Common features of the "repetition" and "same-different" effects in reaction time experiments¹

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Using comparable stimulus and response sets, and the same Ss, the "repetition" and "same-different" effects were studied in two experiments involving several reaction-time (RT) tasks. In Experiment 1, these effects were examined at a 2-sec interval between successive stimuli in the simple (SRT), the recognition (RRT), the choice (CRT), the same-different recognition (S-DRRT), and the same-different choice (S-DCRT) tasks. In Experiment 2, the effects were studied at a 10-sec interval in the CRT and S-DCRT tasks. The results suggest the following main conclusions: (1) The positive repetition effect (i.e., shorter reaction times on "repeated" trials than on "nonrepeated" trials) is not only a feature of the CRT task but may also occur in the SRT and RRT tasks. (2) With increasing intertrial interval, the magnitude of the positive repetition effect diminishes and then reverses into a negative repetition effect. (3) The positive same-different effect (i.e., shorter reaction times on "same" trials than on "different" trials) is affected by an increase in interstimulus interval in a manner that parallels the effect of intertrial interval on the positive repetition effect, suggesting that the processes underlying the two effects are mainly the same. (4) These changes in the magnitude and direction of the repetition and same-different effects are probably a function of discrimination difficulty.

The typical reaction-time (RT) experiment involves a set of stimuli (S_1 , S_2 , etc.), a set of responses (R_1 , R_2 , etc.), and instructions that specify the rules to be observed in the stimulus-response translation of "mapping" (e.g., $S_1 \rightarrow R_1$; $S_1 \rightarrow R_1$; $S_2 \rightarrow$ no response). Typically, the experiment consists of a long series of trials. The S is asked to respond accurately and quickly to the stimuli presented, and, on each trial, the correctness or incorrectness of his response, as well as the response latency, is noted. Within this broad framework, several different RT tasks have been developed, each defined in terms of certain stimulus and response sets and certain mapping rules; among the most widely used are Donders's (1868) a-reaction or simple reaction-time (SRT) task, Donders's c-reaction or recognition

reaction-time (RRT) task, and Donders's b-reaction or choice reaction-time (CRT) task. More recently, some investigators (e.g., Bindra, Williams, & Wise, 1965; Nickerson, 1967) have used a paradigm that may be described as the "same-different" choice reaction-time task (S-DCRT). The properties of stimulus and response sets in this task are similar to those in the CRT task, except that on a given trial two stimuli are presented, either sequentially or simultaneously, and S is instructed to select his response on the basis of whether the two stimuli appear to him to be the same or different. A "same-different" recognition reaction-time (S-DRRT) task has also been developed, which may be considered as the two-stimuli-per-trial equivalent of the RRT task.

Two somewhat curious effects observed in RT experiments have recently drawn considerable attention. One of these is the "trial-repetition effect" reported in a number of CRT studies. This refers to the tendency for the latencies of responses on immediately "repeated" trials (e.g., response on an S_1 trial when the previous trial was also an S_1 trial) to be different from the latencies of responses on "nonrepeated" trials (e.g., response on an S_1 trial when the previous trial was an S_2 trial). As compared to the nonrepeated trials, the repeated trials have been found to yield shorter (Bertelson, 1963, 1965; Hale, 1967; Smith, 1968) or longer (Williams, 1966) latencies. The second effect is the "same-different" effect. This refers to the tendency for the latency of the decision that two identical stimuli are the same, to be different from the latency of the decision that two dissimilar stimuli are different. As compared to the decision "different," the latency of the decision "same" has been found to be shorter (e.g., Nickerson, 1965) or longer (e.g., Bindra, Williams, & Wise, 1965; Bindra, Donderi, & Nishisato, 1968). When the RTs on the "repeated" or "same" trials are shorter, the repetition and "same-different" effects may be called positive; when the reverse is the case, the effects may be called negative.

