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The relationship between incidental learning and conditions of practice.

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THE RELATIONSHIP BETWEEN INCIDENTAL LEARNING
AND
CONDITIONS OF PRACTICE

by

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ABSTRACT

The present study was undertaken to investigate the relationship between incidental learning and conditions of practice.

The subjects used in this investigation consisted of sixty grade nine female high school students with fifteen students randomly assigned to each of the following four groups: the massed practice group with irrelevant stimuli, the massed practice group without irrelevant stimuli, the distributed practice group with irrelevant stimuli, and the distributed practice group without irrelevant stimuli. All the subjects were instructed to learn a list of nonsense syllables presented on a memory drum. They were given thirty trials on the above intentional task. The irrelevant stimuli consisted of ten different geometrical figures arranged so that a different geometrical figure appeared in the memory drum window to the right of each nonsense syllable. A record was kept of the number of nonsense syllables correctly anticipated by all subjects for each trial. The subjects making up the two experimental groups were tested for incidental learning of the geometrical figures immediately after the thirtieth anticipation trial on the memory drum. Incidental learning was tested by the methods of free recall and serial recall.

A t-test revealed that no significant difference was obtained in the amount of incidental learning under massed practice conditions as compared to that obtained under conditions of distributed practice.

As would be expected the analysis of variance indicated that there was a significant difference in the amount of nonsense syllables learned under distributed practice as compared to the amount learned under massed practice.

PREFACE

The author wishes to express his gratitude to Dr. J. E. Callagan for his direction and guidance, which made the execution of this study possible. He is also indebted to Dr. A. A. Smith, whose suggestions were beneficial in analyzing the data. Finally he expresses his thanks to Dr. R. A. Helling for his contribution as a reader.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The concept of "inhibition" as defined below has been postulated to explain the differences in reflex behavior, the performance of motor, psycho-motor and verbal tasks under conditions of massed and distributed practice (Pavlov, 1927; Hull, 1943; Hovland, 1936a; Woodworth and Schlosberg, 1954; Eysenck, 1957.). More specifically, Hull, Hovland, Ross, Hall, Perkins and Fitch (1940), Hull (1943), Woodworth and Schlosberg (1954), and Underwood (1957) use an inhibition construct to account for differences in performance with serial verbal learning under massed and distributed practice, although Underwood tends to favor an interference interpretation. Also Hull et al (1940), Hull (1943), Woodworth and Schlosberg (1954) and Eysenck (1957) make use of an inhibition factor in explaining the phenomenon of reminiscence which tends to be a by product of massed practice. Reminiscence is defined as the "recall or recognition, without intervening overt practice, of items previously learned but not recallable - an increment in a practiced act after a period of nonpractice." (English & English, 1958, p.457). English and English (1958, p.262) define inhibition as "restraining or stopping a process from continuing, or preventing a process from starting, although the usual stimulus is present; a hypothetical nervous state or process that brings about the restraint".

Inhibition is said to be generated more quickly and dissipated more slowly under conditions of massed practice as compared to distributed practice conditions; as a result performance is generally superior under distributed practice. This inhibition is considered to be a negative drive similar to fatigue, and is associated with a tendency to avoid performing the task giving rise to the negative drive (Hull, 1943). In the present study inhibition will be assumed to exist if a significant statistical difference in the number of nonsense syllables learned under massed and distributed practice can be demonstrated. Myers and Miller (1954) believe that performance of a monotonous task gives rise to feelings of boredom and Glanzer (1953) holds that the longer an organism perceives a stimulus-object the greater the amount of stimulus satiation (boredom-like effect) built up to it, and as a result the organism will tend to avoid this stimulus and seek out different stimuli. A somewhat similar theory is held by Montgomery (1952).

If a greater degree of inhibition (fatigue) and/or stimulus satiation (boredom) is built up when performing a task under massed practice conditions than under distributed practice conditions, this inhibitory state will be associated with a need to seek a change, i.e. a need to search for novel or new stimuli. It is postulated in the present study that the above conditions of task performance will lead to a relatively greater degree of incidental learning. Incidental learning in the present study will be what Postman (1964, p.187) describes as Type II incidental learning. He states:

> In Type II of incidental learning the S is given a specific learning task but during practice is also exposed to

> materials or cues which are not covered by the learning instructions. His retention for those features of the situation which are not relevant to the task specified in the original instructions defines the amount of incidental learning, and the measure obtained will again be a function of the test.

The irrelevant stimuli of the present study will have no direct relation to the stimuli which the subjects have been instructed to learn, i.e. they will belong to the class of Type II incidental learning which Postman refers to as "extrinsic" to the "experimenter-defined learning task." By presenting subjects with an opportunity to observe novel stimuli while performing a task under massed or distributed practice conditions, it is predicted that under massed practice conditions the subjects will be able to recall and/or recognize more novel stimuli (incidental learning will be greater). The present study is designed to test this hypothesis.

BACKGROUND AND RELATED RESEARCH

Theoretical Background

As mentioned in the general introduction, attempts to explain the differential effects of massed and spaced practice largely appeal to some interfering or inhibitory condition that weakens quickly with rest. The concept of inhibition is important for this study as it is assumed that an inhibitory-like effect will be generated by the method of presenting the experimental stimuli to the subjects of this study. The above assumption is based on the fact that the conditions of practice used in the present study are somewhat similar to those used in other studies which produced certain effects which experimenters have explained by making use of an inhibitory concept. The theoretical background for the present study has to do largely with a theory of inhibition outlined by Eysenck (1957). Inasmuch as Eysenck's theory developed from Hull's inhibition theory and certain modifications of it, and also because Eysenck uses certain concepts of Hull's, a brief overview of Hull's theory along with modifications will be presented, before relating the present study to Eysenck's outline.

