STRESS, REINFORCEMENT, AND LEARNING

by

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Abstract

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The purpose of the study was to investigate the effects of patterns of reinforcement, anxiety, and induced stress upon the acquisition and retention of nonsense syllables. Previous studies have disagreed about the effect of intermittent reinforcement upon acquisition. Some have indicated no difference as a function of pattern, whereas, others have found that a continuous reinforcement schedule led to superior acquisition. Workers, however, have agreed that superior retention is associated with noncontinuous reinforcement. With regard to anxiety, the findings have been an enigma. Some workers have found that in comparison to nonanxious subjects, anxious subjects learned more quickly, others have found they learned more slowly, and still others have found no difference. In recent years, with the control of task difficulty, phases of learning, and the meaning of the task to the learner, more consistent findings have appeared. Nevertheless, there is still some disagreement. The study of stress, on the other hand, has presented problems specific to it. Methods of producing stress have differed and, consequently, experimental findings have not always been the same. Experimenters, more recently, have sought to control the

nature of the task, the phase of learning, and the conditions under which learning takes place.

In the present experiment, learning took place by one of two schedules. One group was given ten trials to learn ten pairs of low association value nonsense syllables. They were reinforced on each trial. A second group was given twenty trials to learn the same material, but was reinforced on ten trials only. The reinforcement was informing the subject what the correct response was. Half of the students in each group received stressful instructions, half nonstressful.

Each subject was tested individually. After the last acquisition trial, the subject answered the items of the Minnesota Paper Form Board. Following five minutes of this interpolated task, retention was tested by presenting five trials of stimulus words only.

The variances of reinforcement, stress, and anxiety were analyzed to determine correspondence of the results to the hypotheses. Briefly, under 100% reinforcement, acquisition was faster, but only when trials were equated. When reinforcements were equated, the continuously reinforced group was superior for the first phase of learning only. While neither stress nor reactions to the experiment directly influenced acquisition, the interactive effects of stress with reinforcement were significant, namely for stressed subjects, learning was slower under continuous reinforcement, but faster under partial reinforcement.

While acquisition tended to be faster under continuous reinforcement, retention was better under intermittent reinforcement. Exploring the interaction between stress and reinforcement, it was found that while acquisition had little relationship to either stress or anxiety, retention was related to both. In the first place, the stressed group retained more under partial reinforcement but less under continuous reinforcement. In the second place, anxious subjects retained less under stress but more under no stress.

The competition among responses led to the inferior retention of the continuously reinforced groups. Incorrect responses, it was hypothesized, were weakened during the nonreinforced acquisition trials resulting in better retention under intermittent reinforcement.

The retention superiority of the stress group under intermittent reinforcement and of the no stress group under continuous reinforcement resulted from the experimental manipulation of the stress and reinforcement variables. A hypothetical explanation was offered based on the work of Estes and of Skinner.

Finally, the retention superiority of the nonanxious stress group and of the anxious no stress group, it was pointed out, resembled the findings of other experimenters. The weakness of the measure of anxiety, however, prevented a theoretical interpretation of this observation.

FORWARD

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CHAPTER I

PROBLEM AND BACKGROUND

Problem

The purpose of the present study was to investigate the effect of stress and of schedule of reinforcement on the learning of paired-associate nonsense syllables. In addition, the study was designed to explore the interactive effects of stress and of schedule of reinforcement on learning. To these ends, three questions were raised: 1. Does continuous reinforcement lead to better learning than does noncontinuous? 2. Does stress have a detrimental effect on learning? 3. Is there an interactive effect between stress and pattern of reinforcement which effects learning?

The effect of stress on learning is worthy of study notably because the outcomes of stress-learning experiments have generally differed. One methodological weakness of many stress experiments lay in the absence of experimental verification that the experimentally induced stress situation was really stressful. In stress-learning experiments, too, the schedule of reinforcement used has been that of continuous reinforcement. What the present experiment proposed to do, then, differentiating it from other stress experiments, was to control 1. schedule of reinforcement and 2. subjective responses to the stress stimulus.

Learning

Measures of learning vary with the aspect of modifiable behavior being investigated. The measure of learning in the present experiment was the number of correct responses. Two separate phases of learning were examined: acquisition and retention. During acquisition, cues which strengthen a response were present; during retention, these cues were omitted.

The cues which strengthen responses are called reinforcements. In the present experiment, the cues which informed the subject about the nature of the response were the reinforcements. According to Thorndike, "the force and mechanism of the confirming reaction are the force and mechanism of reinforcement, applied to a connection."[1]

Schedules of Reinforcement

Although reinforcing stimuli increase response strength, the relationship between the two is not one to one.[2] A discovery which has challenged psychology is that a response reinforced occasionally has greater response strength than one reinforced all of the time.

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[1]E. L. Thorndike. Selected writings from a connectionists psychology. New York: Appleton-Century-Crofts, Inc., 1949, p. 19.

[2]W. O. Jenkins and J. C. Stanley, Jr., "Partial reinforcement: A review and critique," Psychological Bulletin, 1950, 47, 193-234.

Jenkins and Stanley[1] have critically summarized the literature on intermittent reinforcement. In general, studies agree that in contrast to continuous reinforcement acquisition was slower,[2,3,4] but retention, on the other hand, was better.[5,6,7,8,9,10,11,12]

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[1]W. O. Jenkins and J. C. Stanley, Jr., "Partial reinforcement: A review and critique," Psychological Bulletin, 1950, 47, 193-234.

[2]D. A. Grant and H. W. Hake, "Acquisition and extinction of the Humphreys verbal response with differing percentages of reinforcement," American Psychologist, 1949, 4, 226, abstract.

[3]D. A. Grant and L. M. Schipper, "The acquisition and extinction of conditioned eyelid response as a function of the percentage of fixed ratio random reinforcement," Journal of Experimental Psychology, 1952, 43, 313-320.

[4]D. A. Grant, L. M. Schipper, and B. M. Ross, "Effect of intretrial interval during acquisition and extinction of the conditioned eyelid response following partial reinforcement," Journal of Experimental Psychology, 1952, 44, 203-210.

[5]Grant & Hake. American Psychologist, 1949, 4, 226.

[6]D. A. Grant, H. W. Hake, and J. P. Hornseth, "Acquisition and extinction of a verbal conditioned response with differing percentages of reinforcement," Journal of Experimental Psychology, 1951, 42, 1-5.

[7]Grant & Schipper. J. exper. Psychol., 1952, 43, 313-320.

[8]Grant, Schipper, & Ross. J. exper. Psychol., 1952, 44, 203-210.

[9]J. H. Grosslight and I. L. Child, "Persistence as a function of previous experience of failure followed by success," American Journal of Psychology, 1947, 60, 378-387.

[10]J. H. Grosslight, J. F. Hall, and J. Murnin, "Patterning effect in partial reinforcement," Journal of Experimental Psychology, 1953, 46, 103-106.

[11] O. H. Mowrer and Helen M. Jones, "Habit strength as a function of the pattern of reinforcement," Journal of Experimental Psychology, 1945, 35, 293-311.

[12]W. Wilson, E. J. Weiss, and A. Amsel, "Two tests of the

To be sure, some experimenters have found no difference in acquisition between continuous and noncontinuous reinforcement;[1,2] others,[3,4] too, have made a similar finding with regard to retention. Kanfer's study,[5] however, is noteworthy. Studying humans, he found the partial reinforcement group required more trials to learn but fewer reinforcements.

Although other workers had observed the effects of a partial reinforcement schedule, Skinner[6,7] was first to study it in any systematic way. He trained a group of rats

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Sheffield hypothesis concerning resistance to extinction, partial reinforcement, and distribution of practice," Journal of Experimental Psychology, 1955, 50, 51-60.

[1]M. R. Denny, "The role of secondary reinforcement in a partial reinforcement learning situation," Journal of Experimental Psychology, 1946, 36, 373-389.

[2]L. G. Humphreys, "The effect of random alteration of reinforcement on the acquisition and extinction of conditioned eyelid reactions," Journal of Experimental Psychology, 1939, 25, 141-158.

[3]Denny. J. exper. Psychol., 1946, 36, 373-389.

[4]Virginia Sheffield, "Extinction as a function of partial reinforcement and distribution of practice," Journal of Experimental Psychology, 1949, 39, 511-526.

[5]F. H. Kanfer, "The effect of partial reinforcement on acquisition and extinction of a class of verbal responses," Journal of Experimental Psychology, 1954, 48, 424-432.

[6]B. F. Skinner, "The rate of establishment of a discrimination," Journal of General Psychology, 1933, 9, 302-350.

[7]B. F. Skinner. The behavior of organisms. New York: Appleton-Century-Crofts, Inc., 1938.

to press a bar. Then, he extinguished the response. Finally, he reconditioned the rats by giving reinforcements on a time schedule. He noted that immediately after each reinforcement the rate of responding increased at first, but later declined. With each succeeding reinforcement, however, the decline became slighter until a steady rate of responding was maintained. This, moreover, was accomplished with a minimum of reinforcements.

The experiments in this area which created the most interest were those of Humphreys.[1] He paired a puff of air with a flash of light in order to study the effect of schedules of reinforcement on the conditioning of the human eyeblink. The results indicated that while there were no differences in acquisition between the continuous and the noncontinuous groups, the eyeblink was more resistant to extinction in the groups which had been intermittently reinforced.

One of the few experiments in the effect of partial reinforcement on verbal learning was that of Peterson.[2] She conditioned verbal associations to high and to low

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[1]L. G. Humphreys, "The effect of random alteration of reinforcement on the acquisition and extinction of conditioned eyelid reactions," Journal of Experimental Psychology, 1939, 25, 141-158.

[2]Margaret J. Peterson, "Verbal response strength as a function of cultural frequency, schedule of reinforcement, and number of trials," Journal of Experimental Psychology, 1956, 52, 371-376.

cultural frequency words. Both acquisition and extinction required more trials for the partial reinforcement group, but only for the low frequency words.

Kanfer[1] conditioned his subjects to make a judgment of the movement of light in an autokinetic effect experiment. Reinforcements were verbal. The continuously reinforced group acquired the judgments more quickly, and although they retained them for a time without reinforcement, they forgot the conditioned judgments sooner than the intermittently reinforced group.

A variety of explanations have been offered for the resistance to extinction with partial reinforcement. To date, however, experimental verification of these explanations have not been undertaken. Humphreys[2,3] explained his results in terms of expectancy. During acquisition, the continuously reinforced group respond because they expect reinforcement to follow. Responses drop out rapidly during extinction because the Ss learn to expect no reinforcement to follow. In partial reinforcement, on the

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[1]F. H. Kanfer, "The effect of partial reinforcement on acquisition and extinction of a class of verbal responses," Journal of Experimental Psychology, 1954, 48, 424-432.

[2]L. G. Humphreys, "The effect of random alteration of reinforcement on the acquisition and extinction of conditioned eyelid reactions," Journal of Experimental Psychology, 1939, 25, 141-158.

[3]_____ "Acquisition and extinction of verbal expectation in a situation analogous to conditioning," Journal of Experimental Psychology, 1939, 25, 294-301.

other hand, the Ss continue to respond because they expect the reinforcement to appear eventually as it did during acquisition. While critics have disapproved of this explanation on grounds that it is anthropomorphic, Detambel,[1] as cited in Jenkins and Stanley,[2] criticized the very design of Humphreys' experiment. In Humphreys' verbal expectation experiment[3] the subjects were to guess whether a second light would follow a signal light. When a subject said "yes" and a light followed, the "yes" was strengthened. When the second light did not go on following a "no" response, the "no" was strengthened too. In other words, Humphreys reinforced two incompatible responses. During extinction, the "no" response would be reinforced as a function of the opportunities inherent in the design. Detambel, on the other hand, designed his experiment in such a way that only the correct response would be reinforced. Humphreys' findings were not confirmed. Extinction, though, was more rapid in the continuously reinforced group. Detambel argued that in Humphreys' experiment there was a differential weakening of the incorrect response and strengthening of the correct response,

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[1] M. H. Detambel, "A reanalysis of Humphreys' verbal expectation." Unpublished Master's thesis, Department of Psychology, Indiana University, 1950.

[2] Jenkins & Stanley. Psychological Bulletin, 1950, 47, 193-234.

[3] Humphreys. J. exper. Psychol., 1939, 25, 294-301.

an unconventional design for extinction.

Detambel criticized Humphreys' experimental design; he did not investigate Humphreys' explanation. Grant and others,[1] however, found that by the end of sixty conditioning trials with human subjects, subjective expectations of the frequency of reinforcement resembled the true frequency very closely. Students on a 75% reinforcement schedule guessed that the unconditioned stimulus, a light, would appear approximately on three of four trials.

Skinner[2] explained the resistance to extinction of partial reinforcement in terms of the similarity of responding taking place during acquisition and extinction. He saw the nonreinforced responses, during acquisition, acquiring secondary reinforcing power when the reinforcement appeared. So that if an animal was reinforced once for ten responses, that reinforcement would spread to the nonreinforced responses in the series. Ten responses would be expected during extinction (nonreinforced trials). Skinner, then, defined response in terms of the number of movements preceding a reinforcement. The data of the

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[1]D. A. Grant, H. W. Hake, and J. P. Hornseth, "Acquisition and extinction of a verbal conditioned response with differing percentages of reinforcement," Journal of Experimental Psychology, 1951, 42, 1-5.

