THE EFFECT OF AMPHETAMINE ON SIMPLE AND COMPLEX PAIRED-ASSOCIATES

A Dissertation

Presented to

The Faculty of the Department of Psychology

The University of Houston

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

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by

B. Lee Atkison

August 1966

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ABSTRACT

Hull (1943) integrated the concept of drive into his theory of learning. Although his theory is quite extensive, the principle elements of his theory are contained in the formula $s\bar{E}r = sHr \times D - Ir$. In this formula $s\bar{E}r$ is Reaction Potential, sHr is Habit Strength, D is Drive and Ir is Inhibition. Each element of this formula has several components which in turn become part of a larger formula. In Hull's theory, D is not a generalized factor, but is made up of specific needs such as thirst, hunger, etc.

Taylor (1951) introduced general D into the formula by showing that anxiety, as measured by her TMAS, had the same effects as would be predicted from high D. Other studies verified that anxiety did in fact facilitate learning in which a dominant response was to be learned and disrupted learning in which competing responses were involved.

Studies of amphetamine show that it has some properties similar to drive. Also, Eysenck (1957) suggests that a stimulant would have effects similar to anxiety. This raised the question of whether or not amphetamine has general D functions, or specifically, does amphetamine facilitate the learning of dominant responses and hinder the learning of competing responses?

A total of 60 Ss were divided into four equal groups as follows: 15 received the placebo and learned a high-associative list; 15 received the placebo and learned the competitive list,

15 received 10 mgm. of amphetamine and learned the high-associative list, and 15 Ss received 10 mgm. of amphetamine and learned the competitive list.

The lists were from Haagen's (1949) list and were high associative pairs. In the competitive list, the pairs were scrambled so that the high associative response was incorrect. The lists, of 12 pairs each, were presented on a Hull-type memory drum.

An examination of the results verified that the simple list contained dominant responses and that the complex list not only contained competing responses, but was overall much more difficult to learn. However, there was absolutely no differences found between the placebo and amphetamine groups on the simple or complex task.

This indicates that although some properties of amphetamine suggest drive, it cannot be substituted for general D in the Hull formula as anxiety has been substituted. This also raises the question of whether or not there are many components of drive, some of which will function in some situations, while others function in others. Thus, the general D measured by the TMAS might itself be a specific D that operates only for short periods of time, while amphetamine, certainly at this point, appears to have characteristics of D only after an extended period.

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CHAPTER I

INTRODUCTION

The increasing use of psychopharmacologic agents in the past few years presents special problems, as well as new techniques to the psychologist. It would appear that the best way to utilize these drugs in psychological research is not to take a purely empirical approach to see what the drug does, but to combine drug research, wherever feasible, with other psychological theory and research. Eysenck (1957) and Trouton and Eysenck (1961), for example, attempt to integrate drugs into general theory, by equating stimulant effects with introversion effects and depressants with extraversion effects. Dews (1962), on the other hand, maintains that since each drug has a different effect, such broad terms as stimulant and depressant are no longer meaningful as generic terms. This tendency to look for specific results, seems to be reflected in most drug research of a non-clinical nature (e.g. see Uhr and Miller, 1960) in which drugs are more apt to be used to study "performance." That is, the experimentation is more in line with what is generally called "practical" rather than "theoretical" research. Yet, it would seem that if a drug had properties which caused direct changes such as would be predicted from changes in some hypothetical construct, the value of the drug in testing the theory containing said hypothetical construct would be immeasurable.

One area of research in which enough data have been collected to allow for a fairly comprehensive study is the area of learning.

The subject of inquiry here is: Can we predict the effects of certain drugs from knowing certain facts about learning, or does the drug introduce a variable that calls for a new theoretical system?

The area that seems to offer the most comprehensive theoretical system for the study of drugs was an extension of Hull's (1943) work. It seems that Hull's drive concept might be related to the effects of certain drugs, namely stimulants and depressants. Although Hull was quite cautious about the possibility of a general drive state, Taylor's (1953) paper introduced the idea of a general D into the main stream of Hullian learning theory. This was the introduction of the Taylor Manifest Anxiety Scale. Since then, the relation of anxiety to drive has been further elaborated by theoretical discussions (Farber, 1955; Hunt, 1959; Spence, 1958; and Taylor, 1956), as well as by a number of experiments demonstrating that high anxiety produces results theoretically expected from high D (see next chapter).

In Hull's system, any reaction potential ($s\bar{E}r$) is influenced by the habit strength (sHr), drive (D), and inhibition (Ir). The formula is $s\bar{E}r = sHr \times D - Ir$. In this formula, $s\bar{E}r$ is the reaction potential for any specified response, whether or not the response is correct. If the drive and habit strength are high enough and the inhibition is low enough, the response will take place. Since D has a multiplicative relationship, a high D will raise $s\bar{E}r$ above threshold (at which point a response takes place)

very quickly. If the tendency is for a correct response to occur, then high D facilitates learning. However, if an incorrect response has the greatest reaction potential, or if there are several responses which have an equal chance of being elicited, then high D will disrupt learning. Studies demonstrating this principle will be discussed later.

Although the above is basically the system used in this area of research, and the one that will be followed in the present paper, this by no means is meant to imply that there is unanimity either in regards to the formula (e.g. see Jensen, 1961) or to the effect of anxiety (e.g. the Eysenck position to be discussed later).

Before presenting the reasons why it is hypothesized that stimulants produce a condition similar to high D or anxiety while depressants produce a condition similar to low D, three areas will be discussed: first, the background of the anxiety-high D-stimulant relationship; secondly, an important, slightly different way of viewing this combination, represented by Eysenck; and third, a number of independent, i.e., nontheoretically based drug studies.

The background reveals several relationships important in understanding this study. The first is that anxiety, and other factors discussed in the following chapter, are facets of D. According to the hypotheses presented in this paper, D is facilitative to the learning of a dominant response, but is disruptive to the learning of a nondominant response.

Eysenck views stimulants and anxiety as having similar

effects. Although he views this effect as being the prevention of build up of inhibition, rather than as D, the same overall results would take place. That is, according to the formula, $s\bar{E}r = sHr \times D - Ir$. Thus, in general $s\bar{E}r$ would become higher whether D was increased or Ir was decreased. The only difference would be in the speed with which $s\bar{E}r$ changed. In either case, increase in $s\bar{E}r$ would facilitate learning of a dominant response and inhibit the learning of competitive responses.

Paired-associate learning provides a convenient vehicle for testing these hypotheses since the same stimuli and responses can be introduced in different combinations so that a response may either be dominant or competitive. Thus Ss may be given a stimulant (in this case amphetamine) then after an appropriate time be given a paired-associate task to learn. The results can then be compared with results from Ss who took placebos. This was the procedure used in the present study.

CHAPTER II

BACKGROUND AND HISTORY

In 1953, Taylor introduced the Manifest Anxiety Scale (TMAS), which she had previously used in another study (Taylor, 1951). At this time, as well as later (Taylor, 1956; Spence, 1958), the scale was regarded as a means of measuring general drive level, D. Since 1951, a number of studies have used a high score on the TMAS as equivalent to high D.

GENERAL D AND NONVERBAL LEARNING

Eyelid Conditioning

The first of these studies was Taylor's (1951) original article in which she did eyelid conditioning on two groups of Ss selected by the TMAS. She found that those Ss who obtained high scores on the TMAS conditioned faster than those with low scores.

Two other eyelid conditioning experiments of note were reported the same year, 1951, in which contradictory findings were presented. One, Spence and Taylor (1951), was an attempt to enlarge on Taylor's 1951 study, by varying both anxiety and the strength of the UCS - a puff of air. It was again demonstrated that high-anxiety Ss conditioned better, i.e., gave more CRs, than did low-anxiety Ss. Ss also gave more CRs to a "strong" air puff than to a "weak" air puff, but this difference was not statistically significant.

The other study, (Hilgard, Jones and Kaplan, 1951) failed to find a significant difference in number of CRs between high-

anxiety and low-anxiety Ss, although the difference was in favor of high-anxiety Ss. This, however, was a study of discrimination rather than a straightforward conditioning experiment. The positive CS and negative CS consisted of illumination of adjacent windows. It was found that high-anxiety Ss gave significantly more responses to the negative CS (nonreinforced stimulus) than did the low-anxiety Ss.

At this point, then, it appeared as if high-anxiety Ss were more apt to condition rapidly, but without stimulus discrimination. This conclusion, however, was rejected by the Iowa group, and in 1954, two studies were advanced which appeared to contradict the evidence of Hilgard et al. (1951). Spence and Farber (1954) conditioned high-anxiety Ss and low-anxiety Ss using a positive CS of a 500 cps tone and a negative CS of a 5000 cps tone. In contrast to the Hilgard et al. (1951) study, the only significant difference was between the responses of high-anxiety Ss and low-anxiety Ss to the positive CS, with high-anxiety Ss again showing more conditioning. Also, the high-anxiety Ss gave more CRs to the negative CS, but, reportedly, the high-anxiety Ss tended to discriminate better than low-anxiety Ss. These findings were supported in a study by Spence and Bucroft (1954) although, again, no significant differences in discrimination were found between low-anxiety and high-anxiety Ss.

Prokasy and Truax (1959) reported findings in complete contradiction to the others reviewed here. They found that

low-anxiety Ss, and especially extremely low-anxiety Ss tended to condition more readily than did high-anxiety Ss. They also found that low-anxiety Ss gave more alpha responses (reflex responses to the light) than high-anxiety Ss. They attributed the difference between their results and the results of others mostly to the fact that they did not give a ready signal before presenting the UCS.

In response to this study, Spence and Weyant (1960), and Baron and Connor (1960) did further studies, without a warning signal, and obtained results very similar to the earlier Iowa studies.

It appears then, that despite some contradictory results, eyelid conditioning is facilitated by high-anxiety. There may be some significance to the fact that both studies with contradictory findings used visual CS, but other studies using visual CS have resulted in findings similar to the majority. At this point, the necessary parameters for explaining these two studies, Hilgard, Jones and Kaplan (1951), and Prokasy and Truax (1959) are not readily identifiable.

The preceding evidence clearly indicates that high-anxiety Ss condition better in an eyelid conditioning situation than low-anxiety Ss. Since eyelid conditioning is a relatively simple procedure, it provides an excellent vehicle for testing out anxiety in comparison to other facets of D.

Spence, Farber and Taylor (1954) explored the relationship of electric shock to the CR of high-anxiety and low-anxiety

Ss. They used both shock and threat of shock, and found that both were effective in increasing the conditioning of the Ss. The shock, or threat of shock, significantly increased the CR scores of the high-anxiety group over the other three groups, i.e., the low-anxiety - no shock group, the low-anxiety - shock group, and the high-anxiety - no shock group. Their conclusion is noteworthy:

> "On the basis of these results, it was concluded that level of emotionality, as defined by the presence or absence of shock or threat of shock, is related to performance in eyelid conditioning. And the effect of manifest anxiety upon this performance may be a function of noxiousness or threat in the experimental situation (p. 408)."