Habit (sHr) as outlined by Hull (1943) is said to exist when an association between a stimulus and a response has been developed as a result of a number of reinforced repetitions of a stimulus-response sequence. A habit can be considered to be weak or strong and the strength of the habit, i.e. the strength of the stimulus-response association, is inferred from the relation between the number of reinforced repetitions of the stimulus-response sequence and the probability that the response will be elicited on presentation of the stimulus. The symbol sEr (reaction potential) is used to represent the performance of a habit. Hull conceptualizes such conditions as need for oxygen, food and sex, etc. as basic drives (D). In Hull's theory the assumption is made that habit and drive interact multiplicatively resulting in performance. The equation describing this relationship is: $sEr = f(sHr) \times f(D)$. Hull also postulates two types of inhibition, viz., reactive inhibition (Ir) and conditioned inhibition (sIr) which are in competition with reaction potential. When combined they are called inhibitory potential; and when a sufficient amount exists it can make ineffective the existing habit. Reactive inhibition is similar to pain or tiredness, built up gradually through the occurrence of similar responses. As a result it tends to prevent the future occurrence of this response and therefore inhibits reaction potential (sEr). Due to the discomfort that takes place when fatigue is present the reactive inhibition acts as a negative drive which when reduced by inactivity of the particular response, gives rise to reinforcement of nonresponding (conditioned inhibition, sIr). The summation of sIr and Ir produces a general state of inhibition ($\dot{I}r$). Hull includes Ir and sIr in his basic formula as indicated:

$$sEr = (D \times sHr) - (Ir + sIr).$$

When $\dot{I}r$ is subtracted from sEr, what is left is referred to as the effective reaction potential ($s\bar{E}r$). Hull (1943, p.284) states: "The effective reaction potential ($s\bar{E}r$), i.e., that reaction potential which is actually available for the evocation of action (R), is the reaction potential (sEr) less the total inhibitory potential ($\dot{I}r$)." His equation for the above is the following: $s\bar{E}r = sEr - \dot{I}r$

According to Hull, the antecedent condition leading to the production of reactive inhibition is the amount of work (W) required in performing the particular response. Concerning this, Eysenck (1957, p.55) states: "In seizing upon this 'work' explanation of reactive inhibition, which had originally been advanced by Mowrer (1943) and Miller (1941), Hull was enabled to keep his theory 'peripheralist' in contradistinction to the Pavlovian concept of inhibition, which is central." In regards to the above type of central inhibition as opposed to a strictly peripheral form of inhibition, Eysenck (1957, p.56-57) describes it as follows:

> The term central . . . means anywhere within the central nervous system from a point separated by at least one synapse from the receptor organ on the one side, to a point separated by at least one synapse from the effector organ on the other. It is quite possible, of course, that additional to this central type of inhibition such factors as muscular fatigue, receptor adaptation, and so forth play a part in many of the phenomena discussed under the heading of inhibition.

The validity of Hull's inhibition theory is questioned from two directions. First, logical contradictions within the theory itself and second, some experiments present results which are unfavorable to the theory. In the latter case Ellis (1953) lists a number of studies which fails to confirm the view that inhibition is a function of work and instead suggests that Ir, i.e. reactive inhibition, is independent of effort. In another study by Ammons (1955), a good deal of reactive inhibition was built up even though the task involved was mainly a perceptual one where almost a complete lack of work was involved. The task was tracing a line from one number to the next in a series.

Again, it is very unlikely that the work hypothesis or peripheral origin of inhibition can be offered as an explanation of an experiment done by Hovland and Kurtz (1951). Using twelve subjects who were given the task of learning lists of nonsense syllables by the serial anticipation method, the above authors observed that when the subjects were required to do addition problems just previous to the learning of the syllables, a greater amount of "reminiscence" occurred than when the subjects were not required to do the above addition problems. In explaining the phenomenon of reminiscence some authors, Eysenck (1957) and Hovland (1936b) for example, emphasize the role of inhibition. In the above mentioned experiment (Hovland and Kurtz, 1951), the fact that more reminiscence occurred for the list of nonsense syllables which was preceded by the addition problems, suggests that this combination of tasks produced a greater accumulation of inhibition which dissipated after a short interval of time, hence the greater amount of reminiscence. On the other hand less reminiscence took place when a rest interval was inserted between the addition task and the serial learning of nonsense syllables which suggests that the accumulated inhibition built up from the addition task was allowed to dissipate. The smaller amount of reminiscence which did occur reflects the dissipation of the smaller amount of inhibition accumulated from the serial learning of nonsense syllables. It would be very difficult to attribute the inhibition implied in the above differential amounts of reminiscence to a physical work hypothesis.

Further evidence which tends to cast doubt on Hull's work explanation of reactive inhibition is implied in Irion and Gustafson's (1952) study. Subjects were required to perform on a pursuit rotor under massed practice for five minutes. Immediately after performing this task half of the subjects practised for a further five minutes but this time using the other hand. The control group in the meantime was given a five minute rest period before being required to practise the same task with their other hand. The results showed that the control group performed significantly better with their other hand than the group which did not receive a rest period. The detrimental effects of massed practice carried over from one hand to the other and did not localize in the hand muscles used in the first five minute task. One explanation is that inhibition arose from an origin other than just a peripheral one; otherwise the inhibition would have been expected to have been limited in location to the muscles used in the first five minutes.

Other evidence which appears to question Hull's work response produced inhibition theory is found in a number of classical conditioning experiments carried out by Pavlov and his co-workers. Pertinent to the above is the phenomenon of "subzero" extinction. The extinction of a classical conditioned response occurs by repeatedly presenting the conditioned stimulus to an organism (dog) without the unconditioned stimulus until the conditioned response is no longer elicited by the conditioned stimulus. The conditioned stimulus is the "originally ineffective stimulus for a given response that, by the experimental procedure of conditioning, has become capable of eliciting that response". The conditioned response is the "new response that is elicited by a given stimulus after conditioning.". Conditioning refers to the

> experimental procedure wherein two stimuli are presented in close temporal proximity. One of them has a reflex or previously acquired connection with a certain response, whereas the other is not an adequate stimulus to the response in question. Consequent upon such paired presentation of the two stimuli, usually many times repeated, the second stimulus acquires the potentiality of evoking a response very like the response provoked by the other stimulus. The first-mentioned stimulus is called the unconditioned stimulus, the second-mentioned is the conditioned stimulus. The original response is the unconditioned response, the newly acquired response for the conditioned stimulus is the conditioned response". (English & English, 1958, p.107).