[2]Skinner. The Behavior of Organisms.

Mowrer and Jones[1] experiment support Skinner's explanation, even though they explained their findings in terms of an effort hypothesis. According to Schoenfeld,[2] more sub-categories of response are conditioned during partial reinforcement. In this respect his view is similar to that of Skinner. Denny[3] believed the effect to be due to the presence of additional cues in the external environment. The massing of trials, according to Sheffield,[4] leads to response persistence in partial reinforcement experiments. She obtained no difference in extinction between partially and continuously reinforced rats when trials were spaced. Grant et al[5] found resistance to extinction even when trials were spaced. They felt that their human subjects verbalized responses which mediated resistance to extinction. Wilson

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[1]Mowrer & Jones. J. exper. Psychol., 1945, 35, 293-311.

[2]W. N. Schoenfeld, "On the difference in resistance to extinction following regular and periodic reinforcement." Conference on the experimental analysis of behavior. Unpublished notes, Feb. 27, 1950.

[3]M. R. Denny, "The role of secondary reinforcement in a partial reinforcement learning situation," Journal of Experimental Psychology, 1946, 373-389.

[4]Virginia Sheffield, "Extinction as a function of partial reinforcement and distribution of practice," Journal of Experimental Psychology, 1949, 39, 511-526.

[5]D. A. Grant, L. M. Schipper, and B. M. Ross, "Effect of intratrial interval during acquisition and extinction of the conditioned eyelid response following partial reinforcement," Journal of Experimental Psychology, 1952, 44, 203-210.

et al.[1] also failed to confirm Sheffield's finding of the differential effect upon learning of massing or spacing of trials under partial reinforcement.

Another group of experiments has focused on the pattern of reinforcement as a clue to resistance to extinction. Hake et al.[2] varied both the number of transitions from blocks of unreinforced trials back to reinforced trials as well as length of the block of unreinforced trials. They used one to five transitions and one to six trials in the unreinforced block. They found resistance to extinction to be a decreasing function of the average number of unreinforced trial blocks. What lessened the importance of this experiment was that (1) the variances were not homogeneous and (2) an earlier similarly designed experiment by this group[3] yielded nonsignificant results.

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[1]W. Wilson, E. J. Weiss, and A. Amsel, "Two tests of the Sheffield hypothesis concerning resistance to extinction, partial reinforcement, and distribution of practice," Journal of Experimental Psychology, 1955, 50, 51-60.

[2]H. W. Hake, D. A. Grant, and J. D. Hornseth, "Resistance to extinction and the patterns of reinforcement. III. The effect of trial patterning on verbal 'conditioning.'" Journal of Experimental Psychology, 1951, 41, 221-225.

[3]H. W. Hake and D. A. Grant, "Resistance to extinction and the pattern of reinforcement: II. Effect of successive alternation of blocks of reinforced and unreinforced trials upon the conditioned eyelid response to light," Journal of Experimental Psychology, 1951, 41, 216-220.

The experiments of Grosslight et al.[1,2] have shed some light on the patterning hypothesis. They pointed out that a reinforcement following a nonreinforced response strengthened the persistence to respond after failure. According to these writers, not only is the modal response being strengthened, as Skinner[3] predicted, but an attitude toward the task is established in partial reinforcement as Humphreys[4] inferred. Weinstock[5] and Skinner[6] observed agitation in their rats during the first few nonreinforced trials, but as nonreinforcement continued, signs of emotionality gradually disappeared. These experiments suggested that the nonreinforcement during acquisition elicited stimuli with drive properties. A reinforcement which followed nonreinforcement, then, not

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[1]J. H. Grosslight and I. L. Child, "Persistence as a function of previous experience of failure followed by success," American Journal of Psychology, 1947, 60, 378-387.

[2]_____, J. F. Hall and J. Murnin, "Patterning effect in partial reinforcement," Journal of Experimental Psychology, 1953, 46, 103-106.

[3]B. F. Skinner, "The rate of establishment of a discrimination," Journal of General Psychology, 1933, 9, 302-350.

[4]L. G. Humphreys, "Acquisition and extinction of verbal expectation in a situation analogous to conditioning," Journal of Experimental Psychology, 1939, 25, 294-301.

[5]S. J. Weinstock, "Resistance to extinction of a running response following partial reinforcement under widely spaced trials," Journal of Comparative and Physiological Psychology, 1954, 47, 318-322.

[6]Skinner. The behavior of organisms.

only strengthened the response being acquired, but increased drive as well.

In summary, the specific factor producing greater resistance to extinction in partial reinforcement is not known. It has been speculated that resistance to extinction is due to the arrangement of reinforcements in the pattern. Others have suggested that it is due to the effects which differential patterning generates. It is not certain, moreover, whether the subject during acquisition is learning to discriminate between reinforced and non-reinforced responses or whether he persists in responding because he has learned to expect no reinforcement or because multiple movements constitute one response. Finally, the effect may be brought about by increased drive.[1]

Motivation

Whether reinforcement, as a construct, sufficiently explains the acquisition and retention of behavior depends upon how it is defined. Should reinforcement simply signify that crucial stimulus which increases the strength of a response being acquired, it would inadequately explain the results of experiments such as those of Hurlock.[2]

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[1]Citation is made here of the book by C. B. Forster and B. F. Skinner, Schedules of Reinforcement. New York: Appleton-Century-Crofts, Inc., 1957. This book appeared after this manuscript was written.

[2]E. B. Hurlock, "The value of praise and reproof as incentives for children," Archives of Psychology, 1924, 11, No. 71.

She found scores on a learning task increased or decreased as a function of praise and criticism, consequences objectively unrelated to the quality of performance. In addition, the experimenter's remarks came at a time when they could not inform the subjects what was right or wrong. More inclusive definitions of reinforcement consider the role of cues which have drive properties. These cues, like any other class of variables, have been strengthened or weakened, by events which follow their manifestation.

The study of cues with drive properties has been subsumed under the general area of motivation. The motivational variable receiving the most critical hearing in current research is "anxiety." This report differentiates between anxiety as motivational predispositions and anxiety as an experimentally induced feeling of discomfort. The latter will be considered in the sections on Stress and Learning.

Anxiety

Research workers have arbitrarily defined anxiety in terms of responses to measures which they have assumed to be indicative of anxiety. Techniques for measuring anxiety in learning experiments have varied to some extent. To some experimenters,[1,2] anxiety is the chemico-electric

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[1]H. Basowitz, H. Persky, S. J. Korchin, and R. Grinker. Anxiety and Stress. New York: McGraw Hill, 1955.

[2]J. C. Beam, "Serial learning and conditioning under

reactions of the autonomic nervous system; others[1,2,3] define it in terms of clinical ratings; and a few[4,5,6] have used responses to projective techniques as anxiety indicators. In most studies responses to self report inventories have been considered indicators of anxiety. Of these, the scores on the MMPI were used in two[7,8] post test

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real life stress," Journal of Abnormal and Social Psychology, 1955, 31, 543-551.

[1]K. Diven, "Certain determinants in the conditioning of anxiety reactions," Journal of Psychology, 1937, 3, 291-308.

[2]R. B. Malmo and A. Amsel, "Anxiety produced interference in serial rote learning with observation on rote learning after partial frontal lobectomy," Journal of Experimental Psychology, 1948, 38, 440-454.

[3]H. Sampson and D. Bindra, "'Manifest' anxiety, neurotic anxiety, and the rate of conditioning," Journal of Abnormal and Social Psychology, 1954, 49, 256-259.

[4]D. P. Ausubel, H. M. Schiff, and M. Goldman, "Qualitative characteristics in the learning process associated with anxiety," Journal of Abnormal and Social Psychology, 1953, 48, 537-547.

[5]C. W. Eriksen, "Psychological defenses and 'ego strength' in the recall of completed and incompleted tasks," Journal of Abnormal and Social Psychology, 1954, 49, 45-50.

[6]R. M. Merrill, "The effect of pre-experimental and experimental anxiety on recall efficiency," Journal of Experimental Psychology, 1954, 48, 167-172.

[7]C. W. Eriksen, "Individual differences in defensive forgetting," Journal of Experimental Psychology, 1952, 44, 442-447.

[8]Eriksen, "Stimulus generalization under stress," Journal of Abnormal and Social Psychology, 1954, 49, 561-565.

questionnaires in three;[1,2,3] but the most frequently used instrument has been the Taylor Manifest Anxiety Scale (MAS).[4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20]

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[1]G. Mandler and S. B. Sarason, "A study of anxiety and learning," Journal of Abnormal and Social Psychology, 1952, 47, 166-173.

[2]Mandler and Sarason, "The effect of prior experience and subjective failure on the evocation of test anxiety," Journal of Personality, 1952, 21, 336-341.

[3]S. B. Sarason, G. Mandler, and P. G. Craighill, "The effect of differential instructions on anxiety and learning," Journal of Abnormal and Social Psychology, 1952, 47, 561-565.

[4]E. R. Hilgard, L. V. Jones, and S. J. Kaplan, "Conditioned discrimination as related to anxiety," Journal of Experimental Psychology, 1951, 42, 94-99.

[5]J. D. Lucas, "The interactive effects of anxiety, failure, and intraserial duplication," American Journal of Psychology, 1952, 65, 59-66.

[6]A. J. Marrow, "Goal tensions and recall. II," Journal of General Psychology, 1938, 19, 37-64.

[7]E. K. Montague, "The role of anxiety in serial rote learning," Journal of Experimental Psychology, 1953, 45, 91-96.

[8]Esther G. Noll, "An investigation of the relation of anxiety and task conditions to serial rote learning," unpublished Ph.D. thesis. University of Pittsburgh, 1955.

[9]J. O. Noll, "An investigation of the relation of anxiety to learning and retention," Dissertation Abstracts, 1955, 15, 1916-1917.

[10]C. K. Ramond, "Anxiety and task determiners of verbal performance," Journal of Experimental Psychology, 1953, 46, 120-124.

[11]K. W. Spence and Janet A. Taylor, "Anxiety and strength of the unconditioned stimulus as determiners of the amount of eyelid conditioning," Journal of Experimental Psychology, 1951, 42, 183-188.

[12]K. W. Spence and I. E. Farber, "Conditioning and extinction as a function of anxiety," Journal of Experimental Psychology, 1953, 45, 116-119.

[13]Spence and Farber, "The relation of anxiety to differential eyelid conditioning," Journal of Experimental Psychology, 1954, 47, 127-134.

[14]Spence and R. S. Beecroft, "Differential conditioning and level of anxiety," Journal of Experimental Psychology, 1954, 48, 399-403.

[15]Spence, I. E. Farber, and Elaine Taylor, "The relation of electric shock and anxiety to level of performance in eyelid conditioning," Journal of Experimental Psychology, 1954, 48, 404-408.

[16]Spence, Farber, and H. H. McFann, "The relation of anxiety level to performance in competitional and non-competitional paired associate learning," Journal of Experimental Psychology, 1956, 52, 296-305.

[17]Spence, J. Taylor, and Rhoda Ketchel, "Anxiety level and degree of competition in paired associates learning," Journal of Experimental Psychology, 1956, 52, 306-310.

[18]C. Taffel, "Anxiety and the conditioning of verbal behavior," Journal of Abnormal and Social Psychology, 1955, 31, 496-501.

[19]Janet Taylor, "The relationship of anxiety to the conditioned eyelid response," Journal of Experimental Psychology, 1951, 41, 81-92.

[20]Taylor and K. W. Spence, "The relationship of anxiety level to performance in serial learning," Journal of Experimental Psychology, 1952, 44, 61-66.

Common to most of these definitions of anxiety is the evaluation of behavior as psychologically inadequate. Experimenters, moreover, have not interpreted these evaluations in the same way. Many workers using the MAS have viewed anxiety in terms of its excitatory potential. Others, notably Hilgard[1] and Sarason et al.[2,3,4] have interpreted anxiety in terms of the interference which anxiety effects. While these interpretations are not necessarily antagonistic, they are not easily reconciled.

Farber[5] has selectively surveyed the literature of anxiety-learning experiments. This section will include not only the major studies which Farber had discussed, but many which he omitted. Since the Taylor Manifest Anxiety Scale (MAS) has been used in the majority of anxiety learning

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[1]E. R. Hilgard, L. V. Jones, and S. J. Kaplan, "Conditioned discrimination as related to anxiety," Journal of Experimental Psychology, 1951, 42, 94-99.

[2]G. Mandler and S. B. Sarason, "A study of anxiety and learning," Journal of Abnormal and Social Psychology, 1952, 47, 166-173.

[3]_____ "The effect of prior experience and subjective failure on the evocation of test anxiety," Journal of Personality, 1952, 21, 336-341.

[4]S. B. Sarason, G. Mandler, and P. G. Craighill, "The effect of differential instructions on anxiety and learning," Journal of Abnormal and Social Psychology, 1952, 47, 561-565.

[5]I. E. Farber, "The role of motivation in verbal learning and performance," Psychological Bulletin, 1955, 52, 311-327.

experiments, results obtained with it will be stated and compared with results obtained with other measures of anxiety.