In a partial replication, but with a more stringent criterion for the CR, Caldwell and Cromwell (1959) failed to find the same effects of the shock but did find high-anxiety Ss conditioning better. They suggest that the difference in the two studies is primarily due to the scoring criterion. Spence and Taylor (1951) failed to find significant differences in eyelid conditioning using a "weak" or "strong" puff of air, although the "strong" puffs produced consistently higher CR rates. Spence and Farber (1953) tried to vary D by using high and low-anxiety groups plus extremely high and extremely low-anxiety groups. Their study did not report significant differences between moderate and extreme groups.

Thus, the eyelid conditioning studies did not offer conclusive evidence for or against accumulative drive with different levels of high-anxiety, or high-anxiety plus noxious stimuli. However, this will be discussed further in other

types of learning situations.

Before going on to other types of studies, one other point should be discussed. That is, the above studies used paper-pencil tests for anxiety and obtained significant results. Several studies have utilized other measures of anxiety. Runquist and Spence (1959), for example, found the same differences, i.e., higher CR rate, between high-anxiety Ss and low-anxiety Ss using physiological measures of anxiety. Spence and Taylor (1953) and Taylor and Spence (1954) attempted to use a psychiatric diagnosis rather than an anxiety scale. Although they reported some trends, in the expected direction, as being present, psychotics were the only group that differed significantly from other groups. Psychotics consistently performed higher than the other groups.

Noneyelid Conditioning

Other conditioning studies support the general findings of the eyelid conditioning studies, i.e., that anxiety facilitates conditioning. Welch and Kubis (1947) compared the PGR (psychogalvanic response) conditioning rate of 24 clinically anxious Ss and 22 control Ss. In this study, the UCS was a loud buzzer and the CS was a nonsense syllable. They found that anxious Ss conditioned more rapidly than control Ss. They also noted that the conditioning persisted longer (i.e. was more resistant to extinction) with the anxious Ss than with the control Ss. Schiff, Dougan and Welch (1949) did a replication study, but used children as Ss. They also attempted

to correlate anxiety and ease of conditioning the PGR with EEG (electroencephalograph) abnormalities. However, the only significant finding was a positive correlation between PGR conditioning and anxiety.

Bitterman and Holtzman (1952) selected two groups of Ss on the basis of anxiety as determined from psychometric indices, and performance in a laboratory stress situation. The Ss were all unmarried, male students between the ages of 18 and 25 in a beginning engineering class. The Ss in the "high-anxiety" group were found to condition more readily and to extinguish less readily than the "low-anxiety" group. The UCS used in this study was shock, the UCR was the GSR (galvanic skin response). This study is especially significant because of the homogeneity of the original group of Ss.

Silverman (1960) used a rather unique method of studying anxiety and conditioning. Using shock as the UCS, a 750 cps, 20 db tone as the CS, and the GSR as the response, he gave all Ss the same amount of conditioning. Then, hypothesizing the CS-UCS interval as anxiety arousing, he told half of his subjects that there would be no more shocks. He found that a group of Ss with a CS-UCS interval of .5 sec. extinguished faster when told they would receive no more shocks. This relationship did not hold up with a group with a CS-UCS interval of 6 sec.

Champion and Jones (1962) also studied the relationship between D and extinction. They hypothesized that extinction

was due to build up of inhibition plus drop in D. After forward GSR conditioning of one group and backward GSR conditioning of another group using a tone as CS and a shock as UCS, they divided each of the two groups into an experimental and control group. The experimental group got intermittant shocks and tones (though never paired) during extinction, while the control group received no shock, but only tones. Although in the no-shock group extinction took place as usual, in the shock group further conditioning took place despite the fact that tone and shock were no longer paired.

Becker and Matteson (1961) used a conditioning study to study the effects of anxiety on conditioning in an attempt to determine whether anxiety affects learning as hypothesized by Spence (as discussed in this paper to this point) or as hypothesized by Eysenck (to be discussed in some detail later) or both, since they are not considered mutually exclusive. Extreme scores on an extraversion scale and an anxiety scale were used to select subjects for a GSR conditioning experiment. Only the anxiety scores were found to be related to conditioning. The authors concluded that their findings supported Spence's hypothesis, but not Eysenck's.

Thus, the conditioning studies generally support the theory that anxiety increases D, and facilitates learning (conditioning). There is also evidence that anxiety inhibits forgetting (extinction). The next question is: Does anxiety have the same effect on operant behavior as on classical conditioning? Let

us look first at nonverbal, then verbal learning, to see if this relationship holds up.

Nonverbal Learning

One advantage of nonconditioning studies is that it allows the experimenter to more easily vary the complexity of the learning task. Farber and Spence (1953) combined the two techniques. They selected 40 anxious and 40 nonanxious Ss with the TMAS. They found that the anxious Ss conditioned faster on eyelid conditioning, but that on a complex task the nonanxious Ss performed better. Not only did the nonanxious Ss learn a stylus maze task better, but they made fewer errors compared to anxious Ss as the difficulty of the choice points became greater.

Mandler and Sarason (1952) tested the performance of Ss high and low in test anxiety before and after various types of instructions. Amount of test anxiety was determined by means of a questionnaire. The functions performed on the pre-instruction trial were Wechsler Bellevue digit symbol (digit substitution) test and Kohs Block design performance, number 13. A comparable digit symbol task and Kohs Block Design, number 16, was performed on the post-instruction trial. In between the trials Ss were told they had failed, they had done well, or merely to go to the next part of the test, depending upon the group they were in. The findings were: 1. Low-anxiety Ss did better initially, but that high anxiety Ss improved more rapidly as correct responses were learned. 2. High-

anxiety Ss did best on the second trial without an intervening report of success or failure, whereas low anxiety Ss did better with such reports, especially a report of failure. This study was followed by another study, Sarason, Mandler and Craighill (1952) which was specifically set up to test the interaction effects of anxiety and instructions reported in the first study. It was again found that drive inducing instructions raised performance of low anxiety Ss and lowered performance of high anxiety Ss.

Another study of the relationship between a digit symbol type task and anxiety was one by Matarazzo and Phillips (1955). They found a modified curvilinear relationship with the best scores being made by Ss with moderate anxiety. However, the drop in performance from those with moderate anxiety to those with high anxiety was insignificant (whereas both the moderately anxious Ss and the highly anxious Ss did significantly better on the task than did low anxiety Ss, thus distorting the curvilinear relationship).

One other symbol substitution study should be mentioned. That is the study by Eysenck and Willett (1962). Their definition of high drive and low drive was based on whether or not the task was included in an apprenticeship selection program. They assumed Ss who thought the test was part of a test battery to decide if they were to be admitted to a training program would be more anxious than Ss who were in the program and knew the test was part of an experiment. No difference was found between the two groups in performance, but the low drive group

were found to have higher reminiscence scores. The authors discussed this difference as being due to drive. However, it should be pointed out that "drive" is defined by a quite different set of parameters in this experiment than in the previously discussed studies.

Wenar (1954) examined the effects of anxiety and stimulus intensity on reaction time. The subjects were selected by taking the upper and lower 20% of Ss selected by a modified MAS. The stimuli were: a buzzer, weak shock, and strong shock. It was found that both anxiety and shock decreased reaction time. However, there was little evidence of a summation effect between anxiety and stimulus intensity.

Rather than studying reaction time, per se, Eriksen (1954) used a form of reaction time to determine the effect of anxiety on stimulus generalization. Selecting Ss using the psychasthenia and hysteria scales of the MMPI, Eriksen placed them in an avoidance and nonavoidance to shock groups. Although the Ss were extreme groups (in 20th percentile), they were selected from a college, not a patient, population. The Ss were instructed to move their hand horizontally upon the presentation of the correct square (either large or small in a series of three sizes). It was found that Ss in the avoidance groups showed more stimulus generalization than in the nonavoidance group. It was also found that the hysterics generalized more than did the psychasthenics. Because of the difference in the two groups selected by the MMPI, Eriksen suggests that the TMAS may mea-

sure, not anxiety, but a method of handling anxiety.

Wallach and Gahm (1960) also studied the effects of anxiety and personality type (extraversion versus introversion) on probability learning. They hypothesized that both high-anxiety extroverts and low-anxiety introverts would choose the least probable event more often. However, they assumed that the extrovert would be responding on a 50-50 chance basis (the actual probability was 70-30) and that the introvert would be attempting to solve the problem and anticipate the lower chance event. It was also believed that anxiety would increase the speed of response. Their predictions were borne out. The high anxiety extroverts and low anxiety introverts made the most choices of the low probability event, but the high anxiety extroverts had the shortest reaction time of the four groups and the low anxiety introverts had the longest reaction times.

Using a different approach, Dixon and Wickens (1961) also studied the effects of approach and anxiety on stimulus generalization. However, instead of hypothesizing an approach based on theoretical reasons, they set up the situation so that a specific approach would be used. One group, the RT (reaction time) group was to respond as rapidly as possible to the central of seven lights. The other group, HR (horse racing) was allowed to make a choice as to which light he thought would come on. In each case, the central light came on 80% of the time. Again, anxious and nonanxious groups were created experimentally by giving half of the Ss random electric shocks. In the RT sub-

jects, the shocked group made significantly more false responses. In the HR group, the only difference discovered between the two groups was a tendency in the no shock group toward a gradient. This experiment appears to give some support to the Wallach and Gahm (1960) hypotheses.

McGuigan, Calvin and Richardson (1959) tested the effects of anxiety, measured both by a paper-pencil (TMAS) test and a physiological index (palmar perspiration) on a stylus maze-learning task. Since these two indices of anxiety are unrelated (correlation of .06 in this study), the authors suggest that the TMAS measures a personality, i.e., long range, characteristic, and that the palmar perspiration index (PPI) measures situational, or short range, anxiety. In this study, neither measure of anxiety was found to have a significant relationship with stylus maze performance.

By revising the TMAS, Casteneda, McCandless and Palermo (1956) initiated a number of studies on learning in children concerning the effect of drive on learning. In one study, Casteneda, Palermo, and McCandless (1956) divided fifth grade children into two groups on the basis of the Children's Manifest Anxiety Scale (CMAS). These two groups then performed on a task requiring them to learn which of five buttons turned off each of five different colored lights. The relative difficulty of learning each of the five combinations of buttons and lights was determined empirically with a separate random sample of children. The only significant finding in this study was that

of an interaction effect. High-anxiety children did better than low-anxiety children on the "easier" selections, whereas low-anxiety children did better on the "difficult" selections than did the high-anxiety children. Following up this study, Palermo, Casteneda and McCandless (1956) selected Ss with scores in the upper and lower 20% on the CMAS from several fourth grade classes. These children were then asked to perform a "complex" task. The task was to learn which of two buttons turned out each of four colored lights. Each button turned out two of the lights. As predicted, the high anxiety children made more errors than did the low anxiety children.

In order to control complexity more directly, Casteneda and Lipsitt (1959) designed another learning task. In this task, the child was to push the switch that turned off the light. There was a row of eight lights with a switch under each light. Lights 1, 4, 5, and 8 were controlled by switches directly underneath. However, the other lights were arranged so that switch two controlled light three, switch three controlled light two, switch six controlled light seven, and switch seven controlled light six. Thus, there were four "easy" combinations and four "difficult" or "competing" combinations. The Ss were 108 fifth grade children, divided into two experimental groups of 54. The stress group was told that they had to respond in one second or the trial would be considered an error. No time limit was involved in the nonstress group. There was a significant interaction effect found in

that Ss in the stress group performed better on the "easy" problems and worse on the "hard" problems in comparison with the nonstress group.