Pavlov (1927) showed that once extinction of a conditioned response has taken place (to the point that it completely disappears) by the method of presenting the conditioned stimulus repeatedly in the absence of reinforcement (unconditioned stimulus), the potential evocation of the conditioned response can be diminished still further by continuing to present the conditioned stimulus to the organism without reinforcement ("subzero" extinction). During this continued presentation of the conditioned stimulus the conditioned response is still not elicited. This further diminishing of the potential evocation of the conditioned response is shown when the conditioned response is tested for "spontaneous recovery". When a conditioned response has been extinguished, it can often be elicited again after a period of rest, though response strength is diminished. This phenomenon is referred to as spontaneous recovery. It is found that the conditioned response observed in "spontaneous recovery", after a period of rest, is much weaker under "subzero" extinction conditions than under the usual extinction conditions, thus demonstrating that response-produced inhibition is not the only explanation of response decrement.

Further, Seward and Levy (1949) conditioned rats to obtain food in a goal box at the end of a runway by travelling an elevated pathway from a starting platform to a goal platform. After conditioning, one group of rats was placed directly in the goal box when it was empty of food and permitted to see that the reinforcement was no longer there. They were left in the goal box for two minutes. The control rats were placed in a neutral box X for two minutes. This treatment was applied five times to each group. The following day both groups were given extinction trials. Extinction was considered to have occurred when the subject remained in the starting box A for as long as three minutes. The group that had been able to see before hand that the food was no longer in the goal box extinguished significantly more quickly than the control group. This experiment suggested that the sight of the empty goal box contributed to the extinction of the conditioned running response without the organism having to emit the running response. These results were offered as support for a sign-learning interpretation and seem to oppose Hull's response-produced inhibition theory of response decrement.

Critics have also attacked certain inconsistencies or weaknesses in Hull's inhibition theory itself. For instance, Osgood (1953) criticizes Hull's inhibition theory because he subtracts both Ir, the fatigue-produced inhibition and sIr, the conditioned inhibition, from the reaction potential sEr instead of from the habit strength, sHr. Concerning the above, Osgood (1953, p.347) states:

> Expressed in ordinary language, this seems to mean that Hull looked upon all inhibitory processes as damping performance rather than as subtracting from previously

> learned habit strength. In other words, habits are never unlearned. Is this paradoxical? One may envisage here a cluttering up of the psyche with outmoded habits, but with our scanty knowledge of the neural nature of habit, this need not be disturbing. Remaining within Hull's general framework, it still could be assumed that sIr, as a negative habit phenomenon, subtracts directly from sHr, a positive habit phenomenon (indeed, it seems reasonable that the tendency not to make a response should be the reciprocal of the tendency to make that response, that the strengthening of the former should be the same thing as the weakening of the latter). Fatigue-produced inhibition, Ir, would still summate algebraically with sEr, since both are performance constructs.

Eysenck is still not satisfied with this change inasmuch as Hull has Ir, which symbolizes a negative drive, subtracting from performance (sEr). He refers to a paper done by Gwynne Jones (1958) in which Jones makes positive suggestions on how Hull's theory might be made internally more consistent. The changes he suggests are as follows: subtract negative drive (Ir) from positive drive (D) and multiply the existing drive remaining, whether positive or negative, by the remainder which results from subtracting conditioned inhibition (sIr), a negative habit, from the existing positive habit (sHr). Now the net reaction potential ($s\widetilde{Er}$) becomes equal to the product arising from multiplying the above remaining drive, after subtraction, by the above remaining habit after subtraction. Jones' formulation of the above process is:

$$s\widetilde{Er} = f\left[(D - Ir) \times (sHr - sIr)\right].$$

Eysenck accepting the above formulation of Jones refuses to use the symbol Ir because of its previous connection with peripheral phenomenon and its being traditionally dependent on amount of work performed. He is also opposed to it because of its additive algebraic relationship to conditioned inhibition. He therefore, conceptualizes Ir as a negative, central drive and symbolizes it as (D-). In regards to positive drive he symbolizes this as (D+) and his formula in expanded form is:

$$\widetilde{sEr} = f(D+ \times sHr) + f(D+ \times sIr) + f(D- \times sHr) + f(D- \times sIr)$$

The above formula expressed verbally has the following meaning. The effective reaction potential is equal to positive drive (food deprivation, etc.) multiplied by positive habit (a stimulus-response connection developed through a number of reinforced repetitions), plus positive drive multiplied by negative habit (habit of not responding), plus negative drive (leading to the cessation of activity) multiplied by positive habit, plus negative drive multiplied by negative habit. Concerning the above formula Eysenck (1957, p.58) states:

> Each of the four terms in this equation contains the product of a drive and a habit, and these products are additive and produce effective reaction potential $\widetilde{sEr}$. It should be noted, of course, that D- is a negative drive, i.e. a drive leading to the cessation of activity, and that sIr is a negative habit of not responding. Thus, while D+ X sHr would give rise to a positive sEr, D- X sHr would give rise to a negative performance, i.e. a failure to react. Of particular interest in this connection is the last term in the equation. Both D- and sIr have a negative sign, so that their product should be positive, i.e. a negative drive in conjunction with a negative habit should produce a positive reaction. The phenomenon of disinhibition may be tentatively thought to fall under this category.

Referring to the above expected positive reaction which Eysenck holds will occur when D- is multiplied by sIr, Jones (1958, p.180) states:

> Such a state of affairs would occur rarely in practice, but may furnish a theoretical explanation of such phenomena as the "ultraparadoxical" phase of inhibition observed by Pavlov. The various inhibitory states of the organism induced by Pavlov in various ways may be considered as inhibitory drive states akin to reactive inhibition. In advanced stages of such inhibition, Pavlov noted that positive conditioned stimuli tended to lose their effect, whereas "well developed negative stimuli" (i.e., when sIr

was predominant) "acquired definite excitatory properties".