In her first study, Taylor[1] observed that anxious subjects acquired the conditioned eyeblink response more quickly than did the less anxious. Anxiety, though, was not related to extinction. Using both strong and weak puffs of air, Spence and Taylor[2] found anxious Ss conditioned more quickly than did less anxious. The strength of the puff, however, in no way influenced acquisition. The main difference between these two experiments was that there was less conditioning in the second. Anxious Ss, in a third study,[3] not only acquired the eyeblink response more quickly, but retained it significantly longer than the nonanxious. This relationship between anxiety and conditioning was reaffirmed in Taffel's[4] verbal learning experiment. Anxious Ss, he observed, conditioned faster than the less anxious.

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[1]Janet Taylor, "The relationship of anxiety to the conditioned eyelid response," Journal of Experimental Psychology, 1951, 41, 81-92.

[2]K. W. Spence and Janet A. Taylor, "Anxiety and strength of the unconditioned stimulus as determiners of the amount of eyelid conditioning," Journal of Experimental Psychology, 1951, 42, 183-188.

[3]_____ and I. E. Farber, "Conditioning and extinction as a function of anxiety," Journal of Experimental Psychology, 1953, 45, 116-119.

[4]C. Taffel, "Anxiety and the conditioning of verbal behavior," Journal of Abnormal and Social Psychology, 1955, 31, 496-501.

A facilitating effect of anxiety has not only been found for conditioning, but for generalization as well. Eriksen[1] trained his Ss to make a horizontal arm movement in response to a square of a certain size. Stimulus generalization was greater among hysterics than among psychaesthenics.

This experiment raised the question of whether anxious people generalize because of excitatory potential or because they are unable to make discriminations. Hilgard and others[2] conditioned their Ss to respond to a light which was followed by an air puff. A second light, when it went on, was not followed by an air puff (negative stimulus). Although the high anxiety group conditioned faster at first, differences disappeared by the middle of learning. More important, however, was that the low anxiety group responded less to the negative stimulus. The authors inferred that discrimination is related to absence of anxiety.

Spence and Farber,[3] in a similar experiment, found anxious Ss responded more often to both the positive and

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[1]C. W. Eriksen, "Stimulus generalization under stress," Journal of Abnormal and Social Psychology, 1954, 49, 561-565.

[2]E. R. Hilgard, L. V. Jones, and S. J. Kaplan, "Conditioned discrimination as related to anxiety," Journal of Experimental Psychology, 1951, 42, 94-99.

[3]K. W. Spence and I. E. Farber, "The relation of anxiety to differential eyelid conditioning," Journal of Experimental Psychology, 1954, 47, 127-134.

the negative stimuli than the nonanxious, but the degree of difference between responses to positive and negative stimuli was greater for the anxious groups. These data do not refute the Hilgard finding because the differences were not statistically significant. In a later study by Spence and Beecroft,[1] moreover, anxious Ss made more responses to the positive stimulus but fewer to the negative one. When they discarded Ss who made no response to the positive stimulus for the first fifty trials, differences between the groups became negligible. In still another experiment conducted by this group, Spence and others[2] found no difference in conditioning between the anxious and the nonanxious until shock was introduced. When it was, the high anxiety group conditioned faster. Yet the interaction between shock and anxiety was not significant. The absence of superior conditioning of the anxious group does not confirm their earlier findings.[3,4]

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[1]K. W. Spence and R. S. Beecroft, "Differential conditioning and level of anxiety," Journal of Experimental Psychology, 1954, 48, 399-403.

[2]_____, I. E. Farber, and Elaine Taylor, "The relation of electric shock and anxiety to level of performance in eyelid conditioning," Journal of Experimental Psychology, 1954, 48, 404-408.

[3]Taylor. J. Exper. Psychol., 1951, 41, 81-92.

[4]Spencer & Taylor. J. Exper. Psychol., 1951, 42, 183-188.

Two trends appeared from these data: "1) anxious Ss learned simple tasks requiring few discriminations better than nonanxious Ss; and (2) anxious Ss learned differently as the experimental conditions changed.

Maltzman and others[1] found high anxiety Ss made significantly fewer errors in problems which had but one solution (anagrams), but significantly more errors on problems having more than one solution (water jar). This raises the question, do anxious Ss learn only simple tasks more quickly?

According to Diethelm and Jones,[2] a clinically anxious group learned a maze more poorly than did a control group. Malmo and Amsel[3] observed that the clinically anxious learned syllables presented serially more poorly than did a control group. Psychometrically anxious Ss took longer to learn the correct set of responses in a series than did the less anxious in a study by Taylor and Spence.[4]

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[1]I. Maltzman, J. Fox, and L. Morrisett, "Some effects of manifest anxiety on mental set," Journal of Experimental Psychology, 1953, 46, 50-54.

[2]C. Diethelm and M. R. Jones, "The influence of anxiety on attention, learning, retention and thinking," Archives Neurology and Psychiatry, 58, 325-336.

[3]R. B. Malmo and A. Amsel, "Anxiety produced interference in serial rote learning with observation on rote learning after partial frontal lobectomy," Journal of Experimental Psychology, 1948, 38, 440-454.

[4]Janet Taylor and K. W. Spence, "The relationship of anxiety level to performance in serial learning," Journal of Experimental Psychology, 1952, 44, 61-66.

In a maze learning situation, anxious Ss were decidedly inferior. To this extent results obtained with clinically anxious resemble those obtained with psychometrically anxious.

Control of response tendencies shed some light on the relationship between anxiety and learning. Montague[1] discovered that where the response tendencies were strong, anxious Ss learned more quickly, but where they were weak, the nonanxious learned more quickly. Lucas[2] increased the difficulty of lists of consonants by duplicating some of the consonants. Anxious Ss retained fewer consonants. Ramond[3] studied the learning of anxious and nonanxious groups in a paired associates design. One meaning of the stimulus word was more common than a second. When the more common meaning was correct, the low anxiety group learned more. The groups, however, did not differ with regard to the learning of the less common meaning. This finding refuted Montague's completely. Some findings by Deese et al. closely parallel the Ramond results. In their

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[1]E. K. Montague, "The role of anxiety in serial rote learning," Journal of Experimental Psychology, 1953, 45, 91-96.

[2]J. D. Lucas, "The interactive effects of anxiety, failure, and intraserial duplication," American Journal of Psychology, 1952, 65, 59-66.

[3]C. K. Ramond, "Anxiety and task determiners of verbal performance," Journal of Experimental Psychology, 1953, 46, 120-124.

first experiment[1] anxious groups scored better than nonanxious when the learning was such that a shock could be avoided by responding correctly. They did not, however, explain their findings in terms of a superiority of the high anxiety group. Instead, they felt there were personality variables associated with low anxiety which brought about inferior performance. In their second study,[2] however, they introduced intraserial duplication. No difference in learning was found between the anxiety groups. Intraserial duplication reversed the earlier observed effect of stress and anxiety on acquisition.

Later studies conflicted somewhat with these findings. Spence and others[3] found anxious Ss learned paired associates in which competition among the pairs was minimized faster than did the nonanxious group, but they took longer to learn paired associates in which there was

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[1]J. Deese, R. S. Lazarus, and J. Keenan, "Anxiety, anxiety reduction, and stress in learning," Journal of Experimental Psychology, 1953, 46, 53-60.

[2]R. S. Lazarus, J. Deese, and R. Hamilton, "Anxiety and stress in learning: The role of intraserial duplication," Journal of Experimental Psychology, 1954, 47, 111-114.

[3]K. W. Spence, I. E. Farber, and H. H. McFann, "The relation of anxiety level to performance in competitional and non-competitional paired associate learning," Journal of Experimental Psychology, 1956, 52, 296-305.

intraserial duplication. In a second study Spence and others[1] replicated the findings of the earlier one. But in this study the magnitude of the difference between anxious Ss and nonanxious Ss on the competitive list became smaller.

Spence interpreted these findings in terms of Hullian drive theory. According to Spence, anxious Ss have greater excitatory strength than the nonanxious. They therefore learned simple responses quickly, as in conditioning, but made more errors in complex learning, as in serial and maze learning because the likelihood of making incorrect responses increased. Such reasoning leaves a gap, though. The measure of drive in all of their studies was the Taylor MAS. There is no evidence that the MAS is a measure of drive. It has only been assumed to be. As a matter of fact, it is even questionable that it is a measure of clinical anxiety.

Sampson and Bindra[2] found no relationship between clinical ratings of anxiety and the MAS. In another study, Bindra and others[3] found no relationship between the MAS

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[1]K. W. Spence, J. Taylor, and Rhoda Ketchel, "Anxiety level and degree of competition in paired associates learning," Journal of Experimental Psychology, 1956, 52, 306-310.

[2]H. Sampson and D. Bindra, "'Manifest' anxiety, neurotic anxiety, and the rate of conditioning," Journal of Abnormal and Social Psychology, 1954, 49, 256-259.

[3]D. Bindra, A. L. Paterson, and J. Strzelecki, "On the relation between anxiety and conditioning," Canadian Journal of Psychology, 1955, 9, 1-6.

and conditioning. Even the finding that anxious Ss do better than nonanxious on simple tasks was questioned. Hughes and others[1] found no difference between anxiety groups in a serial learning design. The interstimulus and intertrial intervals in this study were longer than in the Iowa studies. Hughes et al. argued that the reduced difficulty of the tasks eliminated the differences between the anxiety groups. In Noll's[2] investigation when psychometrically anxious Ss were able to habituate to the learning situation, they learned as well as nonanxious. This finding was in keeping with that of Ausubel and others.[3] In their investigation, nonanxious Ss were superior to anxious Ss on the first trial of maze learning, but, thereafter, differences between the groups became negligible. Simplifying the experimental arrangements, as in the Hughes and Noll experiments, however, is not sufficient grounds for reconciling the disagreement about the learning of the psychometrically anxious people. Using both simple and

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[1]J. B. Hughes II, J. L. Sprague, and A. Bendig, "Anxiety level, response alternation, and performance in serial learning," Journal of Psychology, 1954, 38, 421-426.

[2]J. O. Noll, "An investigation of the relation of anxiety to learning and retention," Dissertation Abstracts, 1955, 15, 1916-1917.

[3]D. P. Ausubel, H. M. Schiff, and M. Goldman, "Qualitative characteristics in the learning process associated with anxiety," Journal of Abnormal and Social Psychology, 1953, 48, 537-547.

difficult experimental arrangements, Noll[1] found no differences in learning between the anxiety groups.

Finally, two other experiments using the MAS should be mentioned. Gordon and Berlyne[2] told their Ss that a paired associate nonsense syllable learning experiment was an intelligence test. Only when the anxious Ss were informed that they had done poorly was there a decrement in subsequent learning.

But in another paired associates design, Heilizer and others[3] found the MAS was in no way related to the learning of paired associates nonsense syllables. Of the variances analyzed, only the effect of the experimenter was statistically significant. The writers, however, did not comment on this finding. It was, moreover, very much like that of Schmidt.[4] In this experiment it was the person giving the praise and the person giving

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[1]Esther G. Noll, "An investigation of the relation of anxiety and task conditions to serial rote learning," Ph.D. thesis, University of Pittsburgh, 1955.

[2]W. M. Gordon and D. Berlyne, "Drive-level and flexibility in paired associate nonsense syllable learning," Quarterly Journal of Experimental Psychology, 1954, 6, 181-185.

[3]F. Heilizer, H. S. Axelrod, and E. L. Cowen, "The correlates of manifest anxiety in paired associate learning," Journal of Personality, 1956, 24, 463-474.

[4]H. O. Schmidt, "The effects of praise and blame as incentives to learning," Psychological Monographs, 53, 1941, No. 240.

the blame who significantly affected the outcome of learning.

Many of the investigations linking anxiety with learning were not carried out in an experimental tradition. No one obtained evidence that psychometrically anxious Ss were really anxious when they participated in these studies. As a matter of fact, Gordon and Sarason[1] estimated the relationship between everyday anxiety and test anxiety to be moderate, in the neighborhood of ± .50.

In a series of studies using reactions to the experiment as a measure of anxiety, Sarason and others found anxiety alone did not furnish precise predictions. When success and failure were manipulated, the anxious group improved after neutral instructions, whereas the nonanxious improved after failure.[2] In a second study, they found the subjective feeling of failure was related to inferior performance, but only in the anxious group.[3] The anxious group in a third study[4] performed more poorly on the Kohs

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[1]E. M. Gordon and S. B. Sarason, "The relationship between 'test anxiety' and 'other anxieties,'" Journal of Personality, 1955, 23, 317-323.

[2]G. Mandler and S. B. Sarason, "A study of anxiety and learning," Journal of Abnormal and Social Psychology, 1952, 47, 166-173.

[3]_____ "The effect of prior experience and subjective failure on the evocation of test anxiety," Journal of Personality, 1952, 21, 336, 341.

[4]S. B. Sarason, G. Mandler, and P. G. Craighill, "The effect of differential instructions on anxiety and learning," Journal of Abnormal and Social Psychology, 1952, 47, 561-565.

blocks, but the nonanxious Ss who were not expected to finish performed more poorly than the nonanxious Ss who were expected to finish. These findings were for trial one only. By trial five, most of the differences between the groups disappeared and only the high anxiety group who was expected to finish performed significantly more poorly than the nonanxious group under the same instructions.

Two obstacles prevent a comparison between the Sarason studies and those using the MAS. In the first place, the learning tasks were not comparable; secondly, different methods of producing stress were used. In most MAS studies it was shock; in the Sarason studies it was failure reports.

