Effects of stress on mediated paired-associate learning*

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A verbal paired-associate experiment with 60 fifth grade children replicated the Wismer & Lipsitt (1964) finding of both proactive facilitation and interference in the same Ss. In addition, it was hypothesized and found that stress, induced simply by the requirement that S exert pressure on a hand dynamometer, interacts with type of word pair, tending to enhance both the facilitation and the interference effects.

Using a within-S design similar to that previously employed by Norcross & Spiker (1958), Wismer & Lipsitt (1964) demonstrated both mediated facilitation and interference in the same Ss by administering three successive paired-associate lists to fifth grade children. This was accomplished by administering word pairs under the following four conditions for each S: (a) A-B, B-C, A-C for facilitation pairs, (b) A-B, B-C, A-$C_{reversed}$ for interference pairs, (c) A-B, X-C, A-C for one type of control, and (d) new word pairs in List III for another type of control.

With the same-age children and essentially the same method, the present experiment replicated the previous experiment and, in addition, studied whether or not the introduction of stress during third-list learning would have the effect of enhancing both facilitation and interference. This was expected from the assumption of a multiplicative relationship between drive (stress) and habit saliency or dominance (Spence, 1956; Castaneda, 1956; Castaneda & Palermo, 1955; Palermo, 1957). The reasoning was that enhanced drive should potentiate all responses indiscriminately, and that this would favor the elicitation of dominant habit-hierarchy responses. This should promote A-C responding in List III, at least after initial exposure to the list, and could set the condition for greater facilitation on A-C pairs and greater impairment on A-$C_{reversed}$ pairs.

METHOD

Apparatus

A Kodak Carousel projector with a random-access selector was used to present slides on a screen. An automatic timer controlled presentation rate of the slides, constructed of mat-acetate film on which the stimulus words were typed on an IBM typewriter with carbon ribbon. The word pairs were the same as in Wismer & Lipsitt (1964, p. 443). A children's hand dynamometer with force measured in kilogram units was clamped onto a desk in front of S.

Experimental Design

As in Wismer and Lipsitt, each S learned a mixed list with six pairs in Lists I and II and eight in List III. The chains consisted of two facilitation pairs (A-B, B-C, A-C), two interference pairs (A-B, B-C, A-$C_{reversed}$), in which the C responses in List III were re-paired with a mediationally "inappropriate" A stimulus (e.g., A_1-C_2, A_2-C_1), and two control pairs (A-B, X-C, A-C: designated C-I), in which the mediational link, B, was replaced with a new word in List II. A second control (C-II) consisted of the presentation in List III of two entirely new word pairs. Three counterbalancing groups, exactly as in Wismer and Lipsitt, were used so that each word pair occurred equally often as a facilitation, interference, or control chain.

Subjects

The Ss were 60 fifth graders divided randomly into the three counterbalancing groups, in each of which Ss were further divided into stress and nonstress groups of 10 Ss each. Four Ss were declined because they did not follow directions or pay attention to the slides.

Procedure

Each S was individually tested and sat behind the desk facing the screen. The E then asked whether S was right- or left-handed, whereupon E clamped the dynamometer on the preferred side of the desk. All Ss were then asked to squeeze the dynamometer handle as hard as they could with the dominant hand. This allowed a test of whether there were any strength differences between the stress and nonstress groups (there were none), and enabled setting the dynamometer marker for the stress Ss to one-fourth of their maximum exertion level.

Explanation of the task to all Ss involved using two examples (boy, boy-girl; cat, cat-dog). The Ss were asked to give their responses when the first slide appeared; the next slide would give them the correct response. The Ss were encouraged to guess.

Nonstress Ss were asked to rest their hand on the handle during the entire task. After the first demonstration trial, stress Ss were instructed in the later use of the dynamometer. When the second demonstration slide was presented, they were asked to squeeze the handle until the pointer reached the marker (one-fourth maximum exertion) and to keep the pointer there while they gave their answers. Upon termination of the first slide and presentation of the stimulus-response slide, they were allowed to release the handle. They were then instructed, like the nonstress Ss, to rest their hand on the handle until E told them to start using it. Immediately before List III, stress Ss were asked to start using the dynamometer and were reminded of the procedure.