Eysenck (1957) discusses the changes that occur in behavior as learning develops. He follows quite closely Kimble's (1949, 1952) extension of Hull's theory in which Kimble treats of the growth of reactive inhibition. Kimble describes reactive inhibition as a negative drive very similar to the avoidance of pain. All responses that are effortful produce this inhibition whether the particular responses are reinforced or otherwise, and rest intervals allow the inhibition to dissipate. Since reactive inhibition is a negative drive, Kimble suggests that Ir increases to the point when it cancels out or neutralizes positive drive (subject's motivation to perform the task). At this point a rest pause will automatically occur. Eysenck refers to the above as an involuntary rest pause. During this rest pause Ir will decrease leaving D+ relatively stronger. Once D+ becomes significantly stronger performance once again occurs. The equation describing the above is as follows:

$$(D+ \times sHr) + (D- \times sHr) > 0$$

The duration of the rest pause is a function of the speed at which Ir dissipates. When Ir is significantly reduced the organism begins performing the particular task it has been motivated to do and this performance will continue until a sufficient degree of Ir is built up and once again neutralizes the positive drive (D+). In regards to the present study it is assumed that during the cessation of performance (D- balances D+) the organism performs some other response (voluntarily or involuntarily seeks out or reacts to novel stimuli).

Conclusion

It is to be expected that the central inhibition theory outlined by Eysenck would predict that (a) when stimuli are presented to an organism repeatedly, over a certain length of time (massed presentation) or (b) when an organism practises a relatively new activity under massed practice conditions, performance will be inferior than if the above situations were interrupted by rest intervals (distributed practice). It would follow from Eysenck's outline that negative drive D- would accumulate more quickly under massed practice than under spaced practice. The reason for this is that a certain amount of D- would dissipate during the rest intervals under distributed practice but with massed practice this dissipation of D- would be highly improbable. As a result D- would eventually reach the point when it was equal to D+, at which time an involuntary rest pause would take place.

RESEARCH FINDINGS

Various experimenters will be mentioned who seem to support the contention that inhibition builds up when an organism repeatedly performs a task especially under massed conditions. Following this, experiments will be presented which generally indicate that performance is superior when distributed practice is used as compared to massed practice as would be expected from the inhibition theory just outlined. Superior performance under distributed practice can mean, depending on the particular activity being observed, fewer errors emitted in reaching criterion, less trials to reach a criterion of performance, more verbal stimuli learned within a given time interval or number of trials, a greater number of correct motor responses emitted in a certain period of time or number of trials, and a greater facility in eliciting a conditioned reflex. A short discussion on whether it is the performance and/or learning of a task which is effected by massed and distributed practice will follow the above outline of experiments.

Inhibition and Practice Conditions

Osgood (1953, p.507) states: "Most theories designed to account for the superiority of distributed practice over massed practice postulate some interfering or inhibitory process that dissipates with rest." Pavlov (1927) observed that the strength of conditioned reflexes can be weakened even though the reinforcing stimulus is still being applied. Pavlov reasoned that the conditioned stimuli, when presented over a prolonged period of time and especially when applied under massed practice conditions, i.e. with brief time intervals between presentations, become inhibiting in their effect of eliciting the conditioned reflex.

In speaking about how a weakened reflex may be helped to recover its strength, Pavlov makes several suggestions, such as not using the conditioned stimulus a large number of times in any one experiment and preferably using it only once. When a particular experiment requires that the conditioned stimulus be used a large number of times Pavlov suggests that the elicitation of the conditioned response be interrupted for a few days. In short, he appears to be suggesting using distributed practice.

Woodworth and Schlosberg (1954, p.788) also make use of the concept of inhibition. For instance, they state: "The work decrement often seen in massed trials, . . . can be laid to the accumulation of inhibitions." Eysenck (1957) also explains the difference in performance under massed and distributed practice by a theory of inhibition. In addition, Hull et al (1940) make use of an inhibitory construct in explaining the differential effects of massed and distributed practice in rote learning.

Summary

In conclusion, a number of authors account for the differential effects of massed and distributed practice by stressing the part played by inhibition which arises from massed practice.

Performance and Practice Conditions

The following studies demonstrate on the whole that distributed practice under various conditions and in numerous learning situations leads to superior performance than massed practice. Leuba and Hyde (1905) studied the effect of varying rest intervals while learning to transcribe English prose into German script. The time intervals used were 12, 24, 48 and 72 hours with length of practice kept constant. During the initial period of learning the 24-hour rest intervals proved most effective while at the later stage of learning the 48-hour interval proved most beneficial. The 12-hour interval was the least beneficial. Using a code substitution task, Pyle (1913) discovered that a 24-hour interval interpolated between trials was more effective than massed practice. This state of affairs held true with trials of 15, 30, 45, and 60 minutes in length. The same author found that a group of third-grade children given an arithmetic learning task, did much better when given 10 minutes of practice each day for 10 consecutive days than another group which worked on the task for two 10-minute periods, twice daily on five consecutive days. Lorge (1930), using a perceptual motor task compared results obtained under massed practice with results obtained under distributed practice. It was found that two forms of distributed practice (one minute interval and 24 hour interval between trials) led to superior results than did the massed practice condition.

Intervals of one minute were very nearly as beneficial as intervals of one day. Hardy's (1930) subjects performed on a stylus maze better with shorter and longer periods of rest than with rest periods of moderate length. He also found that short practice periods interpolated between rests of different lengths give rise to results which are superior to those obtained when longer practice periods are used. In addition, Travis (1937) compared the outcome of using 5 minute, 20 minute, 4, 8, 72, and 120 hour rest periods after a number of sessions following one after another of 5 minutes of continuous practice on the pursuit-oscillator. The 20 minute rest period proved to be the most beneficial. The results observed under the 5-minute rest interval were the next best. Jones (1930), using children as subjects in an experiment on the conditioned galvanic skin response, discovered that, when the conditioned and unconditioned stimulus were given in massed presentations, the corresponding responses were weakened in strength but recovered after an interval of one day intervened before any more stimuli were applied. Humphreys (1940) using the conditioned eyelid response, discovered that his subjects acquired this response faster when 60 seconds rather than 30 seconds was used as trial intervals. In still another study using a motor performance task, Travis (1939) demonstrated that the most efficient learning is obtained when longer practice periods are associated with longer rest periods. Finally, in an experiment where the task was rapid manipulation of small pegs, Kimble and Bilodeau (1949), observed that decreasing the time spent working on the task plays a more important part in improving learning than increasing the time of rest intervals.