In summary, the studies with clinically anxious agreed that anxiety was a deterrent to learning. Predictions of learning from psychometric anxiety, on the other hand, yielded limited conclusions. Psychometric anxiety influenced learning, but one could not predict the direction of the effect without controlling (1) the nature of the task and (2) the conditions under which the task was learned. What the more recent studies have demonstrated is that more precise predictions of learning can be made when the experiential variable of stress is controlled.

Stress

The psychology of anxiety and learning is still in its infancy. But at least one effect of its recent history has been the development of the concept of threat. Threat has

been assumed to be any event which a learner experiences as personally harmful. A very common method of inducing threat has been the giving of bogus evaluations.[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16]

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[1]M. Aborn, "The influence of experimentally induced failure on the retention of material acquired through set and incidental learning," Journal of Experimental Psychology, 1953, 45, 225-231.

[2]Lillian Belmont and H. G. Birch, "Reindividualizing the repression hypothesis," Journal of Abnormal and Social Psychology, 1951, 46, 226-235.

[3]J. H. Flavell, "Selective forgetting as a function of the induction and subsequent removal of ego threat," unpublished Master's thesis, Department of Psychology, Clark University, 1952.

[4]Rosalind Gould, "Repression experimentally analyzed," Character and Personality, 1942, 10, 259-288.

[5]Tracy S. Kendler, "The effect of success and failure on the recall of tasks," Journal of General Psychology, 1949, 41, 79-87.

[6]I. J. Korner, "Experimental investigation of some aspects of the problem of repression: repressive forgetting," Teachers College Contributions to Education, 1950, No. 970.

[7]J. Laffal, "The learning and retention of words with association disturbances," Journal of Abnormal and Social Psychology, 1952, 47, 454-462.

[8]R. S. Lazarus and C. W. Eriksen, "The effects of failure stress upon skilled performance," Journal of Experimental Psychology, 1952, 43, 100-105.

[9]_____, R. W. Baker, D. M. Broverman, and J. Mayer, "Personality and Psychological Stress," Journal of Personality, 1957, 559-577.

[10]D. C. McClelland and F. S. Apicella, "Reminiscence following experimentally induced failure," Journal of Experimental Psychology, 1947, 37, 159-169.

[11]R. M. Merrill, "The effect of pre-experimental and experimental anxiety on recall efficiency," Journal of Experimental Psychology, 1954, 48, 167-172.

[12]B. B. Murdock, Jr., "The effects of failure and retroactive inhibition on mediated generalization," Journal of Experimental Psychology, 1952, 44, 156-164.

[13]Sonya F. Osler, "Intellectual performance as a function of two types of psychological stress," Journal of Experimental Psychology, 1954, 47, 115-121.

[14]W. A. Russell, "Retention of verbal material as a function of motivating instructions and experimentally induced failure," Journal of Experimental Psychology, 1952, 43, 207-216.

[15]R. R. Sears, "Initiation of the repression sequence by experienced failure," Journal of Experimental Psychology, 1937, 20, 570-580.

[16]A. F. Zeller, "An experimental analogue of repression. III. The effect of induced failure and success on memory measured by recall," Journal of Experimental Psychology, 1951, 42, 32-38.

Another method has been shocking the Ss electrically.[1,2,3,4,5,6,7,8,9]

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[1]Lillian Belmont and H. G. Birch, "Reindividualizing the repression hypothesis," Journal of Abnormal and Social Psychology, 1951, 46, 226-235.

[2]R. G. Cannicott and J. D. Umberger, "An investigation of the psychoanalytic 'mechanism' of repression: the retention of verbal material associated with noxious stimulation," Proceedings Oklahoma Academy of Science, 1950, 31, 176-178.

[3]K. Diven, "Certain determinants in the conditioning of anxiety reactions," Journal of Psychology, 1937, 3, 291-308.

[4]C. W. Eriksen, "Stimulus generalization under stress," Journal of Abnormal and Social Psychology, 1954, 49, 561-565.

[5]_____ and H. Wechsler, "Some effects of experimentally induced anxiety upon discrimination behavior," Journal of Abnormal and Social Psychology, 1955, 31, 458-463.

[6]R. S. Lazarus and N. Longo, "The consistency of psychological defenses against threat," Journal of Abnormal and Social Psychology, 1953, 48, 495-499.

[7]B. M. Rose, J. W. Rupel, and D. A. Grant, "Effects of personal, impersonal and physical stress upon cognitive behavior in a card sorting problem," Journal of Abnormal and Social Psychology, 1952, 47, 546-551.

[8]S. S. Tomkins, "An experimental study of anxiety," Journal of Psychology, 1943, 15, 307-313.

[9]A. F. Zeller, "An experimental analogue of repression. III. The effect of induced failure and success on memory measured by recall," Journal of Experimental Psychology, 1951, 42, 32-38.

In some experiments[1,2] electrodes have been placed on the subject without actually shocking him. Pacing[3,4] is still another device which has been used. Occasionally heckling has induced threat.[5,6]

Some experimenters[7,8,9,10,11] have used materials for learning which activated conflicts. The materials themselves were threatening.

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[1]H. Kohn, "The effect of variations of intensity of experimentally induced stress situations upon certain aspects of perception and performance," Journal of Genetic Psychology, 1954, 85, 289-304.

[2]G. H. Zimny, "Effect of various motivational techniques upon learning and performance tasks," Journal of Experimental Psychology, 1956, 52, 251-257.

[3]A. Castaneda, "Effects of stress on complex learning and performance," Journal of Experimental Psychology, 1956, 52, 9-12.

[4]W. Z. Davidson, T. G. Andrews, and S. Ross, "Effects of stress and anxiety on continuous high speed color naming," Journal of Experimental Psychology, 1956, 52, 13-17.

[5]J. A. Davis, "Differential effects of stress on learning as a function of the time of introduction," Ph.D. thesis, Department of Psychology, University of Connecticut, 1955.

[6]S. Rosenzweigh and S. Sarason, "An experimental study of the triadic hypothesis: reaction to frustration, ego defense, and hypnotizability. I. Correlational approach," Character and Personality, 1942, 11, 1-19.

[7]A. W. Combs and C. Taylor, "The effect of the perception of mild degree of threat on performance," Journal of Abnormal and Social Psychology, 1952, 47, 420-424.

[8]E. L. Cowen, "The influence of varying degrees of psychological stress on problem solving rigidity," Journal of Abnormal and Social Psychology, 1952, 47, 512-519.

[9]_____, F. Heilizer, and H. S. Axelrod, "Self-concept conflict indicators and learning," Journal of Abnormal and Social Psychology, 1955, 51, 242-245.

[10]P. Worchel, "Anxiety and repression," Journal of Abnormal and Social Psychology, 1955, 50, 201-205.

[11]A. Zender, "A study of experimental frustration," Psychological Monographs, 1944, 56, No. 256.

One further method of inducing threat has been by instructing the subject that the task at hand is very important to him. The subject may be told he is taking an intelligence, personality or achievement test.[1,2,3,4,5,6]

With the exception of the learning experiments of Basowitz and others[7] and of Beam[8] in which the stress conditions had face validity, studies are lacking which describe the properties of the stress variable manipulated in learning experiments.

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[1]Thelma G. Alper, "Memory for completed and incompleted tasks as a function of personality: correlation between experimental and personality data," Journal of Personality, 1948, 17, 104-137.

[2]J. W. Atkinson, "The achievement motive and recall of interrupted and completed tasks," Journal of Experimental Psychology, 1953, 46, 381-390.

[3]A. W. Heyer and L. I. O'Kelly, "Studies in motivation and retention. II. Retention of nonsense syllables learned under different degrees of motivation," Journal of Psychology, 1949, 27, 143-152.

[4]D. H. Kausler, "A study of the relationship between ego-involvement and learning," Journal of Psychology, 1951, 32, 225-230.

[5]W. A. Russell, "Retention of verbal material as a function of motivating instructions and experimentally induced failure," Journal of Experimental Psychology, 1952, 43, 207-216.

[6]I. Sarason, "Effect of anxiety, motivational instructions, and failure on serial learning," Journal of Experimental Psychology, 1956, 51, 253-260.

[7]H. Basowitz, H. Persky, S. J. Korchin, and R. Grinker. Anxiety and Stress. New York: McGraw Hill, 1955.

[8]J. C. Beam, "Serial learning and conditioning under real life stress," Journal of Abnormal and Social Psychology, 1955, 31, 543-551.

Stress and Skilled Performance

How does stress affect a skill which is an integral part of the makeup of the subject? Zander[1] observed that digit span was impaired under stress. While visual and rote memory were unaffected, stress, according to Lantz,[2] lowered scores of tasks involving reasoning. Basowitz and others,[3] however, found both digit memory as well as perceptual discriminations inadequate before paratroop trainees jumped. The differences in ages between the Ss may have accounted for the difference in results. Lantz used young children; Basowitz, young adults. Difference in degree of stress may be an even more likely explanation. It is interesting to note that memory and perception improved, in the Basowitz study, when the days' jumps were over.

A few studies have demonstrated that stress had interfered with the process of abstracting. Beier's[4] results

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[1]A. Zander, "A study of experimental frustration," Psychological Monographs, 1944, 56, No. 256.

[2]Beatrice Lantz, "Some dynamic aspects of success and failure," Psychological Monographs, 1945, 59, No. 1.

[3]H. Basowitz, H. Persky, S. J. Korchin, and R. Grinker. Anxiety and Stress. New York: McGraw Hill, 1955.

[4]E. Beier, "The effect of induced anxiety on flexibility of intellectual functioning," Psychological Monographs, 1951, 65, No. 9.

indicated this, as did those of Cowen[1] in the water jar procedure and Rose and others[2] in a card sorting procedure.

In an experiment by Davidson and others[3] there was a decrease in the naming of colors under pacing stress. Osler[4] observed that there was a decrease in solving arithmetical problems after failure. The Ss in Combs' and Taylor's[5] experiment took longer and made more errors in decoding sentences containing stressful content than those containing neutral content. In a decoding experiment, Lazarus and Eriksen[6] found more errors as well as greater variability under stress. Students with high point averages tended to improve under stress.

A factor common to most of these experiments is the relatively high variability of the Ss working under stress.

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[1]E. L. Cowen, "The influence of varying degrees of psychological stress on problem solving rigidity," Journal of Abnormal and Social Psychology, 1952, 47, 512-519.

[2]B. M. Rose, J. W. Rupel, and D. A. Grant, "Effects of personal, impersonal and physical stress upon cognitive behavior in a card sorting problem," Journal of Abnormal and Social Psychology, 1952, 47, 546-551.

[3]W. Z. Davidson, T. G. Andrews, and S. Ross, "Effects of stress and anxiety on continuous high speed color naming," Journal of Experimental Psychology, 1956, 52, 13-17.

[4]Sonya F. Osler, "Intellectual performance as a function of two types of psychological stress," Journal of Experimental Psychology, 1954, 47, 115-121.

[5]A. W. Combs and C. Taylor, "The effect of the perception of mild degrees of threat on performance," Journal of Abnormal and Social Psychology, 1952, 47, 420-424.

[6]R. S. Lazarus and C. W. Eriksen, "The effects of failure stress upon skilled performance," Journal of Experimental Psychology, 1952, 43, 100-105.

Waterhouse and Child,[1] however, have shed some light on this problem. They told their Ss that they had not done well on a group of tasks. After the experiment, they elicited answers to a questionnaire to determine reactions to stress. When the subject interpreted the experimenter's comments as interfering with progress toward the goal there was a decrement in performance; when they did not make this interpretation, there was an increment. Lazarus and others[2] have gathered data which supported this point of view. In their experiment, stress did not significantly affect literalness except when the interference proneness of the S was considered.

The results of these experiments indicate that stress has a detrimental effect on skilled behavior. This, however, is very understandable. Response patterns which have reached the asymptote of learning can either remain unchanged or can decrease under stress, but will not gain in strength. But the fact that they decrease in strength, seems to be best explained in terms of undifferentiated cues which are elicited by the stress and which interfere with responding.

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[1] I. K. Waterhouse and I. L. Child, "Frustration and the quality of performance: III. An experimental study," Journal of Personality, 1953, 21, 298-311.

[2] R. S. Lazarus, R. W. Baker, D. M. Broverman, and J. Mayer, "Personality and psychological stress," Journal of Personality, 1957, 559-577.

Stress and Acquisition

Results of stress-learning experiments have been equivocal. No flat statement of the relationship between the two can be made. Sears[1] noted that stress depressed learning. Tomkins,[2] too, observed that stress was related to slower learning. Stress, however, facilitated acquisition in an experiment by Kausler.[3] Davis,[4] on the other hand, found stress facilitated learning only when it was introduced toward the end of acquisition. When it was introduced at the beginning of learning, it interfered with acquisition. In comparison to nonstress, fewer errors were made by stressed Ss in a paired associates experiment by Castaneda[5] but only when the S-R pairs were unchanged. The stressed group made more errors when the pairs were changed.

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[1]R. R. Sears, "Initiation of the repression sequence by experienced failure," Journal of Experimental Psychology, 1937, 20, 570-580.

[2]S. S. Tomkins, "An experimental study of anxiety," Journal of Psychology, 1943, 15, 307-313.

[3]D. H. Kausler, "A study of the relationship between ego-involvement and learning," Journal of Psychology, 1951, 32, 225-230.

[4]J. A. Davis, "Differential effects of stress on learning as a function of the time of introduction," Ph.D. thesis, Department of Psychology, University of Connecticut, 1955.