The nonverbal learning experiments discussed thus far appear to have shown rather conclusively two things. That is, anxiety facilitates simple learning and interferes with complex learning. Although all the parameters have not been completely explored, other possibilities are also evident. There is some evidence that, beyond a certain level, anxiety may lose its drive properties and become a disruptive influence. There is also evidence of an interactive effect, so that the effects of anxiety may be altered depending on such things as the instructions given to the Ss.

GENERAL D AND VERBAL LEARNING

The studies reviewed thus far have dealt exclusively with nonverbal learning. The effects of anxiety on verbal learning will now be considered. The two principle methods of studying verbal learning, serial and paired-associate, will be reviewed separately.

Serial Learning

Taylor and Spence (1952) selected 40 Ss on the basis of extreme (upper and lower 15%) scores on the TMAS. The Ss task was to learn the correct order of a list of right or left verbal presentations, presented by a memory drum. There were 20 "choice points" and the Ss learned the "maze" to a criterion of one perfect "run." Not only did the Es find the expected results of low D Ss doing better, but also low D Ss did best

in comparison with high D Ss on the more difficult "choice points." The interpretation of why low D Ss did better was that in this complex task there were more competitive responses. Competitive responses are considered more disruptive to high D (anxious) Ss.

This study was followed up by Hughes, Sprague and Bendig (1954). On the assumption that the results were partially a function of the number of shifts in response required, they added two new lists. The study by Taylor and Spence (1952) required 12 shifts (i.e. from right to left and from left to right). The two new lists contained ten shifts and seven shifts, respectively. The other procedural change in the Hughes, et al experiment was to add a two sec. interval between the presentation of the stimuli. In no instance was a significant difference found between the anxious and nonanxious Ss in this learning task. The difference in results between this study and the Taylor and Spence (1952) study was attributed to the intertrial interval.

Another study designed to show the different effects of D (manifested by a high score on the TMAS) on simple and complex tasks was done by Montague (1953). Using three lists of nonsense syllables of different associative value, and high and low-anxious Ss, he found that high D Ss learned the simple task (high associative value lists) better than did low D Ss. However, the complex task (low associative value list) was learned better by the low D group. The learning of the list

of medium association value fell in between the other two (high and low association lists) as expected.

Willett and Eysenck (1962) used a stressful situation as a criterion of induced anxiety and had Ss learn an easy and a difficult list of nonsense syllables. In the stress situation, Ss learned the list as part of a test to determine whether or not they would be accepted into a trade school. The nonstress Ss were already students and were aware that the procedure was part of an experiment. The only difference found between the four groups (high drive, easy list; high drive, difficult list; low drive, easy list; and low drive, difficult list) was that the high drive (stress), easy list group performed much better than did the other three groups.

Lucas (1952) studied the interaction effects of anxiety (measured by a personality inventory), failure (groups were given varying reports that they were failing) and intra-serial duplication (one list of ten consonants had no duplication, one had two and the other had five duplications). This study differed from previous ones in that Ss wrote their answers after each presentation. An analysis of variance showed that anxiety and the interaction of anxiety and the other two variables each contributed significantly to the total variance. In general, the nonanxious Ss did better than the anxious Ss. Both number of reported failures and number of duplications increased the difference between anxious and nonanxious groups.

Deese, Lazarus and Keenan (1953) studied the effect of high and low anxiety on learning by picking extreme groups,

then utilizing stress inducing and stress reducing techniques. Three groups were utilized: 30 controls, 30 avoidance, and 30 nonavoidance Ss. The learning task consisted of learning a list of 12 consonant nonsense syllables. The avoidance and nonavoidance situations involved the usual shock techniques. Although the anxious Ss performed better under each condition, the large difference between the anxious and nonanxious Ss was under the avoidance condition. The authors suggest that "Taylor's interpretation" may be overly simplified.

A replication of the preceding study was conducted by Lazarus, Deese and Hamilton (1954). However, one important change was made. In the present task, Ss learned a much easier (high amount of intraserial duplication) list of consonant nonsense syllables. This change resulted not only in a failure to obtain the significant differences referred to in the preceding study, but also slight differences in the opposite direction. This was taken as support of Montague's (1953) finding that task difficulty determines the differences in learning between anxious and nonanxious Ss.

Another type of stress was introduced by Kalish, Garmezy, Rodnick and Bleke (1958). They told the experimental groups (consisting of both a low anxiety group and a high anxiety group) that the procedure, learning a list of 12 nonsense syllables, was highly related to intelligence. The nonstress groups were merely told that they were participating in a verbal learning experiment. No differences were found between the nonstress groups, however, in the stress groups, it was found that

the high anxiety group learned significantly faster.

Another study of the effect of motivating instructions on anxious and nonanxious Ss was carried out by Sarason (1956). High, medium, and low anxiety Ss were selected. After 14 trials on a list of nonsense syllables, half of the Ss were told that they were failing. This was followed by another trial immediately and six additional trials 24 hours later. It was found that reports of failure caused a detrimental effect on the performance of high anxiety Ss, both immediately and after 24 hours. The reports of failure were facilitating for the low and middle anxiety groups. Anxiety alone was not found to have a significant effect, either immediately or after 24 hours. A report of failure did have a detrimental effect immediately, but not after 24 hours.

It has no doubt been noted that not all Es introduce the stress at the same point in learning. Bardach (1960) studied the effect of stress, introduced at various points, on the learning process. She found that stress, in the form of electric shock, had more detrimental effects if introduced late in the experiment as opposed to an early introduction.

Sarason (1958) also studied the effect of reassurance on the learning of lists of highly meaningful and low meaningful material. He also used both the Bendig form of the MAS and a test of test anxiety (TAS). The reassurance group were assured that many mistakes were expected and persons were not expected to do well. In this experiment, the MAS anxiety

scales had no significant relationship to performance. However, the TAS was found to have significance in interaction with reassurance versus standard instructions. Reassurance was found to raise the performance of high TAS Ss but to lower the performance of low TAS Ss.

In the last experiment, it was seen that two different measures of anxiety did not allow the same predictions: Rosenstein (1960) tried to predict serial learning from both the Mandler-Sarason Test Anxiety Questionnaire (TAQ) and the Palmer Sweat Index (PSI). The PSI was taken both before the learning situation, but after the S was at ease, and following the administration of the learning task. Neither the TAQ nor the first PSI predicted the learning rate. However, the increase in the PSI did predict, with larger increases being related to faster learning.

Sidowski and Eason (1960) had Ss with extreme TMAS scores learn nonsense syllable lists under usual conditions (control), while squeezing a dynamometer, and under an incentive for top scores (one dollar and class points). Muscle Action Potential (MAP) was measured during learning.

> "The results of the learning scores indicated: (a) Low-Anxious Ss superior to High-Anxious Ss but only over the early trials, and (b) Dynamometer pressure resulted in poorer learning for both anxiety groups. The muscle action potentials showed: (a) High-Anxious Ss gave higher MAP, than Low-Anxious Ss when the dynamometer was used, and with the opposite relation between anxiety groups during the Control and Incentive conditions, and (b) MAPs decreased over trials for High-Anxious Ss, and increased for Low-Anxious Ss. Finally, (a) no difference was found in verbal performance between High and Low MAP groups, where assignments

> of Ss to groups was done on the basis of total MAP scores, summed over trials and conditions, and (b) Mediocre learners showed higher MAPs than Extreme learners for the Induced Muscular Tension conditions, while the opposite effect was obtained for the non-dynamometer conditions (p. 370)."

What, then, can be said about serial learning and anxiety? First, it can be said that, generally, high anxiety facilitates the learning of easy material, but interferes with the learning of difficult material. Obviously "easy" and "difficult" can only be determined empirically, and without an empirical check, results opposite from what is expected may be obtained. In addition, there appear to be a number of factors that may modify, or even reverse these results--for example, the introduction of shock, or other stress factors. Finally, drive appears to have a number of reasonably discrete components. For example, the anxiety measured by the MAS and by the TAS (Sarason, 1958) appeared to have different properties. The Ss who reported a specific anxiety (test anxiety) were not necessarily those who reported a more general anxiety (manifest anxiety). Reassurance about the test is at least outwardly more likely to affect the anxiety measured by the TAS, which is what occurred. Thus, overall, it appears that drive does have definite qualities. However, the various components of drive may not only be nonadditive, they may interfere with each other, producing paradoxical results.

Paired-associate Learning

Since the present experiment uses the paired-associate

model, this section involves more attention to detail and methodology in the review than did earlier sections. Also, inasmuch as the Spence, Farber and McFann (1956) study is most similar to the present study, it will be discussed first and in detail, with other studies being considered in relation to this study.

Spence, Farber and McFann (1956) reported two experiments which were complementary. In each experiment, Ss were selected from the upper and lower 20% scores on the TMAS. Also in each experiment, the Ss learned a list of paired-associates (different as described below) from a memory drum. Pairs were presented every four seconds, with a 1.67 second anticipation period, and a four second rest period between runs. The Ss were given six trial runs on a practice list of 15 paired nouns, then learned a list of paired adjectives to a criterion of two successive perfect runs. In the first experiment, 10 men and 10 women were in each (anxious and nonanxious) group. The experimental list consisted of 15 pairs of adjectives of high association value. The high anxiety Ss learned the list in significantly fewer trials and with fewer errors. No difference was found between the sexes. In the second experiment, only male Ss were utilized (ten nonanxious, nine anxious). This time only 12 paired-associates were used in the experimental task, four of which came from the noncompetitive list and the other eight had little or no associative value. The data for the eight competitive and four noncompetitive pairs were analyzed

separately. The results for the four noncompetitive pairs were the same as was found in the first experiment. The analysis of the eight competitive pairs revealed opposite results, with nonanxious Ss performing significantly better.

This study was followed up by another by Spence, Taylor and Ketchel (1956) in which the two experiments were combined into a factorial design to test the interaction effects of anxiety and type of list. A total of 80 Ss were selected, half of whom were male and half female, divided into two equal groups of anxious and nonanxious Ss. The Ss were selected from the upper and lower 20% on the TMAS. A practice list was presented for six trials to allow the Ss to become familiar with the task. Then Ss learned either a competitive or a noncompetitive list. The noncompetitive list was made up of paired adjectives of high associative value. The competitive list was made up of 10 pairs, four of which had high associative value and six of which had minimal associative value. The expected interaction effect was found to be significant. High anxiety Ss were again found to perform significantly better than low anxiety Ss on high associative material. Although low anxiety Ss tended to perform better than high anxiety Ss on the low associative material, significance was not reached.

Slightly different results were obtained by Ramond (1953) using a similar technique. His lists contained 16 pairs with one list of "strong" (high) association value and one of "weak" (low) association value. His Ss were also selected on the basis

of extreme scores on a modified version of the TMAS. He found no significant difference between his two groups on the high association list. On the low association list, no differences were found. Inspection of the results here reveals a small difference between the performance of nonanxious Ss on the two lists. This suggests that the "strong" association list may not have provided a sufficiently dominant response for a difference to occur.

Taylor and Chapman (1955) did find that anxious Ss performed better on two eight pair lists having few competitional responses.