<u>Summary</u>

Countless other studies have been performed and they as well as the ones cited here, for the most part, present evidence suggesting that for most psychomotor tasks some distributed practice is better than a strictly massed practice situation. Variables such as differences in subjects, methods, tasks, etc. and the interaction between these lead to various complications when an attempt is made to compare experiments and arrive at reliable conclusions about how distribution of practice associates with or interacts with the conditions or variables making up specific tasks.

Extinction and Practice Conditions

Turning now to the effect which massing of trials has on extinction, it is to be noted that Pavlov (1927) observed that extinction of a classical conditioned response takes place more quickly when trials are relatively massed than when they are spaced. The phrase, "internal inhibition", was coined by Pavlov to label the phenomenon of gradual weakening of the conditioned reflex and its final disappearance as a result of the continual presentation of the conditioned stimulus in the absence of the unconditioned stimulus. Because of the fact that the conditioned reflex recovers to some extent after a rest interval (spontaneous recovery), Pavlov deduced that an underlying process of inhibition existed. Referring to extinction of a conditioned reflex by massed trials, Pavlov (1927, p.61) states:

> it was seen that a repetition of the non-reinforced conditioned stimulus was necessary to produce a sufficient summation of the inhibitory after-effect for complete experimental extinction, and it is reasonable to suppose that the shorter the intervals between successive repetitions of the stimulus the more quickly will the required intensity of the inhibitory process be obtained. This also was found to be the case. As a result of repetitions of experimental extinction on the same animal the zero level of a fresh extinction of the reflex is reached more rapidly. This shows that inhibition like excitation is facilitated by repetition.

Speaking of extinction curves Hovland (1936a) distinguishes between two types - the first is a continuous decrease in the strength of a conditioned response in the absence of reinforcement. This decrease occurs quickly early in extinction and gradually slows down as extinction proceeds. The other kind of extinction curve displays an early rise in the strength of the conditioned response coinciding with the second or third trial of extinction. The author offers the explanation that numerous repetitions of reinforcement lead to negative adaptation or what he terms as "inhibition of reinforcement". He also suggests that when the reinforcing stimulus is withheld a disinhibiting effect would occur resulting in an increase of the conditioned response on the second or third extinction trial. Hovland deduces that "inhibition of reinforcement" would be greater with an increase in the amount of massed reinforcements. He also predicts that with distribution of reinforcements, inhibition arising from reinforcement would be dissipated during the interval between reinforcements. This would be demonstrated by the absence of an early rise in the curve of extinction which ordinarily would occur from disinhibition. Using in an experiment, human subjects and the galvanic reaction as the conditioned response, a 1000 cycle tone as the conditioned stimulus and an electric shock as the unconditioned stimulus, Hovland's hypotheses were successively demonstrated. Furthermore, Gagne (1941) obtained results supporting Hovland's proposal that increased response strength on the second extinction trial is due to the dying away of inhibition which occurred as a result of massing acquisition trials. Using rats as subjects in two experiments, Gagne studied the influence of distributed practice on acquisition and extinction rate of a conditioned operant response. His experimental results show a progressive increase in rate of acquisition when the interval between successive trials is made progressively longer and extinction tended to occur faster under the massed trials. However, confidence in the relationship between extinction rate and massed trials suggested by this study is limited because different amounts of reinforcement were used in experiment one and due to the inhibition of reinforcement effect occurring in both experiment one and two. In addition, Gagne (1941, p.208) states, in regards to the above relationship:

> The interpretation of the data of our experiment in this manner, however, is subject to the condition that the six groups began extinction at entirely different levels of response magnitude. These initial differences in the curve of extinction may obscure the relationship between trial intervals and rate of extinction, to some extent.

Likewise, Hilgard and Marquis (1935), using dogs as their experimental subjects, found that extinction of the conditioned eye lid response was more rapid in a group where 60 extinction trials were used each day, than that which was observed in a single dog when 10 extinction trials were presented per day.

In contradiction to Pavlov's contention that massed trials lead to quicker extinction than spaced trials, Porter (1938) was unable to find any significant difference in the extinction rate of a running response in rats when 10 minutes, 5 minutes and a few seconds were the time intervals inserted between extinction trials. The same author (1939) established conditioned eyelid responses to the onset of a visual stimulus (light), founded on the unconditioned response to a puff of air impinging upon the cornea of the left eye. Extinction trials took place by presenting the conditioned stimulus in the absence of the unconditioned stimulus (reinforcement), thirty seconds after the last training trial. Intervals of 180, 80, 40, 20 and 10 seconds were used as the between stimulus intervals during the extinction of the conditioned eyelid response. Porter was unable to find any significant difference in the time it took for extinction to take place. Attempting to explain why Porter's experiments did not show any significant difference in rate of extinction under various intertrial intervals, Reynolds (1945) holds that this is most likely due to the fact that relatively massed conditions were used during original conditioning. Reynolds, in an experiment where the response used was eyelid closure, the conditioned stimulus was a click and the unconditioned stimulus a puff of air directed against the cornea, discovered that when distributed trials were used during conditioning, extinction occurred more rapidly under massed conditions than under spaced conditions. On the other hand when conditioning occurred by massed practice no significant difference in extinction rate was observed when the results under massed and distributed conditions were compared.