[5]A. Castaneda, "Effects of stress on complex learning and performance," Journal of Experimental Psychology, 1956, 52, 9-12.

Cowen and others,[1] using stressful material, determined that conflict words took longer to learn than neutral words. Laffal[2] made a similar observation. Worchel's[3] data contradicted these findings. Acquisition of stress words was no different from acquisition of nonstress words.

McClelland and Apicella[4] found that a group that was told it failed at one task required more trials to learn a second task than a nonfailed group. In an experiment in which each subject was his own control[5] serial learning under life stress was inferior to learning under no stress. Conditioning, however, was more rapid. Controlling anxiety, stress, and failure, Sarason[6] found that learning under stress was inferior to learning under no stress, but only for the anxious Ss. More important still, the nonstressed

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[1]E. L. Cowen, F. Heilizer, and H. S. Axelrod, "Self-concept conflict indicators and learning," Journal of Abnormal and Social Psychology, 1955, 51, 242-245.

[2]J. Laffal, "The learning and retention of words with association disturbances," Journal of Abnormal and Social Psychology, 1952, 47, 454-462.

[3]P. Worchel, "Anxiety and repression," Journal of Abnormal and Social Psychology, 1955, 50, 201-205.

[4]D. C. McClelland and F. S. Apicella, "Reminiscence following experimentally induced failure," Journal of Experimental Psychology, 1947, 37, 159-169.

[5]J. C. Beam, "Social learning and conditioning under real life stress," Journal of Abnormal and Social Psychology, 1955, 31, 543, 551.

[6]I. Sarason, "Effect of anxiety, motivational instructions, and failure on serial learning," Journal of Experimental Psychology, 1956, 51, 253-260.

anxious group who failed, learned more efficiently than either mild or low anxiety nonstressed group. Stressed, anxious Ss who failed, on the other hand, were inferior to anxious S who failed as well as those under no stress.

The value of Sarason's experiment lay in his control of anxiety, personal relevance, and failure. But uncertainty remains. The experiments of Alper[1] and Zimny[2] have indicated that there is no relationship between stress and acquisition.

Studying another phase of learning, Rosenbaum[3] obtained steeper generalization gradients under stress than under no stress. Eriksen,[4] too, found greater generalization under stress. In another experiment it was found that the generalizing tendency did not interfere with the number of discriminations made.[5] The smaller number of

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[1]Thelma G. Alper, "Memory for completed and incompleted tasks as a function of personality: correlation between experimental and personality data," Journal of Personality, 1948, 17, 104-137.

[2]G. H. Zimny, "Effect of various motivational techniques upon learning and performance tasks," Journal of Experimental Psychology, 1956, 52, 251-257.

[3]G. Rosenbaum, "Stimulus generalization as a function of level of experimentally induced anxiety," Journal of Experimental Psychology, 45, 35-43.

[4]C. W. Eriksen, "Stimulus generalization under stress," Journal of Abnormal and Social Psychology, 1954, 49, 561-565.

[5]_____ and H. Wechsler," Some effects of experimentally induced anxiety upon discrimination behavior," Journal of Abnormal and Social Psychology, 1955, 31, 458-463.

available responses which stressed Ss used, in this experiment by Eriksen and Wechsler, differentiated them from non-stress Ss.

Briefly, some experiments reported that stress facilitated acquisition, others that it interfered with it, still others that it had little effect on it. Degree of stress and level of anxiety appear to be critical variables which account for differences in findings.

Stress and Retention

Acquisition under stress has not been studied as extensively as retention. In many stress experiments the incompleted task technique has been used. Zeigarnik[1] discovered the effect. She found that incompleted tasks were recalled better than completed ones. The tension of noncompletion aided recall. Alper's[2] results differed somewhat from those of Zeigarnik in that when personality characteristics were not controlled, the recall of completed tasks was no greater than the recall of completed ones. In a further study Alper[3] enumerated these

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[1]R. D. Zeigarnik, "Das behalten erledigter und unerjedigter handlungen," Psychol. Forsch, 1927, 9, 1-85.

[2]Thelma G. Alper, "Memory for completed and incompleted tasks as a function of personality: an analysis of group data," Journal of Abnormal and Social Psychology, 1946, 41, 403-420.

[3]_____ "Task-orientation and ego-orientation as factors in reminiscence," Journal of Experimental Psychology, 1948, 38, 224-238.

personality characteristics. Briefly, when self esteem is threatened, "strong egos" recalled more completed tasks; "weak egos" preferred incompleted tasks. Eriksen[1] found "strong egos" recalled more incompleted tasks under no stress; "weak egos," on the other hand, recalled more incompleted tasks under stress. He observed, in addition,[2] that hysteria was related to the recall of completed tasks and psychaesthenia, to the recall of incompleted tasks. Glixman[3] added that under stress "strong egos" recalled more completed tasks, but "weak egos," more incompleted tasks. The reverse was true under no stress. Investigating another personality variable, Atkinson[4] observed that as stress increased, those high in need achievement recalled more incompleted tasks; those low in need achievement, fewer incompleted tasks. These experimenters have assumed that completion of a task means success and noncompletion, failure. Operating under this assumption, the interpretation of these experiments has been that under

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[1]C. W. Eriksen, "Psychological defenses and 'ego strength' in the recall of completed and incompleted tasks," Journal of Abnormal and Social Psychology, 1954, 49, 45-50.

[2]_____ "Defenses against threat in memory and perception," Journal of Abnormal and Social Psychology, 1952, 47, 230-235.

[3]A. F. Glixman, "Recall of completed and incompleted activities under varying degrees of stress," Journal of Experimental Psychology, 1949, 39, 281-295.

[4]J. W. Atkinson, "The achievement motive and recall of interrupted and completed tasks," Journal of Experimental Psychology, 1953, 46, 381-390.

stress "weak egos" recall failures and "strong egos," successes; "strong egos" recall failures under no stress; whereas, "weak egos" recall successes.

These interpretations leave much to be desired. Why would "weak egos" recall failures under stress when the recall of successes would enhance them more? Secondly, it is not at all clear what is meant by "weak" or "strong" ego. Marrow[1,2] indicated that completed tasks do not always mean success. As a matter of fact, when task completion meant failure, more completed tasks were recalled. He observed, moreover, that some tasks have properties which facilitated their recall. The ego-involved group, in Smock's[3] experiment, recalled fewer incompleted tasks. Since personality characteristics were not controlled, it is not possible to compare these results with those obtained by other experimenters. What is more important in this experiment is that tasks having anxiety arousing

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[1]A. J. Marrow, "Goal tensions and recall: I," Journal of General Psychology, 1938, 19, 3-35.

[2]_____"Goal tensions and recall: II," Journal of General Psychology, 1938, 19, 37-64.

[3]C. D. Smock, "Recall of interrupted and noninterrupted tasks as a function of experimentally induced anxiety and motivational relevance of the task stimuli," Journal of Personality, 1956, 25, 589-599.

properties were forgotten sooner than other tasks. Sanford and Risser,[1] too, found differences in recall as a function of the nature of the stimuli. More completed puzzles were recalled, whereas more incompleted rhymes were recalled. In addition, Ss who recalled completed tasks better than incompleted ones at the end of the experimental session, showed no preference in recall a few months later. The implication here is that failure inhibited recall. In her experiment, though, Kendler[2] found that the spread of effect of success accounts for the recall of successes.

One experiment has questioned the validity of the findings of Zeigarnik effect experiments. Jourard[3] obtained no difference in preference for completed or incompleted tasks. Using a sensitive measure of ego strength, he found, it, too, was not related to recall. Gilmore[4] explained, however, that findings of Zeigarnik effect experiments are suspect because neither is the nature of the

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[1]R. N. Sanford and J. Risser, "What are the conditions of self-defensive forgetting?", Journal of Personality, 1948, 17, 244-260.

[2]Tracy S. Kendler, "The effect of success and failure on the recall of tasks," Journal of General Psychology, 1949, 41, 79-87.

[3]S. M. Jourard, "Ego strength and the recall of tasks," Journal of Abnormal and Social Psychology, 1954, 49, 51-58

[4]J. L. Gilmore, "Recall of success and failure as a function of subjects' threat interpretations," Journal of Psychology, 1954, 38, 359-365.

incompleted tasks nor is the reaction to the experiment controlled. Although 105" are allotted for the incompleted task session, some Ss become familiar with more items than others, hence biasing retention data. In his experiment, he used tasks which had no possible solution as well as tasks which could be solved. He also asked his Ss to designate the purpose of the experiment. More successes were recalled than failures. This tendency was especially pronounced in the group who felt the situation was stressful.

As yet, it is not certain whether recall in a Zeigarnik paradigm is due to (1) the nature of the task, (2) the personality structure of the subject, (3) the spread of effect of success, or (4) the interpretation of the task by the subject.

The express intent of another group of studies was to experimentally produce repression. Sears[1] found a decrement in recall of tasks in which the experimenter criticized the participant. When the experimenter's comments aroused tension in the Ss, the tasks as well as the comments were frequently forgotten in Gould's[2] study. This tendency to forget anxiety arousing materials was

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[1]R. R. Sears, "Initiation of the repression sequence by experienced failure," Journal of Experimental Psychology, 1937, 20, 570-580.

[2]Rosalind Gould, "Repression experimentally analyzed," Character and Personality, 1942, 10, 259-288.

also reported by Korner.[1] Although conflict words were learned as well as neutral words, Worchel[2] reported that the recall of traumatic words was inferior to that of neutral words. It is erroneous to conclude, however, that inferior recall is a function of stress. In none of these experiments is response strength controlled. What the participants in these experiments forgot may have been incompletely learned responses. Threatening words were recalled less efficiently by both stress and nonstress groups in Merrill's[3] experiment. Although threatening words were recalled more poorly by the stress group on the first recall, no differences appeared between the groups on a second recall. The decrement in recall perhaps is a temporary effect of stress. It may be a result of a reduced rate of responding generated by the stress. Some evidence for this position comes from Kohn.[4]

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[1]I. J. Korner, "Experimental investigation of some aspects of the problem of repression: repressive forgetting," Teachers College Contributions to Education, 1950, No. 970.

[2]P. Worchel, "Anxiety and repression," Journal of Abnormal and Social Psychology, 1955, 50, 201-205.

[3]R. M. Merrill, "The effect of pre-experimental and experimental anxiety on recall efficiency," Journal of Experimental Psychology, 1954, 48, 167-172.

[4]H. Kohn, "The effect of variations of intensity of experimentally induced stress situations upon certain aspects of perception and performance," Journal of Genetic Psychology, 1954, 85, 289-304.

He found less recall under stress than under other experimental conditions. Russell,[1] in addition, found no differences between his stress groups after they became habituated.

In a conditioning experiment in which he administered electric shock to his Ss, Diven[2] produced an effect akin to repression. During the shocked trials, there was a preponderance of recall of shocked words. During nonreinforced trials, nonshocked words were favored. After 48 hours, the Ss recalled even fewer shocked words. Some Ss, however, were aware of the relationship between the shock and the response shocked. When awareness was controlled, Diven found the unaware group recalled more words than those who were aware. Traumatic words constituted a majority of the words which the unaware group recalled. Knowledge of the purpose of the experiment, then, altered the results. Cannicott and Umberger[3] repeated Diven's experiment but found no difference in recall of shocked and nonshocked words for either immediate or

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[1]W. A. Russell, "Retention of verbal material as a function of motivating instructions and experimentally induced failure," Journal of Experimental Psychology, 1952, 43, 207-216.

[2]K. Diven, "Certain determinants in the conditioning of anxiety reactions," Journal of Psychology, 1937, 3, 291-308.

[3]R. G. Cannicott and J. D. Umberger, "An investigation of the psychoanalytic 'mechanism' of repression: the retention of verbal material associated with noxious stimulation," Proceedings Oklahoma Academy of Science, 1950, 31, 176-178.

delayed recall. Aborn[1] observed in his experiment that only Ss who were not set to learn had a decrement in recall. His results differed from those of Diven, but the experimental procedures were not alike.

In other experimental attempts to produce repression, the results have been equally conflicting. Zeller[2] found a decrease in recall after threat. Recall improved when the threat was removed. Flavell,[3] however, found the decremental effects of stress to remain even after the stress was removed. In a different experimental design, failure stress suppressed mediated generalization, according to Murdock.[4] Chansky,[5] too, found threat interfered with recall.

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[1]M. Aborn, "The influence of experimentally induced failure on the retention of material acquired through set and incidental learning," Journal of Experimental Psychology, 1953, 45, 225-231.

[2]A. F. Zeller, "An experimental analogue of repression. III. The effect of induced failure and success on memory measured by recall," Journal of Experimental Psychology, 1951, 42, 32-38.

[3]J. H. Flavell, "Selective forgetting as a function of the induction and subsequent removal of ego threat," unpublished Master's thesis, Department of Psychology, Clark University, 1952.

[4]B. B. Murdock, "The effects of failure and retroactive inhibition on mediated generalization," Journal of Experimental Psychology, 1952, 44, 156-164.

[5]N. M. Chansky, "Threat as a factor in recall in a retraction paradigm," Journal of Psychology, 1956, 41, 3-10.