Korchin and Levine (1957) added a group of hospitalized patients with high anxiety to the usual groups of high anxiety and low anxiety students. Two learning tasks were presented: learning a list of "logically related" pairs and a list of "false equations." The groups were similar in the learning of "logical pairs," but the nonanxious group performed better than did the others on the "false equations." The patient group were similar to the anxious student group, but did somewhat poorer overall.

L'Abate (1959) used nonsense syllables in his paired-associate task. He made up four lists of nonsense syllables, varying in associate value so as to have a list of 0-0 (very low associative value in both stimulus and response), 0-100 (very low associative value in stimulus, very high in response), 100-0, and 100-100. As expected, the list 0-0 was most dif-

ficult to learn, whereas, the list 100-100 was the easiest, with the other two falling in between in difficulty of learning. No direct results of anxiety were noted, but a significant interaction with sex was noted. Anxious men learned more slowly, whereas anxious women learned more quickly. L'Abate considered his results as disagreeing with Spence's since the higher association value did not result in anxious Ss doing better. However, here, again, it must be pointed out that high association value in a nonsense syllable may make it easier to learn the list, without producing early dominant responses. It is early dominant responses which anxious Ss learn faster.

L'Abate (1962) then undertook a replication study in an attempt to determine the parameters involved in the aforementioned results. A more homogenous group of student Ss were utilized and groups were made up in such a way as to balance sex and anxiety level. There were 12 subgroups, each containing 10 high-anxious men, 10 high-anxious women, 10 low-anxious men and 10 low-anxious women. The same four types of lists used in the preceding experiment were used. One unexpected result at this level was of an unexpectedly large number of correct responses on the 100-0 list (higher than on the 0-100 list). After Ss learned one of the lists, they learned another list. The new list consisted either of the same stimulus list, but a different response list, or a new stimulus list with the same response list, or new stimulus and response lists. It was expected that anxiety would facilitate a learning task consisting of a new stimulus and old re-

sponse, but would hinder the learning of a new response to an old stimulus. In general, these hypotheses were confirmed.

Buchwald (1959) was concerned with the question of dominant response in relation to anxiety. First, he found that anxious men (data not significant for women Ss) were more variable in word-association response than nonanxious men, suggesting that word-pairs could not be assumed to have the same response strength for anxious and nonanxious Ss. From the words he had used, he selected those which were used most frequently by both anxious and nonanxious Ss. These pairs were then set up as a paired-associate learning task. A separate sample of anxious and nonanxious male Ss was selected. In this study, the nonanxious Ss learned faster (sig .055) than did the anxious Ss. The author suggests that TMAS scores be interpreted otherwise than as drive.

Another attempt to set up easy and difficult lists via empirical data was conducted by Standish and Champion (1960). An easy list was obtained by measuring speed of response to various pairs in lists. The difficult list was then made by using different responses for the same stimuli. High, low and medium anxiety Ss were selected by TMAS scores. As predicted, the high anxiety group did better on the easy list and low anxiety Ss did better on the difficult list. No consistent pattern was established for the medium anxiety group.

Harleston and Cunningham (1961) hypothesized that in learning paired associate nonsense syllables, a direct relationship

could be established between meaningfulness of material and ease of learning. Specifically, they thought that response meaningfulness was more important than stimulus meaningfulness, but that both were important. This, then, suggested that the descending order of ease for learning nonsense pairs would be: high-high, low-high, high-low and low-low. They further hypothesized that the more difficult the list, the worse high anxiety Ss would perform in relation to low anxiety Ss. The only positive results on four sets of nonsense syllable pairs was that meaningfulness of response was positively related to ease of learning. None of the other results was significant.

With the contradictory results thus far considered, it is obvious that parameters other than level of anxiety and difficulty of learning are involved. Other variables, starting with intelligence, will now be considered.

Harleston (1963) studied the interactive effects of anxiety level, (TMAS), ability level (determined by performance on practice lists) and difficulty level (high versus low associate responses). He found both task difficulty and ability level consistently a significant factor, but not to interact with each other. Anxiety was only a factor on the L-H list (H-H, L-H, and L-L lists used). In this case, the low anxiety Ss did better at all three ability levels.

Besch (1959) studied the interactive effects of anxiety, shock, and paired associate competition. The Ss were selected from the upper and lower 20% on the basis of scores on the

TMAS. Ss were matched on the basis of practice scores, then placed in the shock or no-shock groups. Then the groups were equalized according to anxiety, sex, and ability. Two lists were utilized: a high S-R association list of nonsense syllables, and the competition list of two syllable adjectives used by Spence, Farber and McFann (1956). It was found that anxiety alone had no significant effects, and that shock had a detrimental effect in each case. There also seemed to be some interaction in that shock was more detrimental to the performance of low anxiety Ss.

Lee (1961) using similar techniques obtained somewhat different results. Using all male students as Ss, she also selected those from the upper and lower 20% on the TMAS. Ss learned a list of 15 adjective pairs. Ss were then divided into two groups (one of which received shock between trials) and a new list was learned. The new list had five pairs from the original list, five new pairs, and five pairs in which the stimuli and responses came from the original list, but with different pairings. In this study both shock and anxiety facilitated the learning of the pairs from the original list (i.e. dominant response correct), while hindering the learning of the other pairs.

In a study by Maltzman, Eisman and Morrisett (1961) only the threat of shock was used. Three groups of Ss, high, medium and low on the TMAS were utilized. The learning task consisted of letters (A-J) paired with numbers (1-10). The threat of shock was that certain incorrect responses would be shocked.

A control group was also utilized. Induced anxiety (threat of shock) was found to have no significant effect. However, both low anxiety and high anxiety Ss performed better than did medium anxiety Ss.

Instead of shock, Lovaas (1960 a) used Induced Muscular Tension (IMT) as a means of inducing drive, and muscular tension (measured by number of eyeblinks, MT) as an independent measure of drive. The Bendig revision of the TMAS was also used to obtain high and low anxiety Ss. A list of paired associates, which contained high associative pairs, low associative pairs and competitive pairs of adjectives was learned by the Ss. Both MT and IMT were found to be associated with increased performance on high associative pairs and decreased performance on competitive pairs. MT and IMT were found to be interchangeable in their effects and also appeared to summate when high MT and IMT were present in the same subject. No significant effects could be attributed to differences in TMAS scores.

Lovaas (1960 b) also did a replication of the Spence, Taylor and Ketchel (1956) study, but used IMT in randomly selected Ss rather than using the TMAS. The learning curves and other results obtained in this study so paralleled those obtained by Spence, et al that it was concluded that induced muscular tension and manifest anxiety are both measures of drive and have similar effects on learning.

One other experiment using both stress (failure reports) and TMAS scores as D measures was performed by Levitt and

Goss (1961). Also high and low similarity and high and low associative lists of nonsense syllables were used. The high associative list was learned more rapidly than the low associative list, while the low similarity list was learned more rapidly than the high similarity list. The stress and TMAS variables were found to be insignificant, except that stress facilitated the learning of the low similarity list.

Chansky (1960) also stdied the effect of stress (verbally induced) on learning of, and retention of, paired associate nonsense syllables. However, he also added the variable of continuous and intermittant information. The group with intermittant information did not know whether or not their responses were correct on half of the trials. After the learning trials, Ss were given another task for 5 minutes, then were given the cue words again and a retention score was obtained. Intermittant information resulted in poorer learning performance, but a higher retention score. Although stress alone had no significant effect, it increased performance of both learning and retention when coupled with the intermittant information schedule.

Using a quite different technique, Kleinsmith and Kaplan (1963) obtained results similar to those of Chansky (1960). In a one trial learning experiment, Ss learned pairings of eight words with numbers two through nine. The words were such as to have a fairly high arousal value (kiss, rape, vomit, exam, dance, money, love, swim). The word was presented, then the word and number for a period of four seconds, followed

by slides with colors to be named, then next word, etc. All Ss had GSRs taken while they were learning the lists and each subgroup of six was divided into three with highest arousal and three with lowest arousal. The six subgroups were then asked to recall the pairings after varying intervals of time (two minutes, 20 minutes, 45 minutes, one day, one week). The high arousal Ss showed little immediate (two minute) recall, but increasing recall up to one week. The low arousal group showed high immediate recall, but rapid forgetting. The authors attributed this to "perseverative consolidation" under high arousal.

Kausler, Trapp and Brewer (1959) studied yet another facet of learning with high D and low D Ss. They were interested in intentional and incidental learning. Two experiments were conducted, in one of which D was measured by TMAS, in the other D was induced by instructions. The task was to learn the geometric shape that was associated with the stimulus. The incidental learning was the color of the figure. In each case, the high D Ss performed better than did the low D Ss on intentional learning. No significant difference was noted in incidental learning. The authors suggest that D is situationally oriented.

These experiments on paired-associate learning seem to reveal some rather clear evidence that two types of experiments are involved. In one group, the so called "easy," or "simple" list contained a stimulus-response pair in which the response to the stimulus was dominant. In these cases, anxiety, or

other facets of D were facilitative (one apparent exception is the study by Buchwald). On the other hand, merely making the lists easier to learn did not appear to make for a consistent difference between anxious and nonanxious Ss.

Throughout our review, it appears that the important parameter involved, if anxiety (or other facet of D) is to facilitate learning, is the appearance of a single, correct, dominant response. This is to be expected from the Hull Theory that D is multiplicative. Thus, a single dominant response quickly becomes easily evoked. However, if several responses are available, the reaction potential of each reaches threshold quickly through high D, thus disrupting learning.

Up to this point, the research presented has been viewed primarily from the Hull-Spence theoretical framework. Two basic assumptions have been made concerning this material. The first assumption is that anxiety is a manifestation of drive. The second assumption is that D increases the likelihood of the dominant response tendency, thus facilitating learning where there is a single dominant response to be learned, and hindering learning where the correct response is but one of several competing responses. It is with the first of these assumptions that Eysenck (1957) is in disagreement.

Drugs and Learning

First, a brief review of the purpose of studying the effects of amphetamine is in order. It is a well documented phenomenon that amphetamine will keep performance at a high level after

a period of uninterrupted work. This is true of tasks requiring physical activity, alertness, or continuing routine mental work. This is a specific attribute of the drug amphetamine. As such, it can unquestionably be illustrated that amphetamine increases drive in this sense. However, the question of interest is whether or not amphetamine can be said to have general D functions. At this point, anxiety has been shown to have general D functions and can be used in experiments of general D. Still, this is an independent variable that cannot be easily manipulated within an individual S as can amount of drug. Therefore, in setting up the present experiment, it is important that it be set up in such a way as to avoid the specific function. General D is the function in question.

Hull's (1943) learning theory, which has many variables, basically says that reaction potential is influenced by habit strength, drive, and inhibition, or $s\bar{E}r = sHr \times D - Ir$. When a reaction potential rises above the response threshold, the response will occur. Hull saw drive as nearly synonymous with need, and therefore postulated specific rather than general drives. However, with the introduction of the TMAS, the Spence-Hull theorists postulated a general D function as having the same effect as Hull's specific drives. Anxiety then became a measure of general D.