Adding further support to the previous contention of Pavlov's that massed trials lead to quicker extinction than spaced trials, Rohrer (1947), using as subjects albino rats, found that the rate of experimental extinction of an instrumental conditioned response was more rapid under massed conditions than under distributed conditions. However, he observed no significant difference in extinction rate under the above conditions when the subjects had only a small number (ten) of original reinforcements. This seems to imply that a habit must be at a certain minimal strength before massed conditions prove superior to distributed conditions in achieving a more rapid rate of extinction.

On the other hand Sheffield (1950), using as subjects rats which were trained to run down an alley in search of food, found that when distributed non-reinforced trials were used extinction occurred significantly more quickly than under massed extinction trials. The faster extinction under distributed extinction trials occurred only for the group which underwent training with massed trials. However, for the group conditioned under spaced trials, there was a tendency for spaced extinction to be faster but this tendency was not significant. The results of this experiment, although contradictory to that of Rohrer's (1947) and Reynolds' (1945), seem to suggest as Reynolds' did that rate of extinction has some relationship to the length of the intertrial interval used in original conditioning and whether a similar or different intertrial interval is used during extinction. Greater resistance to extinction tends to occur when the same intertrial interval is used in both original learning and the extinction process.

In an effort to shed further light on this topic, Teichner (1952) performed an experiment attempting to find out first, whether rate of extinction is a function of the time period utilized between trials during the extinction procedure, and secondly, to discover whether extinction rate has some relationship to the time interval inserted between the trials during original learning. He used male hooded rats in an instrumental learning situation. His experimental results suggest that the longer the intertrial interval the more quickly the response is strengthened; secondly, extinction resistance, when other things are held constant, is greater when the intertrial time period is the same during extinction and conditioning than when this interval is dissimilar during the above situations. Lastly, he found that extinction tended to occur more quickly by massing extinction trials than by spacing them.

An additional study in which rats again were used as subjects was performed by Stanley (1952), with the aim of explaining the contradictory experimental results obtained by earlier experiments concerning the relationship of extinction rate and length of intertrial interval. This study attempted to do three things: - first, to obtain evidence on the effect of distributed trials on extinction rate - "a situation where both vigor and correct response measures of extinction are available"; (Stanley, 1952, p.250); secondly, to discover the rate of extinction under distributed conditions using as measures response vigor and correct response, while at the same time removing frustration arising from withholding reward. This, the author attempted to do by reducing the primary drive of hunger through satiating the subjects before the presentation of extinction trials. Finally, an attempt was made to discover "whether a shift from massed training trials to spaced extinction trials, and vice versa, produced any generalization decrement" (Stanley, 1952, p.250). The results were as follows: - the running time of the massed-massed group was significantly faster than the massed-spaced group, but there was no significant difference in running time between the spaced-spaced group and spaced-massed group. Using "correct runs" as a measure, there was a significant difference between the spaced-spaced and the spaced-massed group in favor of the former but no significant difference was obtained between the massed-spaced group and the massed-massed group. Concerning the above results Stanley (1952, p.257) states:

the running time data (frustration extinction) confirm

> Sheffield's (1950) finding that massed extinction trials produce less decrement than spaced extinction trials in terms of a vigor measure of performance. However, the equally significant difference in the opposite direction with correct runs as the measure, indicates that the generality of the Sheffield finding is limited (a) to extinction in a restrictive situation (i.e., a straight alley situation), and (b) to a relatively nonspecific, and presumably a drive, measure of performance in the less restrictive situation (i.e., vigor of running to either goal box in a T-maze).

In regards to that part of the experiment where extinction occurred when the primary hunger drive was absent (the presumed non-frustrating extinction), no significant difference in rate of extinction was obtained between the massed and spaced extinction trial conditions. The author notes that this is not consistent with what might be predicted from Pavlov's internal inhibition theory and Hull's reactive inhibition theory. In summary he states (Stanley, 1952, p.259):

> these data and the over-all pattern of massed-spaced differences broken down according to distribution of acquisition trials conform to expectations based on the factor of frustration-produced drive and the factor of generalization decrement due to shifting from one inter-trial interval during acquisition to another during extinction. In this respect the data are comparable, in general, to previous findings, but not in line with conclusions from extinction theories which assume that response decrement during extinction is a direct function of internal or response-produced inhibition (or fatigue) which dissipates with time.

Speaking about the concept of generalization decrement, Hilgard and Marquis (1961, p.293) state:

> All extinction procedures involve changes in the experimental situation in that the proprioceptive consequences of reinforcement, and eventually responding, are eliminated. If the conditioned response is at all under the control of these stimuli, it should lose strength as a result of such changes, and extinction should be hastened to a degree which depends upon the magnitude of these differences in stimulation between conditioning and

> extinction. The generalization-decrement hypothesis stresses this interpretation.

The above authors again state (1961, p.294):

> The generalization-decrement hypothesis together with the concept of response-produced stimuli, suggests a more detailed analysis of the effect upon extinction of the distribution of extinction trials. . . . Changing the degree of distribution for extinction, or for further practice, would lead to a change in the level of response-produced stimulation and, therefore, to a loss of response strength through generalization-decrement.

Summary

The most common result appears to be for massed practice to produce less resistance to extinction. However, as suggested by the experiments of Reynolds (1945), Rohrer (1947), Sheffield (1950), Teichner (1952) and Stanley (1952), an important factor which plays a part in whether massed trials lead to faster extinction is what trial intervals were used in the previous conditioning trials. These experiments indicated that an increase in extinction resistance tends to take place when the same time interval is used during extinction trials as during conditioning, and any changes made in the experimental arrangement, such as different trial interval length, from the conditioning situation to the extinction situation will tend to lead to faster extinction. The generalization-decrement hypothesis suggests that the above tendency is due to stimuli changes which lessen generalization from the conditioning process to the extinction process.

