

## Conditioned Generalization, Cognitive Set, and the Structure of Human Learning<sup>1</sup>

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The Ss were given learning trials on which stimulus *C* was first preceded by signal *F* and reinforced to response *R*, followed by reconditioning of *C* alone to a new response *R'*. With high accuracy and no detectable response competition, Ss were able to reproduce either *R* or *R'* in response to *F*, as well as to *C*, in compliance with recall instructions.

Some years ago, the writer pointed out that most conditioning data which have been interpreted mediationaly are instances of a generic empirical phenomenon which may be called "conditioned generalization" (Rozeboom, 1958). Slightly specialized from its most general form, the conditioned generalization paradigm is best put as a question of degree: *When stimulus  $S_c$  is conditioned to response  $R$  through pairings of  $S_c$  with a previously established elicitor  $S_u$  of  $R$ , and  $S_u$  is subsequently reconditioned to elicit  $R'$  instead of  $R$ , to what extent does the organism's response to  $S_c$  transfer to  $R'$  rather than perseverating in  $R$ ?* From  $S_c$ 's pairings with  $R$ 's elicitor  $S_u$ , the organism may acquire an unmediated sensory-motor association  $S_c \rightarrow R$  by virtue of which presentations of  $S_c$  directly elicit  $R$ , a sensory-sensory association  $S_c \rightarrow S_u$  in virtue of which presentations of  $S_c$  directly elicit the afferent correlate ("idea") of  $S_u$  and mediately whatever response is in turn elicited by  $S_u$ , or some degree of both. The quantitative dominance of transfer over perseveration in the test phase of

the paradigm thus reflects the extent to which the organism's experienced contingencies between  $S_c$  and  $S_u$  have brought about an S-S learning in virtue of which new responses to  $S_u$  are generalized to  $S_u$ , rather than an unmediated S-R coupling of  $R$  to  $S_c$ .

While numerous mediated transfer studies falling under the conditioned generalization paradigm have appeared in the human-learning literature, none of the published data clarify the manner in which, given opportunity for conflict between perseveration ( $S_c \rightarrow R$ ) and transfer ( $S_c \rightarrow S_u \rightarrow R'$ ) associations, one tends to dominate over the other. An exploration of this question is reported here. Since earlier work (unpublished results) by the writer had indicated the balance between manifest transfer and manifest perseveration in human conditioned generalization to be markedly influenced by the wording of instructions, the present experiment was designed primarily (a) to see how far the dominance of manifest transfer over manifest perseveration, or the converse, can be driven by the wording of instructions, and (b) to separate the effect of instructions upon acquisition from their effect on test-trial behavior.

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## METHOD

*Subjects*

The Ss were 57 male and 48 female students from an introductory psychology course at the University of Alberta. Each S was assigned in the order of arrival to one of the treatment categories in a  $2 \times 3 \times 2 \times 2 \times 2$  factorial design and run singly in a continuous session of about 45-min duration. Two or, in a few cases, three Ss were run under each of the 48 treatment combinations. (The original intent was to have four Ss in each treatment category. However, when summer vacation interrupted subject availability, the primary information sought was so conspicuous in the data already collected that additional Ss seemed unnecessary.)

*Apparatus*

The S was seated before a  $4 \times 3$  in. ground-glass screen upon which various homogeneous screen-filling colors and white-on-black geometrical forms could be projected. Below the visual screen and in front of the rest position for S's hand were 12 buttons positioned horizontally in two rows of six. All stimulus events on a given trial were regulated by a control unit which also recorded S's responses and first-response reaction time. Each trial was programmed by a punched card which E changed manually with a between-trial interval of roughly 5 sec.