Both Alper[1] and Heyer and O'Kelly[2] found their subjects had better delayed recall when they learned under stress. This may have been due in part, Alper[3] later pointed out, that in her study, more stressed than nonstressed Ss rehearsed what they had learned. Russell[4] had his Ss overlearn a list of nonsense syllables. Failure stress was related to inferior immediate recall. Neither motivation nor failure, though, was related to delayed recall. Sarason's[5] results differed slightly from those of Russell. In his experiment, too, failure was not related to delayed recall, but anxious Ss who learned under stress had significantly poorer recall than nonstressed anxious Ss. The inferior delayed recall may be accounted for in terms of the incubation effect of

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[1]Thelma G. Alper, "Task-orientation vs. ego-orientation in learning and retention," American Journal of Psychology, 1946, 59, 236-248.

[2]A. W. Heyer and L. I. O'Kelly, "Studies in motivation and retention. II. Retention of nonsense syllables learned under different degrees of motivation," Journal of Psychology, 1949, 27, 143-152.

[3]Thelma G. Alper, "Task-orientation and ego-orientation as factors in reminiscence," Journal of Experimental Psychology, 1948, 38, 224-238.

[4]W. A. Russell, "Retention of verbal material as a function of motivating instructions and experimentally induced failure, "Journal of Experimental Psychology, 1952, 43, 207-216.

[5]I. Sarason, "Effect of anxiety, motivational instructions, and failure on serial learning," Journal of Experimental Psychology, 1956, 51, 253-260.

anxiety. Bindra and Cameron[1] found significantly greater anxiety after rather than during acquisition. But when stressed during acquisition, immediate recall was better for Kausler's[2] Ss. Stress, however, was in no way related to delayed recall.

The obvious conflict in results of stress retention experiments is not easy to explain. Eriksen and others[3] studied the relationship between personality factors and stress. They found none when they used the Rorschach and the Guilford GAMIN. No relationship was found between rigidity and stress, either.[4] Some experimenters believed subjects' reports were related to results of stress experiments, but McKinney and others[5] found no relationship between the statements which Ss make after the

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[1]D. Bindra and L. Cameron, "Changes in experimentally produced anxiety with the passage of time: incubation effect," Journal of Experimental Psychology, 1953, 45, 197-203.

[2]D. H. Kausler, "A study of the relationship between ego-involvement and learning," Journal of Psychology, 1951, 32, 225-230.

[3]C. W. Eriksen, R. S. Lazarus, and J. R. Strange, "Stress and its personality correlates," Journal of Personality, 1952, 20, 277,286.

[4]E. G. French, "Interrelation among some measures of rigidity under stress and nonstress conditions," Journal of Abnormal and Social Psychology, 1955, 51, 114-118.

[5]F. McKinney, G. B. Strother, R. R. Hines, and R. A. Allee, "Experimental frustration in a group test situation," Journal of Abnormal and Social Psychology, 1951, 46, 316-323.

experiment and their performance during the experiment. In their experiment, each S served as his own control. Under stress, there were more errors, more attempts, and greater variability. The implication here is that there are individual differences in responding to failure.

Perhaps the reason for the lack of agreement among results is that individual differences in remembering have not been controlled. Belmont and Birch[1] divided their groups according to the effect shock had on their learning. Shock facilitated learning in one group, but interfered with it in another. While shock was related to acquisition, it was not related to total recall. The nonshocked group recalled more neutral material but the shocked group recalled more negatively affective material. They found, however, that the Shock-Facilitated-Acquisition group was not the same as the Shock-Facilitated-Retention group. Further evidence for individual differences in forgetting comes from Eriksen.[2] Ss who showed defensive forgetting in one experiment required more trials to relearn affectively toned than neutral words. Ss who did not show defensive forgetting learned both types of words equally well.

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[1]Lillian Belmont and H. G. Birch, "Reindividualizing the repression hypothesis," Journal of Abnormal and Social Psychology, 1951, 46, 226-235.

[2]C. W. Eriksen, "Individual differences in defensive forgetting," Journal of Experimental Psychology, Journal of Experimental Psychology, 1952, 44, 442-447.

Lazarus and Longo,[1] however, reexamined Eriksen's subjects. Those who recalled successes could not be differentiated from those who recalled failures in another learning experiment. They were differentiated by their recall of shock and nonshock materials. Those who recalled failures tended to have better recall of shocked syllables; those who recalled successes had better recall of nonshocked syllables. The differences, though, were not significant.

These experiments suggest that there are styles of remembering threatening material. But the experimental design of Lazarus and Longo experiment suggest a new avenue of approach. Their Ss were asked to learn ten pairs of nonsense syllables under conditions of punishment with electric shock. They were told that they would be shocked on five pairs regardless of whether they had the right answer. In other words, they were reinforced only part of the time. The recall of the shocked syllables may have been influenced by the schedule of reinforcement rather than by the shock per se. If this objection is tenable, what may have contaminated the results of many stress experiments is the lack of control of the method of learning.

The Lazarus and Longo experiment suggested a model for a novel inquiry to the writer, learning under stress

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[1] R. S. Lazarus and N. Longo, "The consistency of psychological defenses against threat," Journal of Abnormal and Social Psychology, 1953, 48, 495-499.

in which schedule of reinforcement is controlled. To this end, six directional hypotheses were stated, the bases of which were the findings of previous experimenters. These hypotheses were:

1. Acquisition under continuous reinforcement is superior to acquisition under noncontinuous reinforcement.
2. Acquisition under threat is inferior to acquisition under no threat.
3. Acquisition of anxious responders is inferior to acquisition of nonanxious responders.
4. Retention under continuous reinforcement is inferior to retention under noncontinuous reinforcement.
5. Retention under threat is inferior to retention under no threat.
6. Retention of anxious responders is inferior to retention of nonanxious responders.

In addition, data was gathered to explore the following nondirectional hypotheses:

7. The interaction between stress and pattern of reinforcement has an effect on acquisition.
8. The interaction between instructions and reaction to instructions has an effect on acquisition.
9. The interaction between stress and reinforcement has an effect on retention.
10. The interaction between instructions and reactions to instructions has an effect on retention.

Summary

A review of the literature indicates that while non-continuous reinforcement does not materially affect acquisition, it is related to superior retention. Studies of anxiety and learning as well as those of stress and learning have widely disagreed with one another. In general, psychometrically anxious subjects were found to learn simple tasks better but complex tasks more poorly than less anxious subjects. These results do not hold up when habituation takes place or when the experimental task is such as to be of equal difficulty to all subjects. In addition, when threat, especially due to failure, interacts with anxiety, interference with discriminating and abstracting behavior was observed. Furthermore, some studies suggest that there is individual variation in the learning of anxious subjects as well as of normals under stress conditions. In the present experiment, schedules of reinforcement, stress, and anxiety were controlled to investigate the separate effects of each on acquisition and retention. In addition, interactions among these variables were explored to determine their influence on the learning of paired nonsense syllables.

CHAPTER II

DESIGN AND PROCEDURE

Experimental Design

The hypotheses of this experiment were tested in the following way. The subjects in the experiment learned the response members of paired associates nonsense syllables by one of two methods, continuous or noncontinuous reinforcement. A five minute interpolated task separated acquisition from retention. Five nonreinforced trials followed the interpolated task. During these trials, retention was measured. Half of the subjects in each group received threatening instructions and half, nonthreatening instructions before the experiment got under way. At the close of the experiment, each subject reported whether or not he was nervous both immediately after he received the instructions and during the experiment proper.

Apparatus

A conventional memory drum was used. It was set up so that the interstimulus time was three seconds and the intertrial time was six seconds. Three tapes of paired associate nonsense syllables were shown. These syllables were of low association value according

to Glaze.[1] In one tape, the stimulus and response appeared together. In another tape, the one used during reinforcement trials, the response followed the stimulus. The third tape had stimuli only. This tape was used during nonreinforcement trials only. The ten pairs of syllables used were:

QUG-YIM
DAX-FEP
ZOJ-QAM
XAD-VOJ
MEF-NEJ
ZIW-LEB
VAF-KIG
XOF-JIH
WUB-JEZ
LAJ-KEF

The Minnesota Paper Form Board was the interpolated tasks. The post task interview contained six questions. These were:

1. Were you worried when you learned this was a (new study method) (test)? Yes. No.

2. Were you worried while you were (learning) (taking the test)? Yes. No.

3. Were you nervous when you learned this was a (new study method) (test)? Yes. No.

4. Were you nervous while you were (learning) (taking the test)?

5. How confident were you before you came in that you were going to do well? Very. Not at all.

6. How confident were you that you were doing your best? Very. Not at all.

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[1] J. A. Glaze, "The association value of nonsense syllables," Journal of Genetic Psychology, 1928, 35, 255-267.

Subject-Experimenter Relationship

All subjects were college freshmen registered in the Improvement of Reading and Study course at Adelphi College. The experimenter was the instructor of the course. In addition, he was the Director of the Reading Service. As such, he was a member of the administrative staff of the college. During orientation week, the Dean of Men explained to the students that it was the Director of Reading who recommended they take the course. The Director also made recommendations regarding the students' continuing a second semester in the course as well as regarding their suitability for college.

Threat

Since the status of many of the students in the course was uncertain, the experimenter reasoned that tests whose scores would be critically evaluated by both the Reading Director and the Dean would be threatening. Tests, on the other hand, which they would not evaluate would not be threatening.

Procedure

Each student registered in the Improvement of Reading Course was randomly assigned to either the threat or the no threat group. There were sixty students in all.

These groups were further divided. Half of each group

was randomly assigned to the 100% reinforcement group and half, to the 50% reinforcement group. Each experimental group, then, had fifteen subjects. Each subject was tested individually. After he sat down, the subject received the instructions appropriate to his group.

The nonthreat group was told:

> Recently, I have developed a new method for studying foreign languages. I have invited you to help me find out how well it works. No record of your performance will be made. Do the best you can.

The threat group was told:

> Since there is some question about your ability to do freshman scholastic work, I am going to give you this intelligence test to determine how fit you are as a student. Your score on the intelligence test, like the other scores reported to you today, will go on your record in the Dean's office.

After the pretask set was instated, the Experimenter said:

> I am going to present ten pairs of nonsense syllables to you. After you have seen the pairs together for two trials, I will present the left hand member or the cue. It will appear in the window of the memory drum. You are to spell the correct meaning, that is the response member of the pair within three seconds. This is what the pairs look like.

E, then, showed the tape in which the stimulus and response appeared together. This tape was shown for two trials. Then he said:

> This time you will be shown the same list of words, but each time you see the cue word, you are to anticipate the meaning. Spell it.

To the 100% reinforcement group, he added:

> The correct meaning will always follow the cue

> word and will appear in the window of the (memory drum) (automatic intelligence tester) so you will know when you are correct.

To the 50% reinforcement group, he added:

> Half of the time the correct meaning will appear in the window of the (memory drum) (automatic intelligence tester) so that you will know when you are correct. Half of the time, however, the meaning will not appear. I will let you know on which trial the meaning will appear.

The continuous reinforcement groups were given ten trials to acquire the list; the partial reinforcement groups were given twenty trials. The correct answers appeared on trials 1, 2, 4, 8, 9, 11, 12, 14, 18, and 19 for the partial reinforcement groups. The interstimulus time was three seconds; the intertrial time was six seconds.

Immediately after the last acquisition trial, the Minnesota Paper Form Board was administered to each subject. He was allowed five minutes to work on the problems. After five minutes, E said:

> This time I am going to show you the cue word only. You are to give the meaning word. The meaning word will not follow. This list has cue words only.

Five retention trials followed these instructions.

At the close of the experiment, E asked S the six questions of the post test interview.

Treatment of the Data

Acquisition scores were the total number of correct productions on each trial. These scores were later pooled by dividing the total number of trials by 2. The mean for

each S on each half was then determined. Retention scores were the total number of correct productions on each post acquisition trial.

The main effects of instructions, patterns of reinforcement, and anxiety were tested in an analysis of variance design. The analyses of variance of acquisition were tested under two different conditions: (1) when trials were equated and (2) when reinforcements were equated.

Summary

Students in an Improvement of Reading and Study course participated in a Stress-Learning experiment. Acquisition was by either continuous or by intermittent reinforcement. Retention was measured after a five minute interpolated task. Reactions to the experiment were determined in a postexperiment interview. The effects of threat, reinforcement, and anxiety were tested in an analysis of variance design.

CHAPTER III

RESULTS AND CONCLUSIONS

Investigations of stress and learning have tacitly assumed that the instructions were genuinely threatening. In the present experiment, this was not assumed. Although the experimenter worded his instructions so that the subject would anticipate harm, the real test of the effectiveness of the instructions was made by determining how the subjects reacted to them.

Chi square tests were made of the responses to the post experimental interview.

TABLE 1

Chi Square Tests of Independence Between Instructions and Reactions

Instructions	Reactions											
	I		II		III		IV		V		VI	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Threat	22	8	24	6	17	13	27	3	19	11	11	16
No Threat	6	24	18	12	4	26	19	11	14	16	12	18
Chi Square	8.68*		2.86		12.71**		7.61*		0.84		0.16	
df	1		1		1		1		1		1	

*P.01
**P.001

These tests indicated that answers to questions 1, 3 and 4 could not have been obtained by chance. The subjects said

that the threatening instructions made them nervous; the Ss did not respond to the nonthreatening instructions in this way.

Since the questions of the postexperimental interview measured similar response tendencies, the interrelationships among them were examined. Table 2 presents these interrelationships. Questions 2, 5, and 6 were excluded from this analysis because responses to them were no better than chance.