Eysenck (1957) puts forth a theory that is somewhat different. He views anxiety as a condition of cortical excitation. Stimulant drugs are also seen as producing cortical excitation. Using Hull's formula, $s\bar{E}r = sHr \times D - Ir$, in which $s\bar{E}r$ is re-

action potential, sHr is habit strength, D is drive, and Ir is inhibition, Eysenck takes the position that anxiety and stimulants produce their results by lowering Ir. This is in contrast to the Spence oriented Es who felt that D was being raised by these same conditions. Practically, it makes little difference, since in each case the end result is the increase of the response potentials. Theoretically, the question is of importance in understanding the problem. Eysenck, Casey and Trouton (1957) suggest a way of testing this theoretical issue. They say,

> "In view of what is known about the growth of reactive and conditioned inhibition, we would expect stimulants to be effective after some time rather than immediately. This follows from the simple consideration that their ability to decrease inhibition is dependent on the previous growth of inhibition; during the early stages of practice little inhibition has been developed and the drug, therefore, can not show any considerable effectiveness in overcoming inhibition (64)."

In testing this hypothesis, they used a pursuit rotor task following the ingestion of: A. 10 mgm. Dextro-Amphetamine Sulfate 75 minutes before the task, B. 10 mgm. Dextro-Amphetamine Sulfate 250 minutes before the task, C. four and a half grains of Sodium Amytal, D. a Placebo. The length of time between the taking of the amytal and placebo and the beginning of the experiment were not reported. The order of the task was: five minutes with the pursuit rotor, ten minutes rest, five minutes practice, ten minutes rest and five minutes practice. During the first five minute period, the group who had taken the amphetamine 250 minutes earlier did significantly better

than the other groups. During the second five minute period, this group continued to do better, and the amytal group did significantly poorer than the other two groups. And finally, during the last five minutes, the group who had taken the amphetamine 75 minutes before the beginning of the task also improved. Although this study was seen as supporting Eysenck's theory, the amphetamine given 250 minutes earlier appears to have increased drive rather than preventing the build up of inhibition. However, before going into this further, a few other drug studies will be presented.

In 1935, Hull studied the influence of caffeine on the learning and relearning of nonsense syllables. Each S was seen for eight consecutive days. On alternate days they were given five grains of caffeine and an identical capsule containing lactose (control). Each S was given the drug at least one hour after the last meal, then relearned to criterion of two perfect repetitions the two 12 unit nonsense syllable lists learned the day before. These experiments were considered as being completed before the drug had time to become effective, and were thus not expected to be influenced by the drug. The purpose of this was to determine the amount of recall from the previous day. In the period between these two relearning periods, the subject was given a steadiness test and a five minute rest period. The subject then left the lab and returned, 3½ hours after taking the drug, for the learning of two new lists of nonsense syllables to a criterion of two perfect repetitions.

Between these two lists were a second steadiness test and a 15 minute rest period. The big difference found in the two conditions was that in the lists learned under the drug condition there was a large, significant trend toward incorrect anticipatory responses.

Reiman (1934) used the common stimulant of caffeine (black coffee prepared under control conditions), to study paired-associate learning. There were eight learning lists consisting of nonsense syllables and three digit numbers. The Ss were presented lists on five consecutive days, but had coffee only on the second and fourth days. Ss had no tea or coffee during those days except in the experiment. Reiman concluded that, "this experiment shows without any ambiguity that the power to form associative bonds is increased by coffee (p 104)."

Caffeine was introduced somewhat more precisely by Switzer (1935). Ss were administered either five grains of caffeine citrate or a placebo. Prior to taking the drugs, Ss' GSR and respiratory reactions had been conditioned. Ss were then given unreinforced trials on four successive days, four hours after ingestion of the drug (or placebo). Drug days and placebo days were experimentally counterbalanced. Ss gave significantly more conditioned responses on days in which they had received the caffeine citrate. This was interpreted as support for the hypothesis that "caffeine augments CR's and at the same time diminishes inhibitory processes." Thus, Switzer seemed to anticipate our present situation and placed herself in both camps. Stimulants augment CRs (a D function) and diminishes inhibition.

Whether or not caffeine had a general D or another specific drug effect in these studies is not clear. Hull did not consider his results as demonstrating a general D, though his study did increase the number of interfering competitive responses that might be anticipated. Reiman saw the caffeine as increasing CR bonds, and Switzer also was able to produce specific results with caffeine. Whether or not these functions are general D functions is not clear.

Franks and Trouton (1958) studied the effect of sodium amobarbital and dexamphetamine sulfate on eyelid conditioning. Four groups were used: one group received the sodium amobarbital 45 minutes before treatment; one group received a placebo 45 minutes before treatment; one group received dexamphetamine sulfate 45 minutes before treatment; and one group received dexamphetamine sulfate 120 minutes before treatment. It was found that the group receiving the dexamphetamine sulfate 45 minutes before treatment did not differ from the placebo group. The sodium amobarbital group conditioned significantly slower than did the placebo group. The group that received dexamphetamine sulfate 120 minutes before treatment conditioned significantly faster. The experimenters, having an Eysenckian orientation, suggest that the results may not be a factor of drive at all. They say,

> "However, it is impossible to determine to what extent the above findings reflect the peripheral motor consequences of the two drugs and to what extent they reflect any direct effects upon some central learning or connection forming process (pp 221)."

Kornetsky (1958) studied the effects of different dosages of three drugs on a simple reaction time task, a choice reaction time task, and a "simple learning task." The drugs were 800 and 1600 mgms. meprobamate, 60 and 120 mgms. phenobarbital and 5 and 15 mgms. d amphetamine. The only significant result was with 1600 mgms. of meprobamate, which had a deleterious effect on all three tasks. Kornetsky (1958) interpreted the failure of the amphetamine to facilitate learning as proof of Eysenck's contention that the drug "would only facilitate performance when fatigue was present (pp 218)." However, another explanation is that the learning task (learning which button to press when the correct sequence was fashioned by randomization) involved a number of competetive responses. This, also, would result in the amphetamine having little effect.

An experiment which used drugs and which was based on the Spence approach was one by Burnstein and Dorfman (1959). Their hypothesis could be summarized as follows: anxiety has a predictable effect on learning; meprobamate reduces anxiety; therefore a meprobamate group will have characteristics of a non-anxious group. A paired-associate learning list was made up of four high associative S-R pairs and eight weak associative S-R pairs. The stimuli in the weak associative pairs consisted of two synonyms of each of the high associative stimulus words. Thus the dominant response for the weak associative stimulus was one of the high associative responses. Ss were both male and female, and were randomly assigned to either placebo or

meprobamate groups. With this competitive list, meprobamate Ss performed better than placebo Ss, thus supporting both the fact that anxiety and drugs may have specific effects on learning.

These studies are few in number and certainly are inconclusive about the effects of drugs on learning. Although the use of drugs in studying behavior is growing rapidly, there is little direct evidence of drug effect on "complex human learning." There are, of course, clinical studies constantly being performed. There are many animal studies (e.g. see Journal of Comparative-Physiological Psychology), as well as general performance (e.g. Uhr and Miller, 1960), general effects and specific effects being studied (e.g. Dews, 1962). However, these studies are not usually seen as part of a general view of personality, cognitive, learning, or other psychological theory.

SUMMARY OF HISTORY

Several trends appear throughout these studies. A single, dominant response is learned quicker if the S obtains a high score on the TMAS than if he obtains a low score on the TMAS. If a correct response is one of several competing responses, the opposite is true. In general, TMAS scores, appear to be a reflection of general D, although some studies seem to indicate that TMAS scores are a reflection of specific functions rather than general D. In fact, added together, these studies

not only suggest specific D's rather than a general D, but that D itself has different functions triggered by various physiological and psychological states. However, the overall history does support the existence of general D, with the evidence being that TMAS scores reflect general D.

The possibility of amphetamine being used as a measure of general D is even less clear. Without doubt, amphetamine has drive properties if consideration is taken of its function of keeping performance at a high level over a long period of time. There are other indications of amphetamine having drive properties. However, the question of whether or not amphetamine can be substituted for anxiety as a measure of general D is very much in doubt. This, then, is the question which this paper attempts to answer.

CHAPTER III

METHODOLOGY

At this time, let us again make explicit the purpose of this study. The important question is whether or not an independent factor, in this instance, amphetamine, can be substituted for a psychological independent variable, in this case, drive. In order to make the study meaningful, it is essential that a specific effect of the independent factor not be interpreted as being a result of the psychological independent variable. In other words, an effect of amphetamine can not be considered to be drive if the amphetamine does not also have other properties of drive. There is no doubt, for example, if the experimental task were continued for a sufficient period of time, an amphetamine group would eventually do better than a placebo group. Continued high performance has repeatedly been demonstrated in such diverse areas (attention, physical activity, tedious performance, simple tasks, complex tasks, etc.) that this must be considered a specific quality of amphetamine. This, of course, could be considered a manifestation of drive. However, as stated before, the interest of this paper is in amphetamine as general D. Thus, the question of necessity is whether or not amphetamine continues to exhibit drive properties when long range effectiveness is experimentally controlled. For the sake of convenience and brevity, the rest of this chapter will be written as if the primary interest is in the effect of the amphetamine. The hypotheses are those

that would be true if amphetamine could be substituted for D.

Statement of Problem

In the present study, the interest is in the effect of 10 mgm. of amphetamine on the learning of competitive and noncompetitive paired associates. The hypothesis is that the drug will affect a person in much the same way as a state of generalized anxiety, which has been shown to facilitate the learning of noncompetitive responses and to disrupt the learning of competitional responses. Up to this point, there seems to be little disagreement, although this simple problem does not seem to have been directly tested.

It is in the timing of the effects of drugs that controversy exists. Spence looking upon anxiety as D (and, if we follow the Eysenckian assumption that anxiety and amphetamine have a similar effect on learning, then amphetamine is also a component of D), would see the drug as having immediate effects (after time is allowed for the drug to take effect, of course). One specific function of amphetamine, on the other hand, is to prevent the build up of fatigue, thus only being effective after some time has elapsed.

In order to resolve this problem, two controls are essential. First, the S must not have been allowed to build up inhibition by prior experience. This is unfortunate since it rules out the use of Ss as their own control, or using any S more than once. The second is to find two tasks, one of which is clearly simple (with no competitive responses readily avail-

able), and the other clearly complex (with clearly competitive responses available).

The hypotheses to be tested were:

1. Ss who have received two five mgm. tablets of amphetamine will learn a simple learning task faster than a comparable group who have received two placebo tablets.

2. A group of Ss, each of whom receives a placebo will do better on a complex learning task than will a group of Ss, each of whom has received 10 mgm. of amphetamine.

3. On the simple learning task, the effect of the amphetamine will be immediate and will be apparent on the first five trials of the learning task.

4. The immediate effect of the amphetamine will be disruptive in the complex learning task. Therefore, the placebo group will perform better on the first five trials.

5. Since the dominant response in the complex learning task is incorrect, the amphetamine group will give more incorrect responses in the complex learning task.

This then constituted the primary considerations and hypotheses of the study. However, additional data could be collected with facility which might add another dimension. What if after learning list A, Ss were requested to learn list B, and vice versa? The Hullian theory would predict that the second list would be more difficult to learn, since the earlier list would provide dominant, incorrect responses. On the other hand, from the specific effect of amphetamine, the prediction

would be that the performance would not be impaired more with amphetamine than with placebo.