Verbal Learning and Practice Conditions

A number of studies dealing with verbal learning, especially those experiments using nonsense syllable material, will be presented as further evidence of the applicability and generality of the previously outlined inhibition theory and to show that verbal learning is also differentially affected by massed and distributed practice. Osgood (1953, p.508), in his review of the literature on massed and distributed practice, states:

> One might expect that relatively homogeneous tasks (composed of similar part activities) would benefit more from distributed practice. Garrett (1940) presents data remotely relevant to this hypothesis: he found that simple repetitious tasks, like code-learning, benefited more from distribution of trials than did complex, difficult tasks, such as learning an artificial language. If we may consider relatively meaningless materials like nonsense syllables and three-place digits to be more homogeneous (i.e. less well differentiated) than meaningful and logically related materials like prose and poetry, then a number of additional studies would testify to the importance of this variable. Lyon (1914), for example found the learning of nonsense syllables and digits to be facilitated by distribution of practice, but the learning of prose and poetry was not.

Woodworth and Schlosberg's (1954) review is generally in agreement with Osgood's in regards to nonsense syllables but disagrees in regards to prose. The above authors (1954, p.790) state that "an interval of a day or longer has been found superior to massed trials in memorizing a list of nonsense syllables or of numbers (Ebbinghaus, 1885; Pieron, 1913; Perkins, 1914) or in learning the substance of a prose passage

(English, Welborn, & Killian, 1934)."

As mentioned earlier in the paper massed practice supposedly produces negative drive, i.e. D- (inhibition) which is not given time to dissipate, thus having a negative effect on performance. On the other hand, distributed practice allows D- to dissipate during the rest intervals thus leading to superior performance. If a rest pause is introduced after the period of massed practice, this should enable D- to dissipate, while leaving $_sH_r$ unaffected; performance after the rest pause should therefore now be superior to performance before the rest pause. The amount of increase in performance (reminiscence) would be a direct measure of the negative drive generated during the massed practice. In the case of learning nonsense syllables very little, if any, reminiscence occurs with distributed practice and with the passage of time some of the difference induced by massed and distributed practice disappears, i.e. the massed practice group performs more like the distributed practice group. Turning now to verbal learning experiments where nonsense syllables are the stimuli presented for learning, a fair amount of evidence can be found which tends to support the inhibition theory discussed earlier. For instance, Hovland (1936b) studied the reminiscence phenomenon by requiring thirty-two subjects to learn twelve nonsense syllables per day for 16 days by the anticipation method. The presentation rate was one nonsense syllable every two seconds. In order to control for rehearsal, the subjects were given colors to name between each distributed practice trial and for a two-minute interval of time after learning. It was found that more material was remembered, and relearning required a smaller number of trials in the group that had a two-minute time period inserted between learning and testing, as compared to the group which was tested for retention immediately after learning. The group which learned by massed practice showed a significantly greater improvement in both recall scores and number of trials to relearn after the two-minute rest period, than did the distributed practice group. This greater improvement of the massed practice group suggests that during the two minute rest period the greater amount of inhibition built up under massed practice was allowed to dissipate. By increasing the interval between each syllable presentation from two seconds to four seconds, it was demonstrated that the difficulty curve became significantly smaller and no reminiscence was obtained for massed or distributed practice. Hovland suggests that a likely explanation would be that some inhibition has dissipated under the above condition.

In another experiment by Hovland (1938a), reminiscence was found to be significantly greater when a rest pause of two minutes followed learning of a nonsense syllable list by massed practice, as compared to the reminiscence obtained when testing was done by recall and relearning immediately after original learning. It was also discovered that it took significantly less trials to learn the list of syllables by distributed practice and no reminiscence was obtained under the above practice condition when testing for recall was done following the rest period, as compared to a small degree of reminiscence (small when compared to the amount obtained under massed practice) obtained when recall was immediate. These results are presented by Hovland in support of an inhibitory explanation of the reminiscence found in rote learning experiments under massed practice conditions.

Again Hovland (1938b), compared the effect on reminiscence by presenting syllables at two rates of speed (two-second and four-second rate) by the anticipation method. It took significantly less trials to learn to criterion with the four-second rate than the two-second rate. When a rest pause was introduced after learning at the two-second rate, a significant amount of reminiscence as measured by recall and relearning was observed. However, reminiscence with the four-second rate of presentation was found to be significantly lower, implying that there was less inhibition accumulated under the slower presentation of stimuli.

In another experiment, Hovland (1938c) found that massed practice under a four-second presentation rate required less trials to learn to criterion than a two-second presentation rate. Again distributed practice led to a reduction in the mean number of learning trials at the two-second presentation rate, but with the four-second presentation rate distribution was much less effective. The results of this experiment are consistent with the inhibition explanation presented by the author in the previously mentioned studies. In still another study of distributed and massed practice, Hovland (1940b) used three different lengths of nonsense syllable lists and had his subjects (32 college students) learn to a criterion of one perfect run through each list by massed and distributed practice. The results showed that with all list lengths distributed practice led to faster learning than massed practice, and as the length of the list became longer the number of trials to reach the criterion level by distributed practice became progressively less when compared to the number of trials required under massed practice.

In his earlier study Hovland (1938a) relates these results to the concept of inhibition.

These experiments were designed to test a number of postulates contained in a theory developed by Hull, Hovland and others (1940). Many of these postulates pertain to an inhibition construct. Referring to this construct Hovland (1938a, p.204) states: "The exact nature of this inhibition is still undetermined, but as a part of a conceptual system it is a useful construct." A quotation from Underwood's (1952, p.85) investigation gives further information about the above theory and the form of inhibition with which it is concerned. He states: "The portion of theory which deals with the present problem postulates a form of inhibition which generates during learning and dissipates with rest. (In its essential properties this inhibition is very comparable to that called reactive inhibition)."

A great deal of rather technical experimentation has been done by Underwood and his associates on the relationship between distribution of practice and various conditions prevailing in rote verbal learning. Underwood found that distributed practice facilitates the learning of serial lists of nonsense syllables under certain conditions. For instance, it was discovered (Underwood, 1952a) that with nonsense syllable lists of low intra-list similarity distributed practice (a 30 second and a 60 second rest interval between trials) led to more rapid learning of the above lists than massed practice. In addition, Underwood (1952b) demonstrated that serial nonsense syllable lists of three different degrees of intralist similarity were learned faster by distributed practice (30 second and 60 second rest intervals) than by massed practice (two second rest interval), and as intralist similarity increased the number of trials to learn increased. However, even though learning difficulty increased as a function of intralist similarity there was no corresponding increase in the facilitation in learning resulting from distributed practice as compared to massed practice. Distributed practice again led to faster learning than massed practice in Underwood's (1953) study, and there was no difference in the rate of learning between the 60 and 120 second intertrial intervals.