TABLE 2

Chi Square Tests of Relationships Among Responses to Post Experimental Interview

Question		III		IV	
I	Yes	Yes	No	Yes	No
		18	10	25	3
	No	3	29	20	12
	Chi Square	19.76***		5.71*	
	r ø	.57		.31	
	df	1		1	

Question		IV	
III	Yes	Yes	No
		20	1
	No	25	14
	Chi Square	7.04**	
	r ø	.34	
	df	1	

*P.05
**P.01
***P.001

These tests indicated that students who were worried also said they were nervous. The interrelationships among the responses are high enough to suggest that the three questions measured the same behavior. To simplify treatment of these data, responses to questions 1, 3, and 4 were pooled to form a measure of anxiety. Those subjects whose responses to the post experiment questions were predominantly "Yes" made up the anxious group. When the predominant response was "No," the subjects were placed in the nonanxious group.

A computation of the Chi Square of the pooled scores indicated that the commonly reported response to threat was anxiety and the response to no threat was absence of anxiety (Table 3). Not only, then, might the differential instructions be a source of variation in learning, but the reactions to these instructions might be a source of variation as well.

TABLE 3

Chi Square Tests of Independence Between Instructions and Anxiety: Pooled Scores

Instructions	Reactions		df	Chi Square
	Anxiety	No Anxiety		
Threat	21	9	1	13.12*
No Threat	7	23		

*P.001

What effects did pretask stress and pattern of reinforcement have on learning? Table 4 presents the mean number of correct syllables for each group during acquisition.

TABLE 4

Means of Four Groups for Each Acquisition Trial: Instructions X Reinforcement

Acquisition

Group/Trial	1*	2*	3	4*	5	6	7	8*	9*	10
100% Threat	0.47	.53	1.00	1.33	1.52	2.20	2.20	2.80	3.93	4.93
100% No Threat	0.73	1.31	2.13	2.86	2.86	4.00	4.33	4.55	4.87	5.30
50% Threat	0.20	0.60	0.80	1.33	1.33	1.40	1.27	1.72	2.40	2.40
50% No Threat	0.37	0.39	0.33	0.60	0.60	0.53	0.47	0.60	1.80	1.60

Group/Trial	11*	12*	13	14*	15	16	17	18*	19*	20
50% Threat	2.33	3.26	2.94	3.20	3.67	3.76	4.20	4.91	5.27	5.27
50% No Threat	2.00	2.40	2.94	2.53	3.20	2.80	2.86	3.60	4.60	4.59

*Reinforced trials for the 50% reinforcement group

A more detailed analysis of the relationship between the hypotheses and the experimental findings are presented here.

Hypothesis One: Acquisition under continuous reinforcement is superior to acquisition under intermittent reinforcement. The hypothesis was tested in the following way: the mean number of correct responses for the continuously reinforced group was compared with the mean number of correct

responses for the intermittently reinforced group when trials were equated (Table 5) and when reinforcements were equated (Table 6). The differences between the groups were tested statistically by analysis of variance. The results indicated that when trials were equated (Table 7) the continuously reinforced group acquired more syllables than the partial reinforcement group. When reinforcements were held constant (Table 8), on the other hand, the continuously reinforced group was superior for the first half of learning, that is, for the first five reinforcements. Thereafter, however, the differences between the groups became negligible. This hypothesis was supported, then, in part only.

Hypothesis Two: Acquisition under threat is inferior to acquisition under no threat. This hypothesis was tested in the following way. The mean number of correct responses for the threat group was compared with the mean number of correct responses for the nonthreat group both when trials were equated (Table 5) and when reinforcements were equated (Table 6). The results were tested statistically by analysis of variance. No differences were found between the groups when trials were equated (Table 7) or when reinforcements were equated (Table 8), hence, not supporting the hypothesis.

Hypothesis Three: Acquisition of anxious responders is inferior to acquisition of nonanxious responders. The hypothesis was tested in the following way. The mean acquisition score of anxious responders was compared with the mean acquisition scores of the nonanxious responders when both

trials were equated (Table 9) and when reinforcements were equated (Table 10). The differences were tested by analysis of variance. No differences were found between the groups, hence not supporting the hypothesis.

TABLE 5

Means and Standard Deviations of Pooled Scores During Acquisition Varying Instructions and Reinforcement: Trials Equated

Group	N	Trials 1-5		Trials 6-10	
		Mean	S.D.	Mean	S.D.
Threat--100% Reinforcement	15	0.97	0.70	3.20	1.56
Threat--50% Reinforcement	15	0.79	0.70	1.84	1.05
No Threat--100% Reinforcement	15	1.86	1.45	4.62	1.69
No Threat--50% Reinforcement	15	0.44	0.30	0.97	0.60

TABLE 6

Means and Standard Deviations of Pooled Scores During Acquisition Varying Instructions and Reinforcement: Reinforcements Equated

Group	N	Reinforcements 1-5		Reinforcements 6-10	
		Mean	S.D.	Mean	S.D.
Threat--100% Reinforcement	15	0.97	0.70	3.20	1.56
Threat--50% Reinforcement	15	1.28	1.01	3.77	1.01
No Threat--100% Reinforcement	15	1.86	1.45	4.62	1.69
No Threat--50% Reinforcement	15	0.72	0.90	3.24	1.45

TABLE 7

Analysis of Variance of Acquisition Varying Instructions and Patterns of Reinforcement: Trials Equated

Effects	Degrees of Freedom	Trials 1-5		Trials 6-10	
		Mean Square	F	Mean Square	F
Instructions	1	1.31	1.61	4.65	1.66
Reinforcements	1	10.41	12.85**	79.35	28.34**
Interaction	1	6.39	7.89**	11.32	4.04*
Error	56	0.81			

*Significant at 0.5 level of probability
**Significant at .01 level of probability

TABLE 8

Analyses of Variance of Acquisition Varying Instructions and Patterns of Reinforcement: Reinforcements Equated

Effects	Degrees of Freedom	Reinforcements 1-5		Reinforcements 6-10	
		Mean Square	F	Mean Square	F
Instructions	1	1.81	1.74	8.03	2.66
Reinforcements	1	5.24	5.03*	0.60	0.20
Interaction	1	3.76	3.61	8.67	2.87
Error	56	1.04		3.02	

*Significant at .05 level of probability

TABLE 9

Analyses of Variance of Acquisition Varying Instructions and Reaction to the Experiment: Trials Equated

Effects	Degrees of Freedom	Trials 1-5 Uncorrected Mean Square		Trials 6-10 Uncorrected Mean Square	
Instructions	1	1.31		4.65	
Reaction	1	0.21		2.28	
Error	56	1.11		4.37	
		Corrected Mean Square	F	Corrected Mean Square	F
Instructions	1	1.14	1.02	6.83	1.56
Reaction	1	0.04	0.03	4.46	1.02
Interaction	1	0.02	0.03	0.67	0.15
Error	56	1.11		4.37	

TABLE 10

Analyses of Variance of Acquisition Varying Instructions and Reaction to the Experiment: Reinforcements Equated

Effects	Degrees of Freedom	Reinforcements 1-5 Uncorrected Mean Square		Reinforcements 6-10 Uncorrected Mean Square	
Instructions	1	1.81		8.03	
Reaction	1	1.89		1.18	
Error	56	1.09		3.16	
		Corrected Mean Square	F	Corrected Mean Square	F
Instructions	1	1.86	1.70	9.24	2.92
Reaction	1	0.03	0.02	3.39	1.07
Interaction	1	0.66	0.60	3.70	1.17
Error	56	1.09		3.16	

Hypothesis Four: Retention under continuous reinforcement is inferior to retention under noncontinuous reinforcement. The hypothesis was tested by computing the average number of correct responses for each reinforcement group on each retention trial (Table 11). These differences were then tested statistically by analysis of variance (Table 12). The data strongly supported the hypothesis, retention was inferior under continuous reinforcement.

TABLE 11

Means and Standard Deviations for Each Retention Trial: Instructions X Reinforcement

Group	N	Trial									
		1		2		3		4		5	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
100% R No threat	15	4.00	2.46	3.33	2.16	3.67	2.60	2.86	3.19	2.86	3.05
100% R Threat	15	2.53	1.69	2.00	1.70	2.20	1.57	1.73	1.33	1.53	1.13
50% R No threat	15	4.27	1.14	4.40	1.52	4.80	1.64	4.67	1.78	4.67	1.84
50% R Threat	15	5.07	2.19	5.00	1.89	5.00	2.17	5.26	2.25	5.33	2.32

TABLE 12

Analyses of Variance of Retention Varying Instructions and Patterns of Reinforcement

	Degrees of Freedom	Retention Trials 1		2		3		4		5	
		Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F
Instructions	1	1.67	0.39	1.97	0.46	5.81	2.00	1.03	0.24	1.66	0.43
Reinforcement	1	29.40	6.93*	51.97	12.17**	58.01	20.03**	88.00	20.95**	117.60	30.25**
Interaction	1	19.25	4.54*	24.03	5.63*	10.63	3.67	29.97	6.90*	19.02	4.88*
Error	56	4.24		4.27		2.90		4.21		3.90	

*Significant at .05 level of probability
**Significant at .01 level of probability

Hypothesis Five: Retention under threat is inferior to retention under no threat. This hypothesis was tested by computing the average number of correct responses for the threat and for the nonthreat group on each retention trial (Table 11). These differences were then tested for significance by analysis of variance (Table 12). The findings did not support the hypothesis.

Hypothesis Six: Retention of anxious responders is inferior to retention of nonanxious responders. The mean retention scores for each anxiety group were computed (Table 13). Differences were tested by analysis of variance (Table 14). The findings did not support the hypothesis.

TABLE 13

Means and Standard Deviations for Each Retention Trial: Instructions X Reactions to Instructions

Group	N	Trial									
		1		2		3		4		5	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Threat Anxious	21	3.43	2.36	2.95	2.16	3.04	2.21	2.86	2.45	2.71	2.57
No threat Anxious	7	4.71	3.70	5.42	3.13	5.42	2.99	5.57	2.80	5.00	1.95
Threat Nonanxious	9	4.67	2.34	4.78	2.29	4.89	2.26	5.00	2.34	5.11	2.18
No threat Nonanxious	23	3.96	2.80	3.39	1.80	3.87	2.23	3.22	2.71	3.39	2.23

TABLE 14

Analyses of Variance of Retention Varying Instructions and Reaction to the Experiment

Effect	Degree of Freedom	Retention Trials: Uncorrected Mean Square 1	2	3	4	5
Instructions	1	1.67	1.97	5.81	1.03	1.60
Reaction	1	2.47	0.59	3.93	0.53	5.19
Error	56	5.07	5.61	4.05	6.30	6.24

		Retention Trials: Corrected Mean Square/F									
		1		2		3		4		5	
		Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F
Instructions	1	0.47	0.09	3.47	0.62	5.21	1.29	2.55	0.40	0.92	0.14
Reaction	1	1.27	0.25	1.16	0.20	2.66	0.65	1.15	0.18	1.85	0.30
Interaction	1	11.37	2.24	42.68	7.61*	33.28	8.22*	58.70	9.31*	46.63	7.47*
Error	56	5.07		5.61		4.05		6.30		6.24	

*Significant at .01 level of probability

Hypothesis Seven: The interaction between stress and pattern of reinforcement has an effect on acquisition. This hypothesis was tested by determining the mean acquisition score of each experimental group when trials were equated (Table 5) and when reinforcements were equated (Table 6). The interaction was tested statistically in the analysis of variance design. The results indicated that when trials were held constant (Table 7), the threatened group acquired fewer syllables under continuous reinforcement than the nonthreatened group; whereas the threatened group acquired more syllables under intermittent reinforcement than the nonthreatened group. No differences were found when reinforcements were held constant (Table 8).

Hypothesis Eight: The interaction between instructions and reaction to instructions has an effect on acquisition. The mean acquisition scores for the instructions and the reactions to instructions groups were computed. The differences were tested for significance by analysis of variance (Tables 9 and 10). No interaction was found between the groups.

Hypothesis Nine: The interaction between stress and reinforcement has an effect on retention. This hypothesis was tested by computing the average number of correct responses for each reinforcement and each instructions group (Table 11). The interaction between the groups was tested in the analysis of variance design (Table 12). The data strongly suggested that under partial reinforcement the

threatened group retained more nonsense syllables than the nonthreatened group; whereas under continuous reinforcement the threatened group retained fewer syllables.

Hypothesis Ten: The interaction between instructions and reactions to instructions has an effect on retention. The hypothesis was tested in the following way. The mean retention scores for each anxiety and each instructions group were computed (Table 13). The interaction was tested by analysis of variance (Table 14). The findings suggest that those subjects who responded to stress with nervousness retained fewer syllables than those who did not; those, on the other hand, who responded to the nonthreatening instructions with anxiety retained more syllables than those who did not.

Summary

Acquisition was superior for the 100% reinforcement group when trials were equated. This superiority was not maintained when reinforcements were equated. When trials were equated, the nonthreatened 100% reinforcement group was superior to the threatened group and the threatened 50% reinforcement group was superior to the nonthreatened group. These differences, too, were not maintained when reinforcements were equated. Reaction to the experiment did not materially affect acquisition.