This study was aimed at elucidating the relation between the trial-repetition and the same-different effects, as well as at determining the basis of the above

discrepancies in the results of experiments on both these effects. By using the same Ss and the same stimulus set, and by varying the tasks in terms of stimulus-response mapping requirements, we hoped to determine the nature of the factors underlying these two effects. Our conjecture was that, if the two effects share common processes, the latencies of "same" and "different" judgments ought to bear a relation to each other that would correspond to the relation between the latencies of "repeated" and "nonrepeated" trials. This prediction arises from the fact that a "same" trial in the S-DRT task (e.g., $S_1-S_1 \rightarrow R_{\text{same}}$), since it requires a response to the second of two identical stimuli, corresponds to the "repeated" trial of the CRT task (e.g., $S_1 \rightarrow R_1$, $S_1 \rightarrow R_1$), and, similarly, the "different" trial in the S-DRT task (e.g., $S_2-S_1 \rightarrow R_{\text{diff}}$) corresponds to the "nonrepeated" trial of the CRT task (e.g., $S_2 \rightarrow R_2$, $S_1 \rightarrow R_1$).

EXPERIMENT 1

The first experiment was designed to determine whether or not the "trial-repetition" effect was present in all the single-stimulus-per-trial paradigms (i.e., SRT, RRT, and CRT), and whether or not the corresponding "same-different" effect was present in both the two-stimuli-per-trial paradigms (i.e., S-DRRT and S-DCRT). Since the same stimuli were used in all tasks, and the tasks were made comparable as far as possible, a comparison of the nature and extent of the two effects may suggest the answers we sought.

Subjects

Sixteen university students, nine women and seven men, served as Ss. Their ages ranged from 17 to 20 years.

Apparatus

The stimuli were two circular patches of white light, A and B. Stimulus A was larger, with a diameter of 7/16 in.; B's diameter was 6/16 in. They were displayed on a multiple-stimulus projector (Grason-Stadler Model 10657) mounted at eye level on a screen located about 3 ft from S, subtending visual angles of approximately 37 min and 32 min of arc, respectively. Stimulus luminance was

approximately 27 ft-L (measured by a spot light meter). The experimental room was dimly illuminated. A warning signal, in the form of a 1,000-Hz tone, could be delivered to S through earphones.

The response unit consisted of two button-operated microswitch keys, mounted on a wooden platform on a table in front of S. Both keys were located 2 in. from a "rest key," on which S rested his index finger between trials. Depending on the experimental condition, one or both response keys were used. When both keys were used, that is, in the CRT and S-DCRT paradigms, they were labeled "big" and "small" or "same" and "different," respectively.

For any given series of trials, the desired stimuli sequences were coded on a punch paper tape whose output controlled a solid-state logic module system (Grason-Stadler 1200 series), which effected the onset and cessation of the warning signal and the task stimuli at appropriate times. A timer (Hewlett-Packard electronic counter, Model 5212A) was triggered at the onset of the appropriate stimulus and stopped by the depression of either response key. Response latency was printed to the nearest millisecond on a recorder (Hewlett-Packard digital recorder, Model 562A).

Experimental Design and Procedure

Each S was tested in a single experimental session consisting of three parts: Part 1 contained the SRT task, Part 2 contained the RRT and CRT tasks, and Part 3 contained the S-DRRT and the S-DCRT tasks.

Each of the tasks in Parts 1 and 2 consisted of a series of 80 test trials, preceded by 20 practice trials. A trial in these tasks started with the presentation of the warning tone for 500-msec, followed, 1 sec later, by a 100-msec stimulus exposure. The S's response terminated the trial. There was a 2-sec intertrial interval (ITI), measured from stimulus cessation to the onset of the next warning tone. In a series of trials, the order of Stimulus A and Stimulus B was randomized with the following restrictions: (a) The two stimuli were equiprobable, $p(A) = p(B) = 0.5$; (b) the first-order sequential stimulus probabilities, $p(A \text{ following } A)$, $p(A \text{ following } B)$, $p(B \text{ following } A)$, and $p(B \text{ following } B)$, were all 0.25; (c) the longest run of "repeated" (A following A or B following B) and "nonrepeated" (B following A or A following B) trials was 4. These restrictions were applied as nearly as possible to each block of 40 trials. In Part 1 (SRT), S was required to respond to Stimulus A or B—whichever happened