In Underwood and Richardson's (1955, p.44) paper these authors state:

> when interlist interference is low, the length of intertrial interval beyond a certain minimum (possible 60 seconds) is not an important variable in either acquisition or retention. While this fact is fairly clear from previous work (as noted earlier), we ran a special group of 14 Ss under the conditions of the present experiment but giving a two-minute intertrial interval on the first list. The retention scores for this group were no higher than for the group having the 30-second interval. We have also noted that when interlist interference is low, slow Ss tend to recall better following massed practice than following distributed practice, whereas fast Ss are likely to show little difference. We believe, therefore, that some type of inhibition theory may adequately handle the facts when interlist interference is low. This inhibition would need to develop during learning and dissipate very rapidly with rest. Under massed practice the inhibition has little opportunity to dissipate, hence performance is depressed. Over a retention interval, however, the inhibition dissipates leaving the massed list apparently stronger than the list learned by distribution to the same criterion. Obviously, in one form or another, such an inhibition theory as suggested in its general form here has been proposed by many previous writers to account for certain phenomena both in motor and verbal learning as well as in conditioning. In any event, it does seem to handle adequately the general facts of massing and distribution when interlist interference is low.

Underwood (1957) did a study to test further, the adequacy of an inhibition theory in explaining the phenomena obtained when massed and distributed practice are used in learning serial nonsense syllable lists. The author found that distributed practice aids in the serial learning of lists of nonsense and consonant lists, and when interference between lists is relatively low, massed practice is followed by superior retention than distributed practice when retention is tested after 24 hours (Underwood, 1952b, 1953; Underwood & Richardson, 1955). Previous to the introduction of the 24 hour interval both the massed and distributed groups had reached the same criterion level of performance. This similarity of criterion level is necessary so that the subjects are exposed to the stimuli the same length of time (equal number of trials). This equal time exposure allows for a higher degree of certitude in concluding that retention for the nonsense lists learned by massed practice is superior to the retention of lists learned by distributed practice. So far these facts support an inhibition theory. Seeking further evidence on the adequacy of an inhibition construct, Underwood (1957) investigated the phenomenon of reminiscence in similar experimental situations which gave rise to the above mentioned experimental facts. There was no indication of reminiscence in a situation where learning is facilitated by distributed practice, and massed practice results in superior retention over distributed practice when interlist interference is low. Underwood suggests that this lack of reminiscence places limits on the adequacy of an inhibition theory.

In conclusion, Underwood (1957, p.143) states:

> The main point to be made by the present study is that it does not now seem justifiable to postulate a rapidly dissipating inhibition which depresses performance and

> does not influence associative strength. It should be remembered also that when interlist interference is high, retention is better following distributed practice than following massed; this strongly suggests that other mechanisms will have to be considered in any complete explanatory system.

A brief look at some of the additional mechanisms suggested by Underwood will now be presented. He takes the view that it is beneficial that verbal learning be looked upon as being divisable into two stages (a) the response learning stage and (b) the associative stage. The first stage is when the responses are learned as separate entities, i.e. as responses; this must take place first before each response can be connected to its appropriate stimulus (the associative stage) (Underwood and Schulz, 1960).

The relationship of the above two stages of verbal learning to distributed practice is as follows. It was observed by Underwood and Schulz (1961a), using paired associate lists made up of nonsense syllables and adjectives, that when interference was developed in responses over several paired associate lists, learning was superior by spaced practice. On the other hand, when interference among responses was slight but pronounced among the stimuli, then spaced practice not only did not aid learning but hindered it. In short, when there is interference during the response learning stage of verbal learning distributed practice has a facilitating effect. Underwood and Schulz (1961b) in another experiment used lists of 16 pairs of words and changed the interference within the lists by modifying the stimulus-response associations of clusters of words representing the same category. For example, under the category disease the words - measles, mumps, polio and cancer were used. The various clusters of words from each category were varied from list to list. For instance in list one, the words used were all from different categories, while in list four, there were four clusters of words on both stimulus and response side and all the words of each cluster on the response side were paired with all the words of a particular cluster on the stimulus side. For example, diseases were paired with men's first names. The authors discovered that spaced practice had no beneficial effect even though the speed of learning differed as a result of the different degrees of interference from list to list. Response integration was not a problem in this experiment as the responses were common words, rather the interference occurred in the associative stage of verbal learning, i.e. in the connecting of familiar words to the specific stimuli. These experiments led Underwood to conclude that distributed practice facilitates verbal learning only when interference occurs in the response integration phase of learning.

In addition, Underwood (1961) concluded that it is not important what the origin of response interference is as long as it reaches a certain crucial level. In regards to the above conclusions, Underwood (1961, p. 232) states:

> Certain implications for analysis follow from this state of affairs. In serial learning the functional stimulus for any given item in the list is essentially unknown. It may be serial position, the immediately preceding item, several preceding items, or some complex of all of these. Therefore, serial learning is not a task providing sufficient isolation between stimulus and response function to produce critical theoretical decisions. This does not mean, of course, that serial learning will not respond to distributed practice. Indeed, it has been found generally "easier" to get positive effects of distributed practice for serial than for paired-associate lists, probably because of differences in rate of presentation usually employed (Hovland, 1949).

Speaking again with respect to the part played by interference in governing how distributed practice facilitates the acquisition of verbal lists, Underwood (1961, p.245) states:

> At the present time the minimal amount of initial interference necessary before a distribution interval of any length will facilitate acquisition cannot be independently specified. The same is true with maximal amount of initial interference.

Summary

It appears