Three randomized orders were given for each list. The stimulus and stimulus-response slides were each presented for 5 sec, with no delay between them. A 5-sec interpair interval was required by the random access mechanism. A trial consisted of six (Lists I and II) or eight (List III) word pairs. The intertrial interval was approximately 10 sec. The interlist interval was also 10 sec and consisted of a lighted blank screen. All Ss were presented with Lists I and II until they performed correctly on 3 successive trials in each. The learning criterion was 3 successive correct trials or a maximum of 12 trials for List III. The E recorded all responses and monitored the S's use of the dynamometer.

RESULTS AND DISCUSSION

Error data from List III performance are given in Table 1, for each counterbalancing group separately within the stress and nonstress conditions. The general

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Table 1
Number of Errors for Different Pair Types and the Three Counterbalancing Groups for the Stress (S) and Nonstress (NS) Conditions

	Facilitation		Interference		Control I		Control II	
Group	NS	S	NS	S	NS	S	NS	S
I	48	43	121	110	39	44	57	51
II	41	36	90	122	54	72	39	57
III	57	51	92	126	61	67	46	78
Total	146	130	303	358	154	183	142	186
Mean	4.87	4.33	10.10	11.93	5.13	6.10	4.73	6.20

tendency was for the greatest number of errors to be made on the interference pairs, the fewest errors to be made on facilitation pairs, and for this effect to be accentuated under the stress condition.

An analysis of variance over stress, pair-type, and group showed that neither stress, $F(1,54) = 2.5$, nor group, $F(2,59) = 1.4$, had significant main effects. However, there was a significant main effect of pair type, $F(3,162) = 217.3$; pair type interacted reliably with stress, $F(3,162) = 7.2$; and the triple interaction was significant, $F(6,162) = 9.5$, all of these beyond the .001 level. The latter effect principally was due apparently to one aberrent counterbalancing group (I), in which stress Ss made fewer interference errors than did nonstress Ss.

Simple two-tailed t tests revealed that reliable interference effects, when performance on these pairs was compared with both types of control pair, occurred under both stress and nonstress conditions (all four comparisons significant beyond the .001 level). However, comparison of the poorer interference-pair performance of the stress Ss with the nonstress Ss fell just short of significance at the .05 level, $t(58) = 1.81$.

Similar comparisons involving the facilitation pairs showed that the stress condition produced the expected effect, whether assessed against C-I, $t(29) = 2.97$, or against C-II, $t(29) = 3.01$. These effects were not significant for the nonstress condition, a fact contributing to the reliable Pair Type by Stress interaction. There were no significant differences in performance on the two types of control pair, under either the stress or nonstress conditions. Moreover, when the facilitation and interference effects were compared between the nonstress and stress conditions without consideration of control-pair responding (means = 4.87 vs 4.33 and 10.10 vs 11.93 in Table 1), the effects did not prove reliable. The modest effects produced by this paradigm apparently require comparison with appropriate control-pair data.

Table 2
Total Number of Different Kinds of Error Made on List III by the Stress and Nonstress Groups

Pair Type		A-C	A-B	Other	No Response
Facili-tation	Nonstress		47	36	63
	Stress		50	28	52
C-I	Nonstress		44	44	66
	Stress		66	41	76
Inter-ference	Nonstress	86	69	35	113
	Stress	90	78	36	154

The expectation of enhanced facilitation and interference under stress was based on an extension of the assumption (Spence, 1956) that increased drive should enhance the relative probabilities of responses dominant in the habit hierarchy, thus making more probable a mediated A-C type of response following A-B, B-C training. The consequence of such an effect would be fewer errors on A-C pairs and more on $A\text{-}C_{reversed}$ pairs. Table 2 shows the different types of List III errors by the stress and nonstress groups. Stress appears to increase dominant (by prior training) A-B responses in contrast to the nonstress group for all word pairs. Moreover, the poorer performance on the interference pairs for the stress group in relation to nonstress may be attributed not so much to increased A-C errors as to greater inhibition of response (154 no-response errors for the stress group compared with 113 for nonstress). It appears that stress increases "conflict" of response, particularly on word pairs in which the response to be learned is competing with other more dominant responses, a finding which was shown also by Lipsitt & Spears (1965). This trend is reversed for facilitation pairs in which stress Ss showed fewer no responses than did nonstress Ss.

Finally, and apart from the effects of stress, the results replicated the Wismer-Lipsitt (1964) finding of mediated facilitation and interference effects in the same Ss at the same time, based upon verbal chaining set up in pretest learning.

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