Thus, hypothesis number six is: With the amphetamine groups, the performance on the second list will be disrupted by the learning of the previous list.

Subjects

Since the build up of inhibition had to be carefully avoided, certain limitations were ready built into the design. Practice lists, which are a regular way of introducing Ss to the procedure could not be used. No Ss could be used more than once. This eliminated the possibility of using Ss as their own control. This made necessary the use of four groups. Subjects consisted of 60 paid volunteers selected from the community. The only criterion of selection was that Ss be between the ages of 18 and 40. The Ss were fairly well distributed over this age range. Ss were actively recruited from Houston State Psychiatric Institute personnel and residents, Baylor University College of Medicine students, University of Houston students, and Rice University students. Other Ss were primarily friends and relatives of these Ss. Thus, the mean IQ and educational level of the Ss of the present study are above the mean of the general population. A total of 61 Ss were selected, but one was dropped because of an adverse drug reaction resulting in an inability to perform in the experiment. The Ss were assigned alternately to control or experimental group with placebos and amphetamines used on alternate days.

The final groups consisted of a slightly unbalanced distribution in terms of sex. The make-up of the groups were: simple placebo - 8 men, 7 women; complex placebo - 8 men, 7 women; simple drug - 10 men, 5 women and complex drug - 10 men, 5 women. Because of the chance factor of a systematic difference in sex with more men in all groups, and a higher proportion of men in the drug groups, results were analyzed for each sex as well as for the group as a whole.

Half of the Ss received two five mgm. amphetamine tablets. The other Ss received two identical-appearing placebos. The tablets could be told apart only by chewing which very few Ss did. The drugs were administered on a fasting stomach during the mornings. The Ss were then allowed to read or walk for two hours, again with no food intake of any kind (although the intake of water was permitted.)

Drug

A 10 mgm. dose of amphetamine was chosen for a number of reasons. It is a commonly used drug, and is frequently used in connection with learning by college students. It is a well known drug that has few dangerous or unpleasant effects, is one of the most frequently used stimulants (after caffeine), and is known to have stimulating effects on the nervous system. Finally, it is one of the most commonly used stimulants in research. The dosage was set at 10 mgm. because of the individual differences encountered with five mgm. and the possibility of the disrupting influence of 15 mgm. For these same reasons, different levels of drugs were not used. Although 10 mgm.

affects different people differently, the dosage is strong enough to have some effect on nearly everyone, and at the same time have a minimal disruptive effect.

Apparatus and Materials

Apparatus consisted of a Hull-type memory drum equipped with paired-associate tapes. The presentation was such that the stimulus appeared alone for two seconds, the stimulus and response appeared together for two seconds, the next stimulus appeared for two seconds, etc. There was a six second pause at the end of each run.

The word lists were chosen from Haagen (1949). His lists gave values for degree of meaning (similarity of meaning), degree of association ("degree to which words are associated in thought: the immediacy, compellingness, or consistency with which one word calls another to mind."), vividness (emotional connections), and familiarity (immediate recognition and absolute certainty of meaning and use). Each of these characteristics is rated on a seven point scale from most to least for each adjective pair. For the present study, pairs were selected which had high associative value. Since a value of 1, signifies an association, that is, "immediate, compelling and consistent," values somewhat higher were chosen to allow enough range for learning to take place. As it was, many Ss learned the high association list within 5 trials (see results section). The second list had the same adjectives in the same order in the stimulus list, but the responses had been jumbled.

Therefore, in the second list, for every stimulus there was a high associative response, but it was wrong for that particular stimulus. The lists are presented in Table 1.

These intervals are similar to the ones used by Spence, Farber and McFann (1956). The difference is that they required their Ss to respond in 1.67 secs., then presented the S and R together for 2.33 secs. Thus, both studies used the same stimulus-stimulus interval of 4 secs., with the present study allowing a slightly longer period for responding.

Procedure

After the medication was received, the S was allowed to do what he wished for two hours, provided he did not eat or drink anything but water, and did not engage in vigorous physical activity. At the end of two hours, he was taken to a room in which there were a table, on top of which was the memory drum, and some chairs. Only the E and the S were present. The S was asked to sit facing the memory drum while the following directions were read by E:

> "The apparatus in front of you is a memory drum. When it is started a word will appear, followed in two seconds by the same word and another word. The object is for you to learn what words go together so that you can call out the second word before it comes into view. They will be presented once so that you can become familiar with them. Following that, the words will continue to be presented until you give all of the correct words within the time limit for two complete runs or until the list has been presented 15 times. Are there any questions?"

At this point a few questions were asked, but most Ss indicated they were ready. A few Ss asked about the drug or purpose of

Table 1

Paired adjective word lists presented in the present study

Simple		Complex	
royal	stately	royal	coiled
cautious	guarded	cautious	stately
distant	removed	distant	guarded
foremost	highest	foremost	saintly
winding	coiled	winding	graceless
awkward	graceless	awkward	threadbare
absurd	stupid	absurd	removed
ragged	threadbare	ragged	corrupt
adept	handy	adept	crabbed
wicked	corrupt	wicked	highest
pious	saintly	pious	handy
grouchy	crabbed	grouchy	stupid

the experiment and they were asked to wait until later for the answer. A few Ss had procedural questions which related to how they should proceed (e.g. should I guess?). These were answered with noncommittal answers (e.g. if you wish). There were also a few Ss who did not quite understand the instructions, in which case more explanation was given.

The experimenter then said, "Remember, this first time is so you can see all the words." The memory drum was turned on. Between the first and second runs, E said, "If you know a word, call it out." The memory drum was then left on, either until the S had successfully completed two complete runs, or until fifteen runs had been completed.

Then, in order to obtain the additive data, E turned off the drum, closed the window through which the S had been looking and opened the window that would expose the other list. These instructions were then read,

> "Now I want you to forget about the first list. A second list will be presented and I want you to learn the new words that go together. I will present the list first, as I did the first time. Ready?"

The recording of scores was done by the E who stood behind the S during the experiment. The score was the number of correct responses on each run. A second score was obtained from the number of trials to criterion (two consecutive perfect runs).

Because of the inequality in number of male and female Ss in the placebo and control groups, and because some studies indicated differences in performance for males and females, re-

sults were calculated for each group individually as well as together.

The data were analyzed by means of the following t tests:

1. Between placebo and drug groups on the simple learning task for the number of correct responses (male, female, total).

2. Between placebo and drug groups on the simple learning task for the number of trials to criterion (male, female, total).

3. Between placebo and drug groups on the complex learning task for number of correct responses for men, women and total group. (not enough Ss reached criterion on the complex task for a test of differences here).

4. Between the placebo and drug groups on the first five trials of the simple task (for men, women and total).

5. Between the placebo and drug groups on the first five trials of the complex task (for men, women and total).

6. Between placebo and drug groups on the number of incorrect responses in the complex learning task (for men, women and total).

7. Between initial learning of simple list and learning of the simple list after learning complex list (In order to utilize our additional data.

8. Between initial learning of complex list and learning of complex list after learning simple list.

CHAPTER IV

RESULTS

The results, shown in tables 2 through 9, can be generally summed up as follows: 10 mgm. of amphetamine, two hours before testing has no significant effect upon learning of paired-associates when conditions are controlled to prevent the build up of fatigue. This is true, not only for the learning of the initial list, but the second list as well. Let us look briefly, however, at each hypothesis.

Hypothesis number 1: Ss who have received two five mgm. tablets of amphetamine will learn a simple learning task faster than will a comparable group who have received two placebo tablets. Neither total number of correct responses (see Table 2), nor trials to criterion (Table 3) show significant differences. Although trials to criterion showed small mean gains for men, women and total groups (not significant because of the large variances involved), the mean number total correct responses for the two groups were almost identical, despite large standard deviations.

Hypothesis number 2: A group who receives placebos will do better on a complex learning task than will a group of Ss each of whom has received 10 mgm. of amphetamine. There was a small (not significant) tendency for men to do better with placebo, but for women to do better with the drug (see Table 4). These small tendencies cancelled out for the group as a whole.

Hypothesis number 3: On the simple learning task, the

Table 2

Number of correct responses on the simple learning task

	Drug Conditions					
	Placebo		Drug			
Ss	M	SD	M	SD	t*	p
Male	142.50	30.86	145.50	22.64	-	ns
Female	151.71	31.09	150.00	27.49	-	ns
Total	146.80	30.58	147.00	23.31	-	ns

* t scores below 1.00 are not given in these tables

Table 3

Number of trials to criterion on the simple learning task

	Drug Conditions					
	Placebo		Drug			
Ss	M	SD	M	SD	t	p
Males	9.88	4.60	10.90	5.07	-	ns
Females	8.00	5.07	9.00	4.50	-	ns
Total	9.00	4.69	10.02	4.00	-	ns

Table 4

Number of correct responses on complex learning task

	Drug Conditions					
	Placebo		Drug			
Ss	M	SD	M	SD	t	p
Males	87.13	32.57	71.00	30.51	1.07	ns
Females	61.71	20.50	83.00	38.02	1.10	ns
Total	75.27	29.71	75.00	36.10	-	ns

effect of the amphetamine will be immediate and will be apparent on the first five trials of the learning task. This hypothesis was clearly not proven (see Table 5). The differences between the two groups were too small to even be considered tendencies.

Hypothesis number 4: The immediate effect of the amphetamine will be disruptive in the complex learning task. Therefore, the placebo group will perform better on the first five trials. As is evident in Table 6, this hypothesis was not supported by the data. The differences were quite small and insignificant.

Hypothesis number 5: Since the dominant response in the complex learning task is incorrect, the amphetamine group will give more incorrect responses in the complex learning task. As with our other hypotheses, the data (see Table 7) give absolutely no support to this conclusion.

Hypothesis number 6: The additional hypothesis from the use of the second list was also unsupported. With the teaching of a dominant list, the performance on a list in which competing responses were present should be disruptive. As seen in tables 8 and 9, there were no differences in learning either list, whether or not it was presented first or second. Again, the simple list was learned quickly, the complex list with difficulty. Still, there was no difference between the placebo groups and the drug groups.

In conclusion, there was absolutely no support for any hypothesis concerning a difference in learning of paired-associates between Ss taking two five mgm. tablets of amphetamine and two placebo tablets.