to occur on a trial—by depressing one (the only) key. In the RRT task of Part 2, S was required to respond only to Stimulus A (or B) by depressing one (the only) key and to make no response on the occurrence of the other stimulus. Half the Ss were instructed to withhold the response to Stimulus B in the first block of 40 trials and to Stimulus A in the second 40-trial block; the other half performed in reverse order. In the CRT task of Part 2, S was required to respond to Stimulus A or B—whichever happened to occur on a trial—by depressing the correspondingly labeled (A: big; B: small) key. The order of the two tasks in Part 2 was balanced so that half the Ss started with the RRT task and the other half with the CRT task.

In Part 3, each of the two tasks (S-DRRT and S-DCRT) consisted of 40 practice trials followed by 160 test trials. A trial was identical to that in Parts 1 and 2 with respect to warning tone, stimulus duration, etc., except that the warning tone was followed by the sequential presentation of a pair of stimuli (AA, BB, AB, or BA) with a 2-sec interstimulus interval (ISI). The order of presentation was randomized with the following restrictions: (a) Every possible stimulus pair occurred equally often, $p(AA) = p(BB) = p(AB) = p(BA) = 0.25$; (b) every stimulus pair followed every other stimulus pair equally often; and (c) the longest runs of repeated stimulus pairs (e.g., AA followed by AA) and repeated responses (e.g., AB $\rightarrow$ R₁ followed by BA $\rightarrow$ R₁) were 3 and 4, respectively. These restrictions were applied as nearly as possible to each block of 80 trials. In the S-DRRT task, S was required to depress one (the only) key if

the two stimuli were judged to be the "same" and to make no response if they were judged to be "different" ("same only" condition) or to make the response only if the stimuli were "different" ("different only" condition). Half the Ss received the "same only" instructions in the first 80-trial block and "different only" in the second, while the other half performed in reverse order. In the S-DCRT task, S was required to respond on every trial, that is, to judge the two stimuli to be the "same" (AA or BB) or "different" (AB or BA) and to indicate the decision by depressing the correspondingly labeled key. The order of tasks in Part 3 was balanced so that half the Ss started with the S-DRRT task and the other half with the S-DCRT task.

The instructions to Ss were to be as fast and as accurate as possible. Rest breaks of 2 min were given between tasks as well as between 80-trial blocks within a part and of 5 min between the parts. The total session lasted about 70 min.

Data Analysis

Data for trials on which S made an error were excluded from the main analysis; error data are presented separately. Medians were calculated from each S's distribution of RTs for correct responses. In the single-stimulus trial tasks (SRT, RRT, and CRT), the medians were obtained separately for "repeated" and "nonrepeated" trials with Stimulus A (large circle) and Stimulus B (small circle). In the two-stimulus trial tasks (S-DRRT and S-DCRT), the medians were obtained separately for "same" and "different" trials with each possible stimulus pair

Table 1
Mean Latencies and Errors of Responses to Two Stimuli, Large Circle (A) vs Small Circle (B)
Obtained in Five Different Reaction Time Tasks (Experiment 1)

Task	Type of Trial	Latency in Msec		Overall Latency (A and B)	Per Cent Errors
		Large (A)	Small (B)		
SRT	Repeated (R)	456	455	456	0.0
	Nonrepeated (N)	473	472	473	0.0
	Overall (R and N)	465	464	465	0.0
RRT	Repeated	619	600	609	7.8
	Nonrepeated	646	614	630	8.9
	Overall (R and N)	632	607	620	8.3
S-DRRT	Same (S)	568	586	577	3.4
	Different (D)	638	646	642	10.4
	Overall (S and D)	603	616	610	6.8
CRT	Repeated	692	666	679	3.9
	Nonrepeated	703	670	687	4.7
	Overall (R and N)	697	668	683	4.3
S-DCRT	Same	829	756	792	5.9
	Different	958	846	906	11.1
	Overall (S and D)	894	801	849	8.5

combination (AA and BB for "same" and AB and BA for "different"). The maximum numbers of RTs contributing to each median were 20 in the case of the SRT, RRT, CRT, and S-DRRT tasks, and 40 in the case of the S-DCRT task.

For the purpose of investigating the relation between the "same-different" effect and the "repetition" effect, difference scores were computed by subtracting the median "same" and "repeated" latencies from the median "different" and "nonrepeated" latencies, respectively (i.e., "different" minus "same"; "nonrepeated" minus "repeated"), for each S for each of the five tasks.

Results

Means of the individual median correct RTs for "repeated" and "nonrepeated" trials and, in the case of S-D tasks, for "same" and "different" trials are presented in Table 1. The effects of different experimental variables were assessed by a four-way analysis of variance [Stimulus: large vs small²; by Judgment: "same" (and "repeated") vs "different" (and "nonrepeated"); by Tasks: SRT vs RRT vs CRT vs S-DRRT vs S-DCRT, by Ss.]

The main effect for tasks was significant [$F(4,60) = 89.374, p < .001$]. In general, RTs tended to increase as a function of task complexity (see Table 1).

The main effect of stimulus was significant [$F(1,15) = 12.7, p < .01$], with longer latencies associated with the large circle (A). The Stimulus by Tasks interaction [$F(4,60) = 6.69, p < .01$] was examined by tests for "simple effects" (Winer, 1962, p. 323). As expected, there was no difference between the latencies of responses to the two stimuli in the SRT task, since the detection of stimulus onset was sufficient for responding. The stimulus effect was significant in the RRT ($p < .025$), CRT ($p < .01$), and S-DCRT ($p < .0005$) tasks. Inspection of the data showed that this interaction reflected the performance of 13, 14, and 11 out of 16 Ss in the three tasks, respectively. In the S-DRRT task, the absence of a significant stimulus effect ($A > B$) seems to be due not to the lack of a stimulus effect in individual Ss, but to the lack of consistency in the direction of the difference between Ss; 14 out of the 16 Ss showed marked differences, ranging from 30 to 125 msec between "same" (AA vs BB) and between "different" (AB vs BA) stimulus-pair combinations, suggesting that individuals tended to process the stimuli differentially. In the S-DCRT and S-DRRT tasks, there was a correspondence in the direction of latency differences with respect to the initial member of the

Table 2
Matrix of Correlations Among Five Reaction Time Tasks Based on Difference Scores ("Different" Minus "Same" RTs and "Nonrepeated" Minus "Repeated" RTs, $N = 16$) in Experiment 1

	SRT	RRT	S-DRRT	CRT	S-DCRT
SRT		.406	.115	.035	.121
RRT			.443*	.354	.197
S-DRRT				.249	.181
CRT					.787**
S-DCRT					

* $p < .05$ ** $p < .001$

stimulus pair. In general, if RT_{AA} was longer than RT_{BB} , then RT_{AB} was longer than RT_{BA} , and if RT_{AA} was shorter than RT_{BB} , then RT_{AB} was shorter than RT_{BA} . This relation held for 13 out of 16 and 12 out of 16 Ss in the S-DCRT and S-DRRT tasks, respectively. On the whole, these results suggest that, beyond the stimulus-detection stage (SRT), Ss tended to process the two stimuli at different rates.

"Same" RTs were shorter than "different" RTs and "repeated" RTs were shorter than "nonrepeated" RTs [Judgment, $F(1,15) = 34.09, p < .001$]. The Judgment by Tasks interaction [$F(4,60) = 13.53, p < .01$] was also significant. Tests of simple effects revealed that the judgment effect ("same" or "repeated" RT < "different" or "nonrepeated" RT) was significant for four of the five tasks (SRT: $p < .05$; RRT: $p < .025$; S-DRRT: $p < .005$; and S-DCRT: $p < .005$). In the CRT task, the difference was not significant, but the latency difference between "repeated" trials and "nonrepeated" trials was in the same direction.

The extent of the relation between the "same-different" effect and the "repetition" effect was determined by calculating correlation coefficients (Spearman's rho) among the difference scores ("different" minus "same," or "nonrepeated" minus "repeated") obtained in the various tasks. The resulting matrix of all possible correlations is presented in Table 2. Only the correlations between RRT and S-DRRT tasks ($\rho = .443, p < .05$) and CRT and S-DCRT tasks

($\rho = .787, p < .001$) were significant. These results show that the shorter the latency for the "same" trials relative to the "different" trials in the S-DRRT and S-DCRT tasks, the shorter the latency for "repeated" trials relative to the "nonrepeated" trials in the RRT and CRT tasks, respectively.

Out of the 7,680 trials (Parts 2 and 3) on which it was possible to make an error, 558 or 7.2% were errors. There were two types of errors: E_{diff} , that is, the error of responding to a "same" or "repeated" trial as though it were a "different" or "nonrepeated" trial, and E_{same} , that is, the error of responding to a "different" or "nonrepeated" trial as though it were a "same" or "repeated" trial. The observed frequencies of these errors are shown in Table 3. E_{same} occurred more frequently than did E_{diff} , and this tendency was more pronounced in the S-DRRT and S-DCRT than in the RRT and CRT tasks. Overall relative error frequency also tended to be higher in the former than in the latter set of tasks.

EXPERIMENT 2

In Experiment 1, "repeated" and "same" RTs were shorter than "nonrepeated" and "different" RTs, respectively. However, a reverse relation ("same" longer than "different" and "repeated" longer than "nonrepeated") has been reported by Bindra, Williams, and Wise (1965) with respect to the "same-different" effect and by Williams (1966) with respect to the "repetition" effect. The "same-different" relation reported in the Bindra, Williams, and Wise study could be attributed to the fact that the stimuli (two tones differing in frequency) were less discriminable than the stimuli (e.g., letters, colors) used in other investigations (e.g., Nickerson, 1967). The difference between Williams' results and those of others (e.g., Bertelson, 1965) may, in turn, be due to the differences in the length of the intertrial intervals (ITI) employed; in the Williams experiment, ITI ranged from 12 to 15 sec, an interval considerably longer than that employed by the others. Since it is reasonable to assume that an increase in ITI will tend to degrade

Table 3
Number of Errors (E_{same} and E_{diff}) in Four Reaction Time Tasks as a Function of Number of Response Alternatives and Number of Stimuli Per Trial in Experiment 1. (Figures in parentheses indicate expected number of errors assuming random distribution.)

Type of Error	Number of Response Alternatives			
	One Response		Two Responses	
	(One Stimulus) RRT	(Two Stimuli) S-DRRT	(One Stimulus) CRT	(Two Stimuli) S-DCRT
E_{same}	57 (46.5)	133 (93.0)	30 (46.5)	143 (93.0)
E_{diff}	50 (46.5)	44 (93.0)	25 (46.5)	76 (93.0)
Total	107 (93.0)	177 (186.0)	55 (93.0)	209 (186.0)

Table 4
Mean Latencies and Errors for Responses Obtained with Two Stimuli, Large Circle (A) vs Small Circle (B) in the CRT and S-DCRT Tasks (Experiment 2)

Task	Type of Trial	Latency in Msec		Overall for Both (A and B)	Per Cent Errors
		Large (A)	Small (B)		
CRT	Repeated (R)	673	695	684	9.2
	Nonrepeated (N)	638	652	645	3.2
	Overall (R and N)	656	674	665	6.2
S-DCRT	Same (S)	992	969	981	14.4
	Different (D)	1059	991	1025	19.6
	Overall (S and D)	1026	980	1003	17.0

the discriminability of sequentially presented stimuli, it is possible that both the above discrepancies arise from variations in stimulus discriminability.

Thus, reducing the discriminability of task stimuli, either by increasing stimulus similarity or by increasing the interval between them, may have the effect of reducing the difference between the latencies of "same" or "repeated" and "different" or "nonrepeated" stimuli, respectively. If a reduction in stimulus discriminability influences the two effects in a parallel way, the idea that the two effects arise from a common set of processes would be supported. Experiment 2 was designed to determine whether or not diminishing stimulus discriminability by using a long (10-sec) interval between stimuli would affect the "repetition" and "same-different" effects in a parallel way.

Subjects

Sixteen Ss (15 males and 1 female) were drawn from the same population as that used in Experiment 1. They were paid \$1.50 per hour.

Procedure

Almost all aspects of apparatus, stimuli, stimulus sequences, procedures, and data analysis were identical to those of Experiment 1. The main difference was that only two out of the five tasks were used (CRT and S-DCRT), and that the ITI in CRT and the ISI in S-DCRT were increased to 10 sec.

Results

Means of the individual median correct RTs for "same" and "repeated," as well as for "different" and "nonrepeated," responses for each of the two stimuli in the CRT and S-DCRT tasks are presented in Table 4. These latency scores were assessed by a four-way analysis of variance [Stimulus: large vs small; by Judgment: "same" (and "repeated") vs "different" (and "nonrepeated"); by Task: CRT vs S-DCRT by Ss].

The main effect for tasks

[$F(1,15) = 126.378$, $p < .001$] was significant, with overall RTs being longer in the S-DCRT task than in the CRT task, as was the case in Experiment 1. Neither of the main effects of stimulus or judgment was significant, but the interactions of each with tasks were significant. The Stimulus by Tasks interaction [$F(1,15) = 15.907$, $p < .05$] was examined by tests of "simple effects," which revealed that the stimulus effect reported in Experiment 1 (RTs for the "large" circle longer than those for the "small" circle) was significant in the S-DCRT task ($p < .01$) but not in the CRT task. This suggests that the longer ITI in the CRT task decreased the discriminability of the stimuli and diminished the tendency to process them differentially. This is evidenced by the fact that latency differences between the stimuli were rather small, compared to those observed in Experiment 1. This was also true of the latency differences in the S-DCRT task, as compared to Experiment 1. The correspondence between the RTs of stimulus combinations AA vs AB and BB vs BA, observed in the S-DCRT task in Experiment 1, was also present in 14 out of the 16 Ss in Experiment 2; that is, whenever RT_{AA} was longer than RT_{BB} , RT_{AB} was also longer than RT_{BA} , and vice versa.

Tests of "simple effects" following the Judgment by Tasks interaction [$F(1,15) = 18.758$, $p < .001$] revealed that both "same" and "repeated" RTs differed significantly ($p < .01$) from "different" and "nonrepeated" RTs, respectively, but in opposite directions. The RTs for "repeated" trials were longer than they were for "nonrepeated" trials, whereas RTs for "same" trials were shorter than RTs for "different" trials. Although the "same-different" effect was in the same direction as that in Experiment 1, the magnitude of the difference between "same" and "different" RTs was considerably reduced.

To assess whether or not any relation between the two tasks still existed, the difference scores were correlated by means of Spearman's rho, as in Experiment 1. The

correlation was significant ($\rho = .471$, $p < .05$), indicating that the assumption that analogous processes occur in the CRT task and in the S-DCRT task remains tenable.

Excluding practice trials, a total of 3,840 responses (1,280 CRT, 2,560 S-DCRT) was recorded. Of these, 516 were incorrect (80 CRT, 436 S-DCRT), representing an error frequency of 13.4%. The distribution of the two types of errors in each task is shown in Table 5. Overall relative error frequency was higher in the S-DCRT task than in the CRT task, as in Experiment 1. The distribution of the two types of errors, E_{same} and E_{diff} differed in the two tasks, with E_{same} occurring more frequently than E_{diff} in the S-DCRT task and less frequently in the CRT task.

DISCUSSION

This discussion is concerned mainly with the significance of the present findings for elucidating the nature of (a) the stimulus-size effect, (b) the positive and negative "repetition" effect, and (c) the positive and negative "same-different" effect.

The Stimulus-Size Effect

The larger circle (A) yielded longer reaction latencies than did the smaller circle (B) in the RRT and CRT tasks of Experiment 1 but not in the SRT task. Since the SRT task may be performed adequately on the basis of only stimulus detection, it would appear that the stimulus-size effect is generated beyond the stimulus-detection stage of stimulus processing. Since the magnitude of the stimulus-size effect was about equal in the RRT and CRT tasks, the effect probably arises from the stage of stimulus processing that is common to these two tasks, namely, stimulus identification. The absence of the stimulus-size effect in the CRT task of Experiment 2 may be attributed to the decreased discriminability of both the stimuli owing to the 10-sec ITI.

In both the S-DRRT and S-DCRT tasks, the relative latencies for the four stimulus-pair combinations (AA, BB, AB, and BA) were determined not so much by

Table 5
Number of Errors (E_{same} and E_{diff}) in Two RT Tasks as a Function of Number of Stimuli Per Trial in Experiment 2. (Figures in parentheses indicate expected number of errors assuming random distribution.)

Type of Error	Number of Stimuli	
	CRT (One Stimulus)	S-DCRT (Two Stimuli)
E_{same}	21 (86)	251 (172)
E_{diff}	59 (86)	185 (172)
Total	80 (172)	436 (344)

the second member of each pair as by the first member of the pair; if RT_{AA} was longer than RT_{BB} , then RT_{AB} was longer than RT_{BA} , or vice versa. In other words, it was the initial member of the stimulus pair that determined the observed latency differences among the four stimulus pairs (AA, BB, AB, and BA).

Why the identification of the larger circle should take longer than that of the smaller circle remains a question for further investigation; perhaps this is a feature of the sensory processes involved in receptors that have the property of spatial extension (e.g., visual and tactual receptors).

Positive and Negative Repetition Effects

A positive repetition effect (i.e., shorter reaction times on "repeated" trials than on "nonrepeated" trials) has been previously reported by Bertelson (1963, 1965), Bertelson and Renkin (1966), Hale (1967), and Smith (1968) in the CRT task. Our results of Experiment 1 show that this effect may also occur in the SRT and RRT tasks, so it may be concluded that the effect does not depend on stimulus identification or any other complex discrimination process or on any response facilitation or inhibition processes (since a single response is specified for all responses, "repeated" or "nonrepeated"). Rather, the effect probably arises from sensory processing no more complex than that involved in the SRT task, perhaps from an increase in the speed of detection of repeated stimuli.

A negative repetition—what Hale has called "negative recency"—effect (i.e., longer reaction times on "repeated" trials than on "nonrepeated" trials), earlier reported from this laboratory (Williams, 1966), has recently been confirmed by Hale (1967) and Moss, Engel, and Faberman (1967). The results of the present Experiment 2 show that this negative effect arises when the ITI is long; the change in ITI from 2 sec in Experiment 1 to 10 sec in Experiment 2 resulted in a reversal of the repetition effect from positive to negative. Presumably, if the ITI were increased gradually, there would be a gradual reduction in the magnitude of the positive repetition effect to zero and then a gradual increase in the magnitude of the negative repetition effect. Though systematic parametric studies have not yet been undertaken, we have plotted as dotted lines the differences between RTs on "repeated" and "nonrepeated" trials reported by Hale (1967) and Smith (1968), as well as the differences found in our experiments, in Fig. 1. It is clear that, for a variety of test stimuli, the relation between ITI and the

direction and magnitude of the repetition effect is essentially as described above.

Positive and Negative "Same-Different" Effects

A positive same-different effect (shorter reaction times on "same" trials than on "different" trials) has been previously reported for the S-DCRT task (e.g., Bindra, Donderi, & Nishisato, 1968; Corballis, Lieberman, & Bindra, 1968; Nickerson, 1965, 1967). Our present results show that the effect may also be obtained in an S-DRRT task. Further, our Experiment 2 reveals that an increase in ISI, which corresponds to ITI in the case of the single-stimulus-per-trial tasks (SRT, RRT, and CRT), leads to a reduction in the magnitude of the positive "same-different" effect; at the 10-sec ISI, the effect was markedly reduced. It is likely that had we employed a still longer ISI, a negative "same-different" effect (i.e., longer reaction times on "same" than on "different" trials) would have been found. This supposition is supported by the fact that negative "same-different" effects have been found in earlier investigations (e.g., Bindra, Donderi, & Nishisato, 1968; Bindra, Williams, & Wise, 1965; Walk, 1965).

The results of experiments in which ISI was varied in a S-DCRT task are also replotted as unbroken lines in Fig. 1 (Bindra, Williams, & Wise, 1965; Klein, 1968). It is seen that the exact time interval at which the direction of the effect changes from positive to negative depends on the nature of the test stimuli used. Thus, as in the case of the "repetition" effect, the direction and magnitude of the "same-different" effect are a function of discrimination difficulty. This parallel, together with the fact that significant positive correlations were found between the difference scores ("nonrepeated" minus "repeated" or "different" minus "same") obtained in the RRT and S-DRRT tasks, as well as those obtained in the CRT and S-DCRT tasks, suggests that the processes that produce the "repetition" and "same-different" effects may be largely the same. The actual magnitude of the two effects would differ, presumably owing to the differences in stimulus-response mapping rules. The consequent differences in the type of comparison processes in the two tasks (e.g., stimulus identification may be sufficient in the case of RRT and CRT tasks, whereas assessment of stimulus equivalence may be involved in the S-DRRT and S-DCRT tasks) would make for differences in the exact ISI or ITI interval at which reversal occurs in the two effects.

The reduction, with increasing ITI, of

Fig. 1. Difference scores representing the "repetition" effect ("nonrepeated" minus "repeated") and the "same-different" effect ("different" minus "same") as a function of the interval between two stimuli (ITI in the case of the CRT task and ISI in the case of the S-DCRT task) in the present Experiments 1 and 2, and as reported in some other recent studies. The intervals indicated represent the time from stimulus onset to stimulus onset as nearly as it could be approximated from the reports. Sources: Bindra, Williams, & Wise (1965); Hale (1967); Klein (1968); Smith (1968).

the positive "repetition" and "same-different" effects, and their final reversal to a negative effect, is best attributed to the increasing difficulty of stimulus discriminability with time. If this is correct, then other stimulus variables (e.g., background noise, similarity of various stimuli presented, duration of stimulus presentation, etc.) that would make stimulus discriminability more difficult should also affect the magnitude and direction of these effects. This is supported by the observation that, in general, the more easily discriminable or "codable" stimulus characteristics (e.g., forms of letters, colors of light patches) appear to yield a positive effect over a longer range of ISIs while the less easily discriminable or "noncodable" stimulus characteristics (e.g., length of lines, pitch of tones) appear to yield a negative effect at relatively short ISIs. Error data, showing a higher proportion of errors under conditions which attenuate the positive "repetition" and "same-different" effects, are also consistent with the discrimination difficulty hypothesis.

But why an increase in the difficulty of stimulus discriminability should affect the

repetition effect is a question that required further investigation. The available evidence indicates that the reversal in the direction of the "repetition" and "same-different" effects from positive to negative is brought about primarily by a relative increase in the reaction times for "same" or "repeated" trials rather than by a relative decrease in the reaction times for "different" or "nonrepeated" trials (e.g., Bertelson & Renkin, 1966; Corballis, Lieberman, & Bindra, 1968; Hale, 1967; Klein, 1968). This observation suggests that the stimulus discrimination involved in the various reaction-time tasks is based on a comparison of the incoming stimulus to the background noise or to the trace of an earlier stimulus, and that, as discrimination difficulty increases, it becomes more and more difficult to judge the equivalence of repeated stimuli.

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NOTES

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3. In tasks where a pair of stimuli were presented per trial (S-DRRT and S-DCRT), the dichotomy was based on the first stimulus of the pair, i.e., "large" (A) included the stimulus combinations "AA" and "AB" and "small" (B) included the stimulus combinations "BB" and "BA." This grouping was suggested by results of a pilot study using the same stimulus set.

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