The retention of the 50% reinforcement group was superior to that of the 100% reinforcement group. Neither

instructions nor reactions to the instructions, in and of themselves, affected retention. The data suggested, however, that under certain conditions of reinforcement, instructions yield greater retention scores than under others. To be exact, under 100% reinforcement, it was the nonthreatened group who retained more; under 50% reinforcement it was the threatened group. A final finding of the study was that the anxious students retained more under nonthreatening instructions than the nonanxious students; whereas anxious students retained less under threatening instructions than nonanxious students.

CHAPTER IV

DISCUSSION OF RESULTS

The purposes of the present study were to investigate hypotheses of verbal learning derived from studies of stress and of reinforcement as well as to explore the interactive effects of stress with schedules of reinforcement on learning.

Of six directional hypotheses, only one was completely supported. This one predicted retention inferiority under continuous reinforcement. A second directional hypothesis stated that the acquisition of the continuously reinforced group would be superior to the intermittently reinforced group. This hypothesis was supported in part. The continuously reinforced group was found to be superior only when trials were equated. Finally, the hypotheses dealing with the relationship between threat, reaction to threat and learning were not supported. Methodologically the present experiment was unlike other stress experiments, making it difficult to analyze critically the lack of support of these hypotheses.

The results of the testing of the nondirectional hypotheses were more promising. With regard to acquisition, when trials were equated, the stressed group under 100% reinforcement acquired fewer syllables than the nonstressed group learning under that schedule; but the stressed group

under 50% reinforcement acquired more syllables than the non-stressed group learning under the same schedule. When reinforcements were equated, however, no interaction was found. The interaction, too, between subjective reactions to stress and the stress itself did not affect acquisition. Yet the interactions between these variables influenced retention. Those who responded to threat with anxiety recalled fewer syllables than those who responded without anxiety. But those who responded to the nonthreatening instructions with anxiety recalled more syllables than those who responded without anxiety. Finally, under threat, the continuously reinforced group recalled fewer syllables than those learning under no threat. The intermittently reinforced group under no threat, on the other hand, recalled fewer syllables than those learning under threat.

In so far as psychological practice is concerned, the only advantage of 100% reinforcement in paired associate learning is that it lends itself to a higher rate of responding at the beginning of acquisition. When this is weighed against the absence of differences between the two schedules of reinforcement in the later phase of acquisition as well as aginst the more salient finding of the retention superiority under intermittent reinforcement, the gains accrued from massing reinforcements become obscured.

The nonreinforced trials during acquisition under intermittent reinforcement holds a central position in the

theoretical explanations of the greater resistance to extinction under this schedule. Common to most explanations of the partial reinforcement effect (PRE) is that there is responding during acquisition in the nonreinforced trials which is related to greater resistance to extinction. Explanations differ, though, in labeling this responding.

In the present experiment, too, responding during the nonreinforced trials is prominent. Theoretically, one would expect a decrease in response strength during trials following nonreinforcement. Yet on trials 4, 8, 11, 14, and 18, all reinforced trials following nonreinforcement, there was an increase in response strength (Table 4). On these trials responses appeared in the window of the memory drum which functioned as cues to other responses. The increase on this trial may be simply due to the presence of secondary reinforcers.

Such secondary reinforcers appear an equal number of times for all learning groups, however, and hence would not in itself explain the PRE. The writer hypothesized that since incorrectly perceived responses convey information[1] the intermittently reinforced group make guesses which are weakened during nonreinforcement; under continuous reinforcement, a guess may strengthen an incorrect response and

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[1]P. D. Bricker and A. Chapanis, "Do incorrectly perceived tachistoscopic stimuli convey some information," Psychological Review, 1953, 60, 181-188.

the reinforcement appearing in the window of the memory drum may strengthen still another response. The competition among responses under continuous reinforcement, then, results in poor retention. Under intermittent reinforcement, since many of the guesses are weakened, there is less response interference. This results in the better retention of this group.

The hypothesis invoked to explain the results of the present experiment resembles the one used by Kendler et al.[1] in their animal experiment. They felt that the response produced cues conditioned to the instrumental response are interfered with in the continuously reinforced group, but not in the intermittently reinforced group.

To turn, now, to the interaction between stress and reinforcement, it was observed that under continuous reinforcement there was less response strength under stress than under no stress; whereas under intermittent reinforcement, there was greater response strength under stress than under no stress. This finding was for the acquisition data when trials were equated as well as for the retention data. Tests of the acquisition data when an equal number of reinforcements were involved yielded no significant differences between the groups.

Since the present study was exploratory, the findings

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[1] H. M. Kendler, S. S. Pliskoff, M. R. D'Amato and S. Katz, "Nonreinforcement versus reinforcement as variables in the partial reinforcement effect," Journal of Experimental Psychology, 1957, 53, 269-276.

are suggestive and do not support any theoretical position. The simplest explanation of the present findings is that when both reinforcement and stress are manipulated experimentally, less response strength results under stress-continuous reinforcement than under no stress-continuous reinforcement and greater response strength results under stress-intermittent reinforcement than under no stress-intermittent reinforcement.

Theoretical explanations of these findings can only be tested through subsequent research. One such explanation will be presented here, but it is only speculative.

Since shock, Estes[1] found, inhibited responding temporarily, the writer hypothesized that stress stimuli, being noxious, temporarily inhibited the rate of responding. The low rate of responding was found under continuous reinforcement. Stress did not have a corresponding inhibitory effect under intermittent reinforcement. Estes and Skinner[2] pointed out that the effects of stress (shock) become conditioned to the stimuli which set off a response. The writer further hypothesized that during intermittent reinforcement, the nonreinforcement weakened the effects of

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[1] W. K. Estes, "An experimental study of punishment," Psychological Monographs, 1944, 57, No. 263.

[2] _____ and B. F. Skinner, "Some quantitative properties of anxiety," Journal of Experimental Psychology, 1941, 29, 390-400.

stress so that they did not interfere with the rate of responding. A chi square test of the responses of the stress groups lends some support to this argument. From Table 15 it can be seen that under continuous reinforcement significantly more subjects responded to stress with anxiety than under intermittent reinforcement.

TABLE 15

Chi Square Test of the Responses of the Two Reinforcement Groups to Threat

Group/Response	Anxious	Nonanxious	Chi Square
Intermittent reinforcement	8	7	4.08*
Continuous reinforcement	13	2	

*Significant at the P.05 with 1 df.

Under intermittent reinforcement, then, the nonreinforced trial weakened the interfering effects of stress. This would explain the absence of a decremental effect of threat under this schedule. But under no stress, the instructions provided cues to responding as well. The nonreinforced trials, the writer hypothesizes, weakened such responding resulting in the slower rate of learning in comparison to the stress group.

The slow rate of acquisitions of the continuously reinforced threat group and of the intermittently reinforced nonthreat group, although results of different operations, nevertheless led to the same outcome, namely,

fewer trials in which responses were strengthened. The retention superiority of the continuously reinforced nonthreat over the continuously reinforced threat group and of the partially reinforced threat over the partially reinforced nonthreat group can be simply attributed to their greater response strength at the end of acquisition. It is possible to hypothesize further that since a subject experiences success when reinforced for a correct response, that the retention superiority of these groups is due to their experiencing more successes during acquisition. Kendler[1] had noted that retention superiority in her experiment was associated with a spread of effect of success.

Turning to the more complex problem of the relationship between anxiety and learning, it was observed that although the predominant reaction to stress was "anxiety," stress was related to acquisition, and anxiety was not. Both stress and anxiety, though, were related to retention. In the experiment by McKinney et al.,[2] too, statements by subjects about performance were found to be unrelated to learning under stress. An inherent weakness in a self report technique to assess anxiety is that it lends itself

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[1]Tracy S. Kendler, "The effect of success and failure on the recall of tasks," Journal of General Psychology, 1949, 41, 79-87.

[2]F. McKinney, G. B. Strother, R. R. Hines, and R. A. Allee, "Experimental frustration in a group test situation," Journal of Abnormal and Social Psychology, 1951, 46, 316-323.

to falsification. Even though the subjects said they were anxious under stress, such statements constitute a weak basis for a theoretical interpretation of the relationship between anxiety and learning. Still another explanation of the absence of difference between the anxiety groups during acquisition is that the task was equally difficult for both groups. The nonsense syllables had very low association values.

To return to the findings, those subjects who responded to threat with anxiety retained fewer syllables than those who did not. Those subjects, on the other hand, who responded to the nonthreatening situation with anxiety had higher retention scores than those who did not. Although methodologically unlike the Sarason, Mandler, and Craighill[1] experiment, the results are similar. They found anxious Ss who were ego involved (threatened) performed more poorly on a stylus maze than ego involved Ss who were not anxious. They also found that anxious Ss who were not ego involved performed better than Ss who were neither ego involved nor anxious. They argued that when a situation has properties which arouse test anxiety (stress), the increase in anxiety (drive) level will lead to poorer performance in those Ss who have task-irrelevant responses in their response

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[1]S. B. Sarason, G. Mandler, and P. G. Craighill, "The effect of differential instructions on anxiety and learning," Journal of Abnormal and Social Psychology, 1952, 47, 561-565.

repertory. For Ss without such response tendencies, the cues of the test situation will raise their general drive level resulting in improved performance. Since neither drive level nor the relevance of responses to the task were systematically investigated, the applicability of this explanation to the present data is only suggestive.

In conclusion, the writer sees two major limitations to his study. In the first place, the validity of the measure of anxiety was not established. In the second place, the experiment did not have a typical partial reinforcement design. In most partial reinforcement experiments, the reinforcements are delivered, but the subject is not told when to expect them. He may, however, build up expectancies. In the present experiment, the Ss were told before each reinforced trial that the reinforcements would appear. The results, therefore, may be a function of heightened awareness during these trials, rather than of the schedule itself. This is a topic for future research.

Summary

Statements of hypotheses involving one independent variable were not found to be completely reliable predicters of verbal learning. The retention superiority of the intermittently reinforced was explained in terms of the absence of response interference. When the interactions between stress and reinforcement were explored, the results suggested

that such interactions were worthy of further study. The results, the writer felt, were outcomes of the ways in which the two independent variables, stress and reinforcement, were manipulated in the experiment. A hypothetical explanation was offered for the better learning of the intermittently reinforced group under stress, namely, in terms of the weakening effect which the nonreinforced trials had on the responses elicited by the instructions. Exploration of the interaction between stress and reaction to stress yielded results comparable to those of other experimenters. Finally, the limitations of the experimental design were pointed out.

CHAPTER V

SUMMARY

The purpose of the study was to investigate the effects of patterns of reinforcement, anxiety, and induced stress upon the acquisition and retention of nonsense syllables. Previous studies have disagreed about the effect of intermittent reinforcement upon acquisition. Some have indicated no difference as a function of pattern, whereas, others have found that a continuous reinforcement schedule led to superior acquisition. Workers, however, have agreed that superior retention is associated with noncontinuous reinforcement. With regard to anxiety, the findings have been an enigma. Some workers have found that in comparison to nonanxious subjects, anxious subjects learned more quickly, others have found they learned more slowly, and still others have found no difference. In recent years, with the control of task difficulty, phases of learning, and the meaning of the task to the learner, more consistent findings have appeared. Nevertheless, there is still some disagreement. The study of stress, on the other hand, has presented problems specific to it. Methods of producing stress have differed and, consequently, experimental findings have not always been the same. Experimenters, more recently, have sought to control the nature of the task, the phase of learning, and the conditions

under which learning takes place.

In the present experiment, learning took place by one of two schedules. One group was given ten trials to learn ten pairs of low association value nonsense syllables. They were reinforced on each trial. A second group was given twenty trials to learn the same material, but was reinforced on ten trials only. The reinforcement was informing the subject what the correct response was. Half of the students in each group received stressful instructions, half nonstressful.

Each subject was tested individually. After the last acquisition trial, the subject answered the items of the Minnesota Paper Form Board. Following five minutes of this interpolated task, retention was tested by presenting five trials of stimulus words only.

The variances of reinforcement, stress, and anxiety were analyzed to determine correspondence of the results to the hypotheses. Briefly, under 100% reinforcement, acquisition was faster, but only when trials were equated. When reinforcements were equated, the continuously reinforced group was superior for the first phase of learning only. While neither stress nor reactions to the experiment directly influenced acquisition, the interactive effects of stress with reinforcement were significant, namely for stressed subjects, learning was slower under continuous reinforcement, but faster under partial reinforcement.

While acquisition tended to be faster under continuous reinforcement, retention was better under intermittent reinforcement. Exploring the interaction between stress and reinforcement, it was found that while acquisition had little relationship to either stress or anxiety, retention was related to both. In the first place, the stressed group retained more under partial reinforcement but less under continuous reinforcement. In the second place, anxious subjects retained less under stress but more under no stress.

The competition among responses led to the inferior retention of the continuously reinforced groups. Incorrect responses, it was hypothesized, were weakened during the nonreinforced acquisition trials resulting in better retention under intermittent reinforcement.

The retention superiority of the stress group under intermittent reinforcement and of the no stress group under continuous reinforcement resulted from the experimental manipulation of the stress and reinforcement variables. A hypothetical explanation was offered based on the work of Estes and of Skinner.

Finally, the retention superiority of the nonanxious stress group and of the anxious no stress group, it was pointed out, resembled the findings of other experimenters. The weakness of the measure of anxiety, however, prevented a theoretical interpretation of this observation.

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