Table 5

Number of correct responses on first five trials of simple learning task

	Drug Conditions					
	Placebo		Drug			
Ss	M	SD	M	SD	t	p
Males	34.13	16.41	35.30	13.49	-	ns
Females	39.57	15.90	38.80	12.50	-	ns
Total	36.67	15.85	36.47	13.10	-	ns

Table 6

Number of correct responses on first five trials on complex learning task

	Drug Conditions					
	Placebo		Drug			
Ss	M	SD	M	SD	t	p
Males	9.45	5.90	11.20	8.68	-	ns
Females	13.37	10.88	14.40	10.06	-	ns
Total	11.27	8.55	12.27	8.93	-	ns

Table 7

Number of incorrect responses in complex task

	Drug Conditions					
	Placebo		Drug			
Ss	M	SD	M	SD	t	p
Males	20.50	12.16	17.40	15.68	-	ns
Females	12.43	6.33	19.00	24.00	-	ns
Total	16.73	10.42	18.00	17.91	-	ns

Table 8

Comparison of correct responses on simple task immediately and following complex task under two drug conditions

Placebo

	Immediate		Following Complex Task			
Ss	M	SD	M	SD	t	p
Males	142.50	30.86	159.13	7.14	1.39	ns
Females	151.71	31.09	163.86	14.44	-	ns
Total	146.80	30.58	161.33	11.18	1.67	ns

Drug

	Immediate		Following Complex Task			
Ss	M	SD	M	SD	t	p
Males	145.50	22.64	159.20	17.46	1.38	ns
Females	150.00	27.49	156.80	19.80	-	ns
Total	147.00	23.31	158.40	17.59	1.41	ns

Table 9

Comparison of correct responses on complex task immediately and following simple task with placebo and with amphetamine

Placebo

	Immediate		Following Simple Task			
Ss	M	SD	M	SD	t	p
Males	87.13	32.57	67.75	29.60	1.20	ns
Females	67.71	20.50	81.43	23.49	1.08	ns
Total	75.27	29.71	74.13	26.91	-	ns

Drug

	Immediate		Following Simple Task			
Ss	M	SD	M	SD	t	p
Males	71.00	30.51	85.10	32.78	-	ns
Females	83.00	38.02	82.80	12.53	-	ns
totals	75.00	36.10	84.33	27.14	-	ns

The question might be raised as to whether or not the simple list was made up of stimulus and dominant response, and the complex list of stimulus and competing response. First, it is readily apparent that the simple list was much easier learned than the second. As can be seen in tables 10 and 11, the difference between the two negates the possibility of the two being of equal difficulty. This suggests that the responses to the simple list are dominant. This is further suggested by a breakdown of incorrect responses during the initial runs (i.e. before the other list had been presented). Not all the incorrect responses were response words in the list, although the preponderance of incorrect responses were from the response list. By chance, one would expect any particular response to be used nine per cent of the time. There was no case of a correct complex response being given as an incorrect response in the simple list (before the other list had been presented). However, 16 per cent of the incorrect responses to the complex list were the correct answers to the simple list. Although the competitive nature of the complex list is clearly evident, there is not so much support for the simple list as having clearly dominant responses, although the ease of learning, as well as the higher percentage of simple list responses certainly suggests dominant responses. As a further check of the results, the six words of the list, in which the expected dominant response was used most often (with these six words 22 per cent of the incorrect responses on the complex list would have been

Table 10

Number of correct responses on the first five trials on the simple and complex learning tasks

Placebo Groups

	Simple		Complex			
Ss	M	SD	M	SD	t	p
Male	34.13	16.41	9.45	5.90	4.00	.0050
Female	39.57	15.90	13.37	10.88	3.63	.0050
Total	36.67	15.85	11.27	8.55	5.46	.0005

Drug Groups

Ss	M	SD	M	SD	t	p
Male	35.30	13.49	11.20	8.68	4.75	.0050
Female	38.80	12.50	14.40	10.06	3.40	.0050
Total	36.47	13.10	12.27	8.93	4.08	.0005

Table 11

Number of total correct responses on the simple and complex learning task

Placebo Groups

	Simple		Complex			
Ss	M	SD	M	SD	t	p
Male	142.50	30.86	87.13	32.57	3.50	.0050
Female	151.71	31.09	61.71	20.50	6.12	.0005
Total	146.80	30.58	75.25	29.71	6.50	.0005

Drug Groups

	Simple		Complex			
Ss	M	SD	M	SD	t	p
Male	145.50	22.64	71.00	30.51	6.20	.0005
Female	150.00	27.49	83.00	38.02	3.19	.0100
Total	147.00	23.31	75.00	36.10	6.49	.0005

correct for the simple list), were analyzed. Again, there were no significant differences found between the drug group and the placebo group.

In addition, 13 of 15 Ss in both the placebo and drug groups learned the simple list (when presented first) within the 15 trial limit. This established the simple list responses as dominant, whether or not they had been so previously. However, the amphetamine group did no worse than the placebo group on the complex list, even after the simple list had been learned.

CHAPTER V

DISCUSSION

The present study indicates that despite the drive properties of amphetamine under specific circumstances, it does not have general D properties. One implication of this is that other measures of general D, such as anxiety, may also have specific, rather than general D functions. General D as a factor in Hullian learning theory is rather new. A brief review of the use of this independent variable during the past few years will illustrate the implications of amphetamine having specific rather than general D functions.

Hull (1943), the originator of the presented formula, stated in substance, that a given response depends on habit strength, drive, and inhibition. The formula was much more elaborate and complex than this in the final analysis, since various parameters of the basic formula were included and integrated into the system. Although some authors (e.g. see Jensen, 1961) have attempted to alter the formula in such a way as to give more or less weight to various components of the formula, it has remained rather basic. Since a response is more likely to be evoked if drive increases or inhibition decreases (under the original formula or any of the revisions), any factor which increases D or decreases I should increase the likelihood of a response being evoked. Since this is true of all potential responses, a single dominant response would quickly rise above threshold with increased D or decreased I

and be evoked. However, if a number of responses were available, none of which was dominant, the increase in D, or decrease in I, would hinder the learning of the correct response.

Taylor (1951) introduced the TMAS which initiated the practice of using anxiety as a measure of general D. Following this, a number of experimental studies (e.g. Spence and Taylor, 1951; Spence and Farber, 1954; Spence and Weyant, 1960; Spence, Farber and Taylor, 1954; Runquist and Spence, 1959; Spence and Taylor, 1953; Taylor and Spence, 1954; Farber and Spence, 1953; Taylor and Spence, 1952; Spence, Farber and McFann, 1956; and Spence, Taylor and Ketchel, 1956) and theoretical papers (e.g. Taylor, 1956; Farber, 1955; and Spence, 1958) by the Iowa school were introduced to support the hypotheses that: there is a general D; anxiety is one facet of D; D facilitates the learning of a single dominant response, but disrupts the learning of more complex material. There have been a number of other studies, notably Montague's (1953) excellent study, that have supported the results obtained by the Iowa group.

In the nonverbal studies, the support for the high anxiety, high drive hypothesis is especially strong. All of the studies reviewed, with the exception of the study by Prokasy and Truax (1959), support the high drive hypothesis or at least are in a positive direction, though some do not reach significance. The Prokasy and Truax (1959) study does not appear to have a plausible explanation, except for the always possible statistical anomaly. Other nonverbal studies, Mandler and Sarason (1952), Sarason, Mandler and Craighill (1952),

Matarazzo and Phillips (1955), Eysenck and Willett (1962), McGuigan, Calvin and Richardson (1959), at first glance appear to not support the high-anxiety high-drive hypothesis. However, these studies are either performance (i.e. not learning per se) or learning in which no dominant responses are available.

The verbal studies are more difficult to collect, integrate, and extrapolate because of the large number of parameters introduced into the learning situation. There is also a tendency to equate easy learning tasks with the learning of a task in which the dominant response is correct, and difficult learning tasks with learning of a task in which competing responses are available. However, the weight of the evidence suggests that when a task is composed of a set of dominant responses to be learned, high anxiety is facilitative; and when a set of responses in which the correct response is not the response with the highest dominance, high anxiety is detrimental.

The present experiment is highly similar to the Spence, Farber and McFann (1956) study which showed positive results. The similarities included the same type of study (Paired-associative learning), and the same type of material (high associative adjective pairs from Haagen's (1949) word list). Differences included Spence's use of a practice list, slightly different time presentation periods, inclusion of a mixed list by Spence, and, of course, high anxiety and low anxiety groups rather than drug and placebo. Although these other differences could conceivably cause such a clear cut difference in the re-

sults of the two studies, there is no theoretical reason why they should do so.

Thus, the evidence appears to support the view that high drive facilitates the learning of a dominant response, and disrupts learning of competitive responses.

The drug studies reviewed previously gave very equivocal results concerning the general D properties of drugs, especially amphetamines. The results suggested that anxiety relieving drugs given to anxious subjects would give results expected of low D subjects. Several experiments demonstrated that stimulants changed the shape of the learning curve, strengthened associative bonds, and improved performance in certain nonverbal learning situations. However, no clear-cut results could be used to demonstrate the increase or decrease of general D in Ss who had ingested stimulant drugs. In fact, one point of view, represented by Dews (1952), goes so far as to suggest that even the term stimulant has no real meaning since each drug has its own specific properties. However, the drug that is most homologous with stimulant, i.e. amphetamine, has long been known to have certain properties comparable to properties of a high drive state. The clearest case of this is amphetamines well known property of allowing the recipient of the drug to maintain a high level of performance over an extended period of time. This, of course, could very well be an operational definition of "drive." However, this paper is concerned with a very specific kind of drive, i.e. the general D concept developed by the Spence-Taylor (Iowa)

group from the drive concept of Hull's (1943) theory of learning.

The drug, amphetamine, was substituted for anxiety in a situation analogous to several previously described experiments in which anxiety was shown to have general D properties. However, in the present experiment, the amphetamine did not even show tendencies in the directions expected if general D properties are present. This, then, suggests several hypotheses of theoretical importance.

The first of these, of course, is that amphetamine can not be considered as a means of inducing general D. This is unfortunate since it would have supplied a more convenient means of manipulating general D than is presently available.

Another implication of this study is that Hull (1943) may have been correct in stating that D consisted of specific needs. If amphetamine has one property that suggests drive, but does not produce results expected from increased drive in other situations, this may also be true of other so-called measures of general D. In this regard, consider those experiments which demonstrated that different measures of general D (shock, threat of shock, squeezing a hand dynamometer, MAS, TAS, etc.) often produce slightly different results. In fact, drive may well be found to be made up of a number of operations, some of which, such as anxiety, may appear to have general D functions in the sense that in learning situations which can be represented by the formula ($s\bar{E}r = sHr \times D - Ir$) anxiety can be used as a measure of D. However, further study needs to be carried out to

ascertain whether or not anxiety always causes a person to react as if a specific need deprivation were present.

In conclusion, the present study gives no support to the suggestion that amphetamine and anxiety have the same effects on learning (Eysenck-1957). There is no evidence from the present study that amphetamine facilitates or impedes the learning of easy or difficult, competitive or dominant responses, in comparison with the learning of the same responses after taking a placebo. It would appear that amphetamine's effect on learning is limited to the specific property of amphetamine of preventing the build-up of fatigue. Thus the only benefit the student of learning can hope to derive from amphetamine is to be kept awake while researching the subject.

CHAPTER VI

SUMMARY

Hull (1943) integrated the concept of drive into his theory of learning. Although his theory is quite extensive, the principle elements of his theory are contained in the formula $s\bar{E}r = sHr \times D - Ir$. In this formula $s\bar{E}r$ is Reaction Potential, sHr is Habit Strength, D is Drive and Ir is Inhibition. Each element of this formula has several components which in turn become part of a larger formula. In Hull's theory, D is not a generalized factor, but is made up of specific needs such as thirst, hunger, etc.

Taylor (1951) introduced general D into the formula by showing that anxiety, as measured by her TMAS, had the same effects as would be predicted from high D. Other studies verified that anxiety did, in fact, facilitate learning in which a dominant response was to be learned and disrupted learning in which competing responses were involved.

