose of the present investigation was to examine the effect of varying St duration (1 vs. 3 sec.) with S-R duration constant (1 sec.) on the rate which Ss learn a PA list. Nodine (1963), using St durations of 1/2, 1, 2, and 4 sec., reported that increasing St durations significantly increased the number of correct responses on recall trials. In a later experiment (Nodine, 1965), he found a similar but nonsignificant effect of St duration. The reason for the inconsistent statistical finding is not apparent. The present study will add further statistical information utilizing data collected in a different manner than Nodine's. Nodine (1963, 1965) interjected recall trials among the anticipation trials because a St duration of 1/2 sec. did not permit anticipation and a St duration of 1 sec. made anticipation difficult. During the recall trial, the responses were not presented and each St was presented for 4 sec. In the present study, recall trials were not used in order to eliminate possible confounding effects of the recall trials on the St duration variable. In an attempt to eliminate possible difficulties in anticipating within 1 sec., numbers rather than nonsense syllables (which Nodine used) were utilized as responses.

Method

The Ss were 72 University of Washington undergraduate and graduate students most of whom had previously participated in one or more verbal learning studies, but who had not been exposed to CCC stimuli or number responses.

Seven CCC trigrams (KZQ, PWV, BXJ, YCF, GLM, DHS, and TRN) were used. Their construction from the 21 consonants equated various measures of meaningfulness for each trigram. One letter of each trigram was red and two were black. A factorial design using red letter position (initial, medial and final) and St duration (1 and 3 sec.) yielded six groups of 12 Ss each. The Ss were randomly assigned to the groups. Both the 1 sec. and the 3 sec. St duration groups had a 1 sec. S-R duration. The intertrial interval (ITI) was 2 sec. for the former groups and 4 sec. for the latter.

The Ss were required to learn a seven-pair PA list of CCC trigrams as stimuli and the numerals one through seven as responses. The Ss performed to a criterion of two successive correct trials. Four randomizations of each PA list were presented to each S, and three different orders of these randomizations were counterbalanced across Ss. The Ss were not informed in the instructions that the PA task could be learned using any one letter, nor that a transfer test would be given after the PA task.

On the transfer task the 21 consonants were presented individually for 2 sec. each with the color of the letter being the same as during the PA learning. Two transfer tests were given in succession to each S. Three randomizations of the consonants were used and four randomizations of the list orders were counterbalanced across Ss. The Ss were asked to give the number which had previously been associated with each letter and were urged to guess. The dependent measures used in the statistical analyses were the number of trials to criterion on the PA task and the number of correct responses per letter position on the transfer task. A .05 significance level was used for all comparisons.

Results

An analysis of variance was performed on the PA data in which St duration and red letter position were the between-S factors. Only the effect of St duration was

significant ($F = 22.81$, $df = 1/66$, $p < .001$). This finding statistically supports the fact that Ss who experienced a 3 sec. St duration reached criterion faster than Ss who experienced a 1 sec. duration (16.39 and 33.31 trials, respectively). The significant effect of St duration is consistent with Nodine's (1963) result and gives some credence to the possibility that Nodine's failure to find a significant effect of St duration in his latter experiment (Nodine, 1965) was due to sampling fluctuations. It seems safe to conclude that as the St duration increases the rate of learning, as measured by recall or trials to criterion, also increases.

Of incidental interest is the fact that the total learning time (TLT = trials to criterion x time of a trial) for the Ss who learned at a 1 sec. St duration was approximately the same as that for Ss who learned at a 3 sec. duration, 466.34 and 458.92 sec., respectively. This finding contrasts with that reported by Nodine (1965). He indicates that there is a significant positive correlation between St duration and TLT. Three possible reasons for the discrepant findings regarding TLT are: (a) the 1 sec. St duration used in the present study might have been too short to allow Ss to anticipate within that interval until a great amount of overlearning occurred; (b) Nodine (1965) interjected recall trials among the anticipation trials which might have distorted the effects of St duration; and (c) due to an error, ITI and St duration were confounded in the present experiment. There is reason to believe that "c" is of minimal importance (see Underwood, 1961) and "b" is of maximal importance (see Berry & Battig, 1966).

An analysis of variance was performed on the transfer task data in which St duration and red letter position were the between-S variables, while letter position within a CCC trigram (letters within) and successive transfer task were the within-S variables. Two of the 15 comparisons were significant (the main effect of letters within, $F = 21.94$, $df = 2/132$, $p < .001$, and the interaction effect of red letter position by letters within, $F = 14.17$, $df = 4/132$, $p < .001$). The mean number of correct responses across the Ss for whom the first (second; third) letters were red to letters in the initial, medial, and final positions were 4.58, 1.33, and 1.15 (2.65, 2.60, and 1.08; 2.54, 1.58, and 2.94), respectively. These results replicate the findings of Rabinowitz and Witte. See their article for an interpretation.

The hypothesis, as St duration increases the functional St and the nominal St should become identical, received no statistical support from the transfer task results. Three interpretations of the null results are offered:

1. The principal effect of increasing St duration might have been to permit the Ss to: (a) choose the functional St in fewer trials; or (b) rehearse the S-R associations. Either or both of the above would be expected to produce faster PA learning, but *not* affect the functional St utilized.

2. It is possible that the total time the St items are exposed rather than the time they are exposed on a particular trial is the variable that affects St selection behavior. Due to different learning rates, the St items were exposed only 1-1/2 times longer on the average for Ss in the 3 sec. than for Ss in the 1 sec. St duration groups. This difference in total exposure time might not have been sufficient for different St selection behaviors to develop.

3. The following might have occurred: (a) the Ss associated the nonfunctional St elements with the functional elements rather than directly with the responses (see Underwood, 1963); and (b) the degree of these associations increased with increasing St duration. If both occurred, it does not necessarily follow that the effect of the St duration variable would be manifest on the transfer task because the rate at which the individual letters were presented was probably too rapid for mediation to occur (see Schulz & Lovelace, 1964).

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Note

1. This research was supported by USPHS grant MH 12157-01.