*Procedure*

Each S received a total of 248 color-training, form/color, color-retraining, form-test, and color-test trials as follows: On a *color-training* trial  $C_i R_i$  ( $i = 1, \dots, 6$ ) or *color-retraining trial*  $C_i R'_i$  ( $i = 1, \dots, 5$ ), color  $C_i$  appeared on the display screen and remained visible until S pressed button  $R_i$  or  $R'_i$ , respectively. On a *form/color* trial  $F_i C_i R_i$  ( $i = 1, \dots, 6$ ), form  $F_i$  appeared on the screen for 1.5 sec and was then replaced with zero delay by color  $C_i$ , which persisted until S pressed button  $R_i$ . A form/color trial could be terminated by S only after the color appeared. On a *form-test* or *color-test* trial, form  $F_i$  or color  $C_i$  was presented and remained visible until S's first response, which produced no feedback other than trial termination. The trials were grouped in six uninterrupted series, each introduced by a distinctive set of instructions which, except for the initial task orientation, was the same for every S. With one exception, the sequence of stimuli and reinforced responses within each series was likewise the same for each S.

The exception was that the particular form, color, and button assigned to paradigm roles  $F_s$ ,  $C_s$ , and  $R_s$ , respectively, for half the Ss were assigned to respective paradigm roles  $F_6$ ,  $C_6$ , and  $R_6$ , for the other half, and conversely.

*Phase I.* Each S was informed that his task was to learn the correct button response to each color stimulus, and that the appearance of a color would sometimes be preceded by a form. The Ss receiving Initial Instructions 1 (S-S set) were advised that they would later be asked to recall what colors the forms went with; Ss receiving Initial Instructions 2 (S-R set) were advised that they would later be asked to recall what buttons the forms went with, while Ss receiving Initial Instructions 3 (no set) were told merely that the forms were warning signals. The S then received a series of 144 trials, 12 each of color-training trials  $C_i R_i - C_6 R_6$  and 12 each of form/color trials  $F_i C_i R_i - F_6 C_6 R_6$ . The various types of trials were mixed in a semirandom order in which color-training trials occurred most frequently at the beginning of the series while form/color trials predominated at its end.

*Phase II.* The S was next instructed that he was now to learn new responses to the colors, and was then given 60 color-retraining trials, 12 each of  $C_i R'_i - C_6 R'_6$ , in semirandom order. Responses (buttons)  $R'_1 - R'_6$  were all distinct from each other and from  $R_1 - R_6$ , while as retention controls,  $R'_6$  was the same as  $R_6$  and  $C_6$  was omitted from Phase II altogether.

*Phase III.* This consisted of two series of form-test trials, one under instructions to transfer (T-test) and one under instructions to perseverate (P-test). Specifically, T-test instructions requested S to respond to each form by pressing the button which was now correct for the color that was previously paired with the form, while P-test instructions requested S to press the button which was previously correct on trials beginning with that form. Half the Ss in each sex and initial-instructions group received their P-test first and T-test second, while the test order was reversed for the other half. The P-test series consisted of 12 form trials, two each on  $F_1 - F_6$  in semirandom order, while the T-test series consisted of 10 form trials, two each on  $F_1 - F_5$ . (Form  $F_6$  was omitted from the T-test because its associated color did not appear in the color-retraining series.)

*Phase IV.* Finally, Ss were given two series of color-test trials, one under instructions to recall the new color responses (t-test) and one under instructions to revert to the original color responses (p-test). Half the Ss in each of the

treatment categories differentiated previously received their p-test first, while the other half were t-tested first. The p-test series consisted of 12 color-test trials, two each on  $C_1$ - $C_6$ , while the t-test series consisted of 10 trials, two each on  $C_1$ - $C_5$ . It will be noted that the treatment of color stimuli in Phases I, II, and IV essentially reproduces with nonverbal material the "MMFR" procedure (Melton, 1961) introduced by Barnes and Underwood (1959) for analysis of retroactive inhibition in verbal learning.

### RESULTS AND DISCUSSION

The design of this experiment makes available both within-S comparisons among various response measures at different stages of the experiment, and between-S comparisons on the same measure under different factorial treatment combinations. The treatment variables are: (a) sex of S; (b) initial instructions; (c) particular stimuli and responses used for the retention controls; (d) form-test order; and (e) color-test order. Except for one unimportant sex difference to be mentioned, none of the factorial treatment variables other than initial instructions produced any effects, either main, interaction, or joint, which approached statistical significance at the .05 level.

Learning was rapid in both Phases I and II, reaching a probability of correct

response in the upper .90s by around the tenth trial on each color in Phase I (counting both  $C_1R_1$  and  $F_1C_1R_1$  as trials on  $C_1$ ) or around the sixth trial in Phase II, and increasing to about .99 by the end of the series. While initial instructions had no effect on Phase I or Phase II learning rates, males made 32% more errors in Phase I than did females ( $p < .01$ ). This difference receded to a statistically insignificant 11% in Phase II, however, and except for a borderline  $p$  value on one of the latency measures, no further sex differences worthy of statistical respect were found.

In Phases III and IV, several measures were obtained of S's manifest retention of associations with which Phase II reconditioning attempted not to interfere. Color  $C_6$  was preceded by form  $F_6$  and reinforced to  $R_6$  in Phase I, and neither of these two stimuli appeared again until their respective test trials. The color  $C_5$  paired with  $F_5$  and reinforced to  $R_5$  in Phase I also continued to be reinforced to  $R_5$  in Phase II; hence  $R_5$  was the only response to  $F_5$  or to  $C_5$  which manifested experimentally intended associations to these stimuli. The manifest-retention rates obtained on these measures under each initial-instructions condition are shown in Table 1. The null

TABLE 1  
MANIFEST RETENTION OF CONTROL ASSOCIATIONS<sup>a</sup>

Retention	Initial-instructions Group			All Ss
	1 (S-S set, $N = 36$ )	2 (S-R set, $N = 35$ )	3 (no set, $N = 34$ )	
Form retention				
$F_5$ , T-test	.930	.957	.765	.885
$F_5$ , P-test	.903	.971	.809	.894
$F_6$ , P-test	.862	.986	.883	.908
Color retention				
$C_5$ , t-test	1.000	.971	.985	.986
$C_5$ , p-test	.972	.971	.971	.971
$C_6$ , p-test	.972	1.000	.985	.986

<sup>a</sup> Each entry is the proportion of correct responses, i.e.,  $R_5$  to  $F_5$  and  $C_5$ ,  $R_6$  to  $F_6$  and  $C_6$ , made by Ss in the indicated category to the listed stimulus, and is based on two observations per S for each measure.

hypotheses (a) that initial set has no true effect on manifest form retention (sum of *S*'s correct form-retention responses, tested by chi-square comparison of distributions across initial-instructions conditions), and (b) that there is no true difference between manifest form retention and manifest color retention (sum of *S*'s correct color-retention responses less sum of correct form-retention responses, tested by *t* for difference from zero) can be rejected at the .05 and .01 levels, respectively.

The distributions of responses to the transfer-test form stimuli (i.e.,  $F_1-F_4$ ) under the various combinations of initial and form-test instructions are summarized in Table 2. While the profound effect of test instructions upon form-test behavior needs no sampling-theoretical confirmation, the influence of initial instructions is more statistically problematic. Inspection of the total number of times each *S* successfully complied with instructions on all T-tests and P-tests of forms  $F_1-F_4$  showed differences among the compliance distributions under the various initial-instructions conditions which by chi-square were significant at the .05 level on the P-test and at

the .01 level on the T-test. The nature of this effect is such that, whereas only small differences appear between the S-S set and S-R set groups, *S*s given no initial set show a much higher rate of very poor compliance. The primary influence of initial instructions is thus likely an attention phenomenon in which *S*s who attend, for whatever reason, to the forms in Phase I retain all aspects of their form experiences better than do *S*s given no incentive to heed them. A secondary interactive effect, significant at the .05 level even though small numerically, is that while *S*s given an initial S-S set do better on the T-test than on the P-test, the reverse is true for *S*s given an S-R set and even more so for *S*s given no initial set (*S*'s P-test compliance less T-test compliance, tested for initial-instructions difference by analysis of variance). This suggests not only that selective attention can bias the extent to which *S* acquires S-S rather than S-R structures, but also that human learning may run more naturally to the latter than to the former.

The effects of instructions upon Phase IV responding to the transfer-test colors (i.e.,  $C_1-C_4$ ) are shown in Table 3. Where-

TABLE 2  
DISTRIBUTIONS OF PHASE III RESPONSES TO TRANSFER-TEST FORMS<sup>a</sup>

Transfer rate <i>Perseveration rate</i> (Noise rate)	Initial-instructions Group			All <i>S</i> s
	1 (S-S set, <i>N</i> = 36)	2 (S-R set, <i>N</i> = 35)	3 (no set, <i>N</i> = 34)	
T-test (instructions to transfer)	<b>.940</b> <i>.007</i> (.053)	<b>.928</b> <i>.007</i> (.065)	<b>.762</b> <i>.000</i> (.239)	<b>.878</b> <i>.004</i> (.118)
P-test (instructions to perseverate)	<b>.003</b> <i>.900</i> (.097)	<b>.000</b> <i>.960</i> (.041)	<b>.000</b> <i>.816</i> (.184)	<b>.001</b> <i>.893</i> (.106)

<sup>a</sup> Each entry gives the proportion of transfer-test responses obtained in each treatment category (a total of eight responses per *S*, two for each form) which manifested transfer (boldface), perseveration (italics), or noise (parenthesized), respectively. A test response to transfer-test form  $F_i$  manifests "perseveration" if it is the response  $R_i$  reinforced to form  $F_i$  and color  $C_i$  in Phase I, "transfer" if it is the response  $R_i$  reinforced to color  $C_i$  in Phase II, and is "noise" otherwise.

TABLE 3  
DISTRIBUTIONS OF PHASE IV RESPONSES TO TRANSFER-TEST COLORS<sup>a</sup>

Transfer rate <i>Perseveration rate</i> (Noise rate)	Initial-instructions Group			All Ss
	1 (S-S set, N = 36)	2 (S-R set, N = 35)	3 (no set, N = 34)	
t-test (instructions to recall new response)	<b>.986</b> <i>.004</i> (.010)	<b>.975</b> <i>.000</i> (.025)	<b>.970</b> <i>.000</i> (.030)	<b>.978</b> <i>.001</i> (.021)
p-test (instructions to recall old response)	<b>.018</b> <i>.892</i> (.090)	<b>.000</b> <i>.936</i> (.064)	<b>.000</b> <i>.930</i> (.070)	<b>.006</b> <i>.919</i> (.075)

<sup>a</sup> Each entry gives the proportion of transfer-test responses obtained in each treatment category (a total of eight responses per S, two for each color) which manifested transfer (boldface), perseveration (italics), or noise (parenthesized), respectively. A test response to transfer-test color  $C_i$  manifests "perseveration" if it is the old response  $R_i$  reinforced to  $C_i$  in Phase I, "transfer" if it is the new response  $R'_i$  reinforced to  $C_i$  in Phase II, and is "noise" otherwise.

as the minute initial-instructions differences are highly insignificant, the overall superiority of compliance on the t-test over that on the p-test (S's sum of correct responses to  $C_1-C_4$  on the t-test less those on the p-test, tested by  $t$  for difference from zero) is significant beyond the .01 level.

On the face of it, these data show that with suitable encouragement, mature humans can mediate very well indeed. Although response  $R'_i$  ( $i = 1, \dots, 4$ ) was never reinforced to form  $F_i$ , their mutual association with color  $C_i$  allowed S to make  $R'_i$  to  $F_i$  with about 90% accuracy when instructed to do so. While S's set during the  $F_i/C_i$  pairings makes some difference for S's later success at recall, Tables 1 and 2 show that within each initial-instructions group, S's ability to synthesize  $F_i \rightarrow R'_i$  out of  $F_i \rightarrow C_i$  and  $C_i \rightarrow R'_i$ , even when  $R'_i$  conflicts with the response  $R_i$  to which stimulus complex  $F_i C_i$  was initially reinforced, is not appreciably inferior to S's ability to reproduce the original direct connection  $F_i \rightarrow R_i$ , while the latter, in turn, is not impaired by mediated conflict from

$F_i \rightarrow C_i \rightarrow R'_i$ . Traditionally interpreted, it would thus appear that under favorable conditions of instructional set during learning and recall, mediated associations can manifest near-perfect dominance over unmediated ones, or vice versa.

However, the profound effect of test instructions upon S's transfer-test behavior, whereby S successfully complies with E's request either to transfer or to perseverate, calls into question the very associationistic framework in terms of which the conditioned-generalization paradigm was originally interpreted, namely, that the test-trial balance between transfer and perseveration measures the extent to which S acquires S-S rather than S-R associations from his Phase I experiences. For no matter how elaborate a pattern of associationistic arrows be hypothesized among the elements  $F_i$ ,  $C_i$ ,  $R_i$ , and  $R'_i$ , there is no association-theoretical mechanism by which test instructions can alter the strengths of component associations in such a network to make possible S's demonstrated ability to vary his form-test responding in near-perfect compliance with the requested re-

call. The same problem arises for an associationistic explanation of the color-test data (Table 3). While color retraining cannot be expected to extinguish  $C_1 \rightarrow R_1$  completely,  $C_1 \rightarrow R'_1$  was entirely ascendant over  $C_1 \rightarrow R_1$  by the end of Phase II. Even allowing for some drift toward equalization during the interval between reconditioning and testing, we should still expect  $C_1 \rightarrow R'_1$  to be substantially stronger than  $C_1 \rightarrow R_1$  on the color tests—as seemingly counter-indicated by the 92% accuracy of Ss' p-test recall. In any event, retention of both these associations should result in an appreciable  $C_1$ -test incidence of  $R_1$  and  $R'_1$  in relative proportions which, to the extent that they manifest the comparative strengths of different associations to the same stimulus, test instructions have no power to modify.

That there is *no competition whatsoever* between transfer and perseveration responses in the present data, is shown most strikingly by the composition of incorrect transfer-test responses. Let S's response to forms  $F_1$ – $F_4$  or colors  $C_1$ – $C_4$  be called a "manifest competition error" if it is  $R'_1$  when  $R_1$  is correct in accord with test instructions, or is  $R_1$  when  $R'_1$  is correct. A manifest-competition-error base rate of about one incorrect response in eleven, or one in nine if we exclude the two buttons which were never reinforced, may be attributed to random guessing; above this, manifest competition errors presumably reflect conflict between transfer and perseveration tendencies. But out of a total of 277 incorrect responses obtained on all transfer-test trials (form tests and color tests combined), only 11, or 4.0%, were manifest competition errors. While the statistical assessment of this percentage is complex and inexact, it seems highly probable that its parametric value is less than 9%. (For example, if it could be assumed that the 277 incorrect responses were all independent observations with a para-

metric probability  $p$  of being a manifest competition error,  $.022 < p < .071$  would be a 95% confidence interval for  $p$ .) Thus, rather than competition between transfer and perseveration being responsible to even a limited degree for the occasional failure of test compliance, there appears to be an active *suppression* of competition errors even when S is unable to recall the compliance response.

Previous efforts to explain the lack of manifest competition between old-list and new-list responses in A–B, A–C verbal learning paradigms have appealed to a concept of "list differentiation" (cf. Postman, 1961, p. 154; Melton, 1961, p. 184f.) While this notion has never been made entirely clear, and its associative status has been questioned (Mandler, 1965, p. 324f.), it is best construed associationistically as a context-cue hypothesis that the nominal A–B, A–C paradigm may functionally be  $x$ A–B,  $y$ A–C learning. Applied to the present experiment, this interpretation presupposes the existence of context cues  $x$  and  $y$  such that  $x$  but not  $y$  is present throughout Phase I, while  $y$  but not  $x$  is present throughout Phase II. Then the associations acquired by S in Phase I should be  $x$  $C_1 \rightarrow R_1$ ,  $x$  $F_1 \rightarrow C_1$ , and  $x$  $F_1 \rightarrow R_1$ , rather than merely  $C_1 \rightarrow R_1$  etc., while Phase II training consists not so much in replacing  $C_1 \rightarrow R_1$  with  $C_1 \rightarrow R'_1$  as in establishing  $y$  $C_1 \rightarrow R_1$ . Hence if P-test and p-test instructions somehow arouse  $x$  (or its internal counterpart) in S while T-test and t-test instructions arouse  $y$ , it follows that when color  $C_1$  is tested under instructions to persevere the effective stimulus is actually  $x$  $C_1$ , whereas under transfer instructions it is  $y$  $C_1$ ; whence S's responses on the color tests should manifest perseveration or transfer as requested. Similarly, under perseveration instructions the effective form-test stimulus is  $x$  $F_1$ , which operates both upon direct association  $x$  $F_1 \rightarrow R_1$  and

mediated association  $x F_1 \rightarrow (x) C_1 \rightarrow R_1$  to elicit perseveration response  $R_1$ . Whereas under transfer instructions, while  $y F_1$  tends to elicit both  $R_1$  and  $C_1$  by generalization through component  $F_1$  in  $x F_1 \rightarrow R_1$  and  $x F_1 \rightarrow C_1$ , the standing  $y$  combines with the elicited  $C_1$  to arouse  $R'_1$  via  $y C_1 \rightarrow R'_1$ ; hence  $R'_1$  should dominate over  $R_1$  on T-test trials so long as association  $x F_1 \rightarrow C_1$  is sufficiently stronger than association  $x F_1 \rightarrow R_1$ . But while this interpretation accommodates the qualitative test-instructions effect, it fails quantitatively. If for no other reason than that considerable stimulus generalization should obtain between  $x F_1$  and  $y F_1$  and between  $x C_1$  and  $y C_1$ , stimulus  $F_1$  or  $C_1$  should have an appreciable tendency to elicit both  $R_1$  and  $R'_1$  on all test trials even if the context cues create a bias in favor of the compliance response. This is especially true of T-test trials, where substantial generalization between contexts is essential to the explanation and on which, however opportunistically one plays with generalization parameters, the probability of a compliance response should be considerably less than on the P-test unless  $F_1$  elicits  $R_1$  entirely through the mediation of  $C_1$  (a possibility which the data counterindicate—see below). But not only is compliance just as high on the T-test as on the P-test; the data contravene any interpretation which entails even a trace of test-trial competition between transfer and perseveration.

It seems most unlikely that any theory which construes human learning to be merely the formation of evocation bonds between psychological atoms can adequately account for the present results, irrespective of whether the bonds so hypothesized be S-S or S-R, mediated or direct, in nature. What S apparently learns and retains from the contingencies among  $F_1$ ,  $C_1$ ,  $R_1$ , and  $R'_1$  is not an aggregate of associations which, when appropriately

cued, brings forth a heap of disjoint ideas or incipient responses in various degrees of mutual interference and output availability, but some sort of well-structured totality in which the internal counterparts of  $R_1$  and  $R'_1$  are embedded at positions so discriminably distinctive that each can be picked off by stimulus  $F_1$  or  $C_1$  conjoined with the proper position cue without a whisper of competition between them. The best bet is that what S retains are genuine cognitive memories (Rozeboom, 1965), or dispositions thereto, of the events experienced in Phases I and II in virtue of which the test stimulus arouses *beliefs* something like " $F_1$  was paired with  $C_1$ ," " $R_1$  was originally correct for  $C_1$ ," and " $R'_1$  but not  $R_1$  was correct for  $C_1$  after the change."

Whatever Ss learned in this experiment, provocative clues about its structure are afforded by the reaction-time data, even though sporadic reluctance of the apparatus to record these correctly complicated their analysis. The most frequent error was improper reset between trials, usually producing a grossly inflated reading for S's next latency, while on about 1% of trials the recorder failed to print out reaction time at all. In an attempt to filter out reset error, all recorded latencies greater than 10 sec were treated as omissions, 3% of the observations being so discarded. With these exclusions, each S's average reaction time was separately computed for the terminal Phase II trials and each different type of test trial. Table 4 shows the means and SDs of these latencies among all Ss and, more importantly, among just those Ss who responded errorlessly on all test trials. (Since incorrect responses tend to have longer latencies, the all-S reaction times are partially redundant with the data in Tables 1-3. In contrast, the errorless-S latencies reflect properties of responding under conditions of maximal retention.) Noteworthy among the errorless-S comparisons, statistically evaluated in Table 5, are: (a) Test-trial latencies to retention-test colors are indistinguishable from the terminal Phase II latency. This is true even for  $C_6$ , which S had not seen since Phase I. (b) Latencies to transfer-test colors are on both the t-test and the p-test greater by a small but statistically significant amount than latencies to the terminal Phase II

TABLE 4  
LATENCY MEANS AND STANDARD DEVIATIONS<sup>a</sup>

Series:	Phase II, last ten trials		Form tests					Color tests				
			T-test		P-test			t-test		p-test		
Stimuli:	$C_1-C_4$	$C_5$	$F_1-F_4$	$F_5$	$F_1-F_4$	$F_5$	$F_6$	$C_1-C_4$	$C_5$	$C_1-C_4$	$C_5$	$C_6$
Table 5 label:	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>	<i>g</i>	<i>h</i>	<i>i</i>	<i>j</i>	<i>k</i>	<i>l</i>
Errorless <i>Ss</i> <sup>b</sup>												
Mean	12.8	12.4	18.9	16.6	14.1	14.5	13.6	14.1	12.5	14.7	12.9	12.4
SD	3.1	3.5	8.0	6.6	5.8	5.4	3.9	3.5	3.6	5.1	3.5	5.9
All <i>Ss</i> <sup>c</sup>												
Mean	12.7	11.9	20.9	19.9	16.6	16.2	19.0	14.2	11.9	15.9	13.5	12.7
SD	3.3	3.7	9.1	13.0	9.4	10.9	14.7	4.7	3.4	6.1	5.2	5.0

<sup>a</sup> *S*'s score on each measure is his average reaction time, in tenths of a second, on all trials with the stimuli and series indicated, this consisting of eight observations per *S* for each transfer-test measure (stimuli  $F_1-F_4$  and  $C_1-C_4$ ) and two per *S* for each retention-test measure (stimuli  $F_5$ ,  $F_6$ ,  $C_5$ , and  $C_6$ ).

<sup>b</sup>  $N = 39$ , excluding one anomalous *S* who exceeded the postexclusion errorless-*S* mean by more than three *SDs* on seven of the latency measures and by more than five *SDs* on three.

<sup>c</sup>  $N = 105$ .



and retention-test colors. (c) Latency to the transfer-test forms on the T-test is pronouncedly greater than latency to these stimuli under P-test conditions. (d) Whereas retention-test forms are at the same latency level as transfer-test forms on the P-test, they are significantly lower than the latter on the T-test.

On the face of it, the pronounced increase in form-test latency required for transfer responding compared to perseveration is the time required for mediation—or better, to use a term with fewer associative overtones, for “integration”—since to give the correct transfer response to form  $F_1$ ,  $S$  has to put together two separate experience residues bridged by a color coupled in one with  $F_1$ , whereas perseveration responding requires  $S$  only to tap the experience residue containing  $F_1$ . If this latency difference were merely integration time, however, it should also be shown by form  $F_2$  inasmuch as compliance with instructions requires integration on all T-test trials even though the response so arrived at is for  $F_2$  the same as its perseveration response. But while latency to  $F_2$  is indeed elevated above its P-test level, the errorless- $S$  increment was only half as great as it was for the transfer-test forms. Consequently, much of the additional latency required for transfer responding may well be the action time not of integration as such, but of selection among response alternatives which appear in the integrated structure, akin to the additional discrimination time required for correct test responding to colors with the more complex conditioning histories (see below). If so, then the fact that this

selection increment did *not* appear under P-test conditions further suggests that  $S$ 's cognitive set has some control over what materials are fed into the judgmental procedure.

The T-test/P-test latency difference for transfer-test forms becomes even more informative when compared to the corresponding difference on the color tests. We know from the high T-test and P-test compliance rates that the experience residues from Phase I provide access from  $F_1$  to both  $C_1$  and  $R_1$ . In what fashion does  $C_1$  participate in the  $F_1/R_1$  coupling? If  $F_1$ 's access to  $R_1$  were entirely through  $C_1$ , we should expect the T-test/P-test latency difference on  $F_1$  to be about the same as the t-test/p-test latency difference on  $C_1$ , whereas for transfer-test forms, this difference was strongly in the reverse direction. The data thus suggest that  $S$ 's experience residues included a direct relation between  $F_1$  and  $R_1$ , independent of  $C_1$ , which was ascendant under P-test conditions. The compliance rates in Tables 2 and 3 also support this inference. If responding to  $F_1$  always proceeded through  $C_1$ , compliance on the P-test should have been inferior to compliance on the T-test to about the same extent that p-test compliance was inferior to t-test compliance. Since this predicted P-test inferiority did not in fact appear, P-test recall of  $R_1$  in response to  $F_1$  seems to have been not wholly dependent upon recall of  $C_1$ .

Finally, it should be noted that while  $S$ s were able to recall both old and new responses to the transfer-test colors with

TABLE 5  
STATISTICAL SIGNIFICANCE OF DIFFERENCES BETWEEN ERRORLESS- $S$  LATENCIES IN TABLE 4<sup>a</sup>

<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>	<i>g</i>	<i>h</i>	<i>i</i>	<i>j</i>	<i>k</i>	<i>l</i>	
.79	<b>-5.94</b>	<b>-3.99</b>	-1.61	-1.92	-1.62	<b>-2.12</b>	.59	<b>-2.68</b>	-.31	.38	<i>a</i>
	<b>-5.59</b>	<b>-4.14</b>	<b>-2.03</b>	<b>-2.42</b>	<b>-2.21</b>	<b>-2.63</b>	-.05	<b>-2.63</b>	-.92	.03	<i>b</i>
		<b>2.08</b>	<b>5.08</b>	<b>3.62</b>	<b>4.16</b>	<b>4.10</b>	<b>6.03</b>	<b>3.28</b>	<b>5.39</b>	<b>4.57</b>	<i>c</i>
			<b>2.28</b>	<b>1.80</b>	<b>2.95</b>	<b>2.30</b>	<b>4.58</b>	<b>1.49</b>	<b>3.80</b>	<b>3.64</b>	<i>d</i>
				-.60	.50	.00	1.94	-.67	1.42	1.45	<i>e</i>
					1.01	.51	<b>3.21</b>	-.22	1.95	1.83	<i>f</i>
						-.73	1.99	<b>-1.49</b>	1.12	1.24	<i>g</i>
							<b>2.51</b>	-.83	1.84	1.65	<i>h</i>
								<b>-3.17</b>	<b>-1.03</b>	.05	<i>i</i>
									<b>2.25</b>	<b>2.45</b>	<i>j</i>
										.58	<i>k</i>

<sup>a</sup> Column and row heads designate the various latency variables listed in Table 4. The entry in row  $x$  and column  $y$  is the  $t$ -statistic computed for errorless  $S$ s ( $N = 39$ ) under the null hypothesis that the expected value of an errorless- $S$ 's score on  $x$  minus his score on  $y$  is zero. Differences significant at the .05 level for  $df = 38$  (namely, greater than 2.02 in magnitude) are shown in boldface.

high accuracy (cf. Table 3), new recall was nonetheless better than old by a statistically significant 6%. Moreover, this attrition in old-response retention appears to be due specifically to the conditioning of *different* responses to these stimuli in Phase II, since recall of Phase I responses to both of the retention-test colors, including the one ( $C_6$ ) omitted from Phase II altogether, remained at the new-recall level (p-test data, Table 1). Hence while S was able to output what he retained from Phases I and II without interference among the components of this experience residue, the learning of new responses to old stimuli did interfere with *retention* of prior learning involving those stimuli. With due acknowledgment that so complete a suppression of competition probably requires clearly discriminable responses and perhaps considerable overlearning (cf. Mandler, 1965), this is in complete agreement with the results of several recent verbal learning studies of similar design (Barnes and Underwood, 1959; Postman, 1962a,b; McGovern, 1964). It is important to observe that the present lack of performance interference cannot be attributed merely to separate association systems ("list differentiation") cleanly uncoupled by context cues, even were this plausible theoretically. For the longer test-trial latencies to colors with a history of recon-

ditioning implicate some central discriminative action required to sort out the various components of the more complex experience residues, and would not make sense were the underlying events merely a succession of interference-free elicitations.

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