Studies of amphetamine show that it has some properties similar to drive. Also, Eysenck (1957) suggests that a stimulant would have effects similar to anxiety. This raised the question of whether or not amphetamine has general D functions, or specifically, does amphetamine facilitate the learning of dominant responses and hinder the learning of competing responses?

A total of 60 Ss were divided into four equal groups as follows: 15 received the placebo and learned a high-associative list; 15 received the placebo and learned the competitive list,

15 received 10 mgm. of amphetamine and learned the high-associative list, and 15 Ss received 10 mgm. of amphetamine and learned the competitive list.

The lists were from Haagen's (1949) list and were high associative pairs. In the competitive list, the pairs were scrambled so that the high associative response was incorrect. The lists, of 12 pairs each, were presented on a Hull-type memory drum.

An examination of the results verified that the simple list contained dominant responses and that the complex list not only contained competing responses, but was overall much more difficult to learn. However, there was absolutely no differences found between the placebo and amphetamine groups on the simple or complex task.

This indicates that although some properties of amphetamine suggest drive, it cannot be substituted for general D in the Hull formula as anxiety has been substituted. This also raises the question of whether or not there are many components of drive, some of which will function in some situations, while others function in others. Thus, the general D measured by the TMAS might itself be a specific D that operates only for short periods of time, while amphetamine, certainly at this point, appears to have characteristics of D only after an extended period.

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APPENDIX

SUMMARY DATA

Table I Number of Simple Correct 1st 5 Runs

	Simple Placebo		Simple Drug		Complex Placebo		Complex Drug	
1.	Male	46	Male	40	Female	25	Male	55
2.	Female	46	Male	23	Male	39	Male	29
3.	Male	25	Male	49	Female	52	Male	56
4.	Female	16	Male	15	Male	47	Male	53
5.	Male	31	Male	27	Female	49	Female	48
6.	Male	46	Male	35	Female	52	Female	43
7.	Male	48	Male	46	Male	44	Male	42
8.	Female	59	Male	55	Female	50	Female	24
9.	Male	2	Female	51	Male	39	Female	41
10.	Female	50	Female	19	Male	40	Male	53
11.	Female	25	Female	33	Male	50	Female	53
12.	Female	51	Male	20	Male	35	Male	33
13.	Female	30	Female	40	Male	36	Male	50
14.	Male	26	Female	51	Female	57	Male	33
15.	Male	49	Male	43	Female	36	Male	45
	Sum	550	Sum	547	Sum	651	Sum	658

SUMMARY DATA

Table II Number of Simple Correct 2nd 5 Runs

	Simple	Placebo	Simple	Drug	Complex	Placebo	Complex	Drug
1.	Male	60	Male	50	Female	51	Male	60
2.	Female	60	Male	60	Male	60	Male	52
3.	Male	51	Male	59	Female	60	Male	60
4.	Female	30	Male	32	Male	59	Male	60
5.	Male	54	Male	52	Female	60	Female	60
6.	Male	60	Male	53	Female	60	Female	60
7.	Male	60	Male	56	Male	59	Male	56
8.	Female	60	Male	60	Female	60	Female	47
9.	Male	32	Female	60	Male	60	Female	56
10.	Female	60	Female	40	Male	56	Male	60
11.	Female	55	Female	56	Male	60	Female	60
12.	Female	60	Male	50	Male	55	Male	51
13.	Female	51	Female	59	Male	54	Male	58
14.	Male	39	Female	60	Female	60	Male	40
15.	Male	59	Male	52	Female	55	Male	56
	Sum	791	Sum	799	Sum	869	Sum	836

SUMMARY DATA

Table III Number of Simple Correct 3rd 5 Runs

	Simple	Placebo	Simple	Drug	Complex	Placebo	Complex	Drug
1.	Male	60	Male	59	Female	60	Male	60
2.	Female	60	Male	60	Male	60	Male	53
3.	Male	53	Male	60	Female	60	Male	60
4.	Female	40	Male	49	Male	60	Male	60
5.	Male	60	Male	55	Female	60	Female	60
6.	Male	60	Male	60	Female	60	Female	60
7.	Male	60	Male	60	Male	60	Male	60
8.	Female	60	Male	60	Female	60	Female	53
9.	Male	53	Female	60	Male	60	Female	60
10.	Female	60	Female	46	Male	60	Male	60
11.	Female	60	Female	60	Male	60	Female	60
12.	Female	60	Male	59	Male	60	Male	59
13.	Female	59	Female	60	Male	60	Male	60
14.	Male	46	Female	60	Female	60	Male	54
15.	Male	60	Male	60	Female	60	Male	60
	Sum	851	Sum	868	Sum	900	Sum	879

SUMMARY DATA

Table IV Number of Simple Correct Total

	Simple Placebo		Simple Drug		Complex Placebo		Complex Drug	
1.	Male	166	Male	149	Female	136	Male	175
2.	Female	166	Male	143	Male	159	Male	138
3.	Male	129	Male	168	Female	172	Male	176
4.	Female	86	Male	96	Male	166	Male	173
5.	Male	145	Male	134	Female	169	Female	168
6.	Male	166	Male	144	Female	172	Female	163
7.	Male	168	Male	162	Male	163	Male	158
8.	Female	179	Male	175	Female	170	Female	123
9.	Male	87	Female	171	Male	159	Female	157
10.	Female	170	Female	105	Male	156	Male	173
11.	Female	140	Female	144	Male	170	Female	173
12.	Female	171	Male	129	Male	150	Male	143
13.	Female	150	Female	159	Male	150	Male	168
14.	Male	111	Female	171	Female	177	Male	127
15.	Male	168	Male	155	Female	151	Male	161
	Sum	2,202	Sum	2,205	Sum	2,420	Sum	2,376

SUMMARY DATA

Table V Number of Complex Correct 1st 5 Runs

	Simple	Placebo	Simple	Drug	Complex	Placebo	Complex	Drug
1.	Male	21	Male	18	Female	7	Male	6
2.	Female	5	Male	9	Male	8	Male	2
3.	Male	12	Male	21	Female	31	Male	14
4.	Female	11	Male	6	Male	18	Male	3
5.	Male	2	Male	3	Female	27	Female	12
6.	Male	12	Male	11	Female	8	Female	15
7.	Male	2	Male	21	Male	3	Male	8
8.	Female	26	Male	24	Female	12	Female	0
9.	Male	4	Female	9	Male	18	Female	17
10.	Female	12	Female	11	Male	11	Male	31
11.	Female	4	Female	9	Male	15	Female	28
12.	Female	21	Male	14	Male	11	Male	19
13.	Female	10	Female	11	Male	0	Male	11
14.	Male	1	Female	6	Female	6	Male	6
15.	Male	11	Male	8	Female	4	Male	12
	Sum	154	Sum	181	Sum	169	Sum	184

SUMMARY DATA

Table VI Number of Complex Correct 2nd 5 Runs

	Simple Placebo		Simple Drug		Complex Placebo		Complex Drug	
1.	Male	39	Male	25	Female	16	Male	21
2.	Female	10	Male	32	Male	32	Male	16
3.	Male	27	Male	47	Female	51	Male	35
4.	Female	24	Male	21	Male	26	Male	18
5.	Male	21	Male	13	Female	53	Female	25
6.	Male	34	Male	21	Female	30	Female	23
7.	Male	15	Male	51	Male	11	Male	23
8.	Female	32	Male	43	Female	28	Female	2
9.	Male	12	Female	31	Male	37	Female	40
10.	Female	34	Female	27	Male	28	Male	49
11.	Female	29	Female	26	Male	32	Female	53
12.	Female	37	Male	32	Male	38	Male	23
13.	Female	25	Female	38	Male	19	Male	28
14.	Male	3	Female	28	Female	22	Male	7
15.	Male	32	Male	21	Female	5	Male	29
	Sum	374	Sum	456	Sum	428	Sum	392

SUMMARY DATA

Table VII Number of Complex Correct 3rd 5 Runs

	Simple	Placebo	Simple	Drug	Complex	Placebo	Complex	Drug
1.	Male	45	Male	28	Female	41	Male	35
2.	Female	26	Male	55	Male	55	Male	30
3.	Male	52	Male	60	Female	36	Male	45
4.	Female	40	Male	29	Male	59	Male	38
5.	Male	36	Male	22	Female	43	Female	41
6.	Male	46	Male	41	Female	24	Female	31
7.	Male	37	Male	58	Male	21	Male	30
8.	Female	43	Male	52	Female	44	Female	11
9.	Male	24	Female	54	Male	47	Female	58
10.	Female	52	Female	41	Male	54	Male	58
11.	Female	40	Female	37	Male	35	Female	59
12.	Female	52	Male	43	Male	53	Male	28
13.	Female	37	Female	49	Male	30	Male	40
14.	Male	15	Female	37	Female	37	Male	9
15.	Male	39	Male	23	Female	21	Male	36
	Sum	584	Sum	629	Sum	600	Sum	549

SUMMARY DATA

Table VIII Number of Complex Correct Total

	Simple Placebo		Simple Drug		Complex Placebo		Complex Drug	
1.	Male	105	Male	71	Female	64	Male	62
2.	Female	41	Male	96	Male	95	Male	48
3.	Male	91	Male	128	Female	70	Male	94
4.	Female	75	Male	56	Male	139	Male	59
5.	Male	59	Male	38	Female	81	Female	78
6.	Male	92	Male	72	Female	38	Female	69
7.	Male	54	Male	130	Male	35	Male	61
8.	Female	101	Male	119	Female	84	Female	13
9.	Male	40	Female	94	Male	102	Female	115
10.	Female	98	Female	79	Male	93	Male	138
11.	Female	73	Female	72	Male	82	Female	140
12.	Female	110	Male	89	Male	102	Male	70
13.	Female	72	Female	98	Male	49	Male	79
14.	Male	19	Female	71	Female	65	Male	22
15.	Male	82	Male	52	Female	30	Male	77
	Sum	1,112	Sum	1,265	Sum	1,129	Sum	1,125

SUMMARY DATA

Table IX Number of Incorrect Responses in Complex Runs

Placebo

		1st 5	2nd 5	3rd 5	Total
1.	Female	6	5	2	13
2.	Male	5	1	0	6
3.	Female	10	4	3	17
4.	Male	9	6	14	29
5.	Female	4	0	0	4
6.	Female	7	6	2	15
7.	Male	11	18	11	40
8.	Female	3	10	5	18
9.	Male	14	7	5	26
10.	Male	3	2	1	6
11.	Male	8	13	7	28
12.	Male	2	8	3	13
13.	Male	5	5	6	16
14.	Female	0	2	1	3
15.	Female	3	7	7	17
	Total	90	94	67	251

SUMMARY DATA

Table X Number of Incorrect Responses in Complex Runs

Drug

		1st 5	2nd 5	3rd 5	Total
1.	Male	12	13	11	36
2.	Male	15	21	16	52
3.	Male	3	0	2	5
4.	Male	2	3	3	8
5.	Female	4	4	4	12
6.	Female	27	23	11	61
7.	Male	0	4	1	5
8.	Female	0	0	1	1
9.	Female	8	3	1	12
10.	Male	4	3	0	7
11.	Female	6	4	0	10
12.	Male	10	5	7	22
13.	Male	10	5	4	19
14.	Male	7	3	4	14
15.	Male	2	3	1	6
	Total	110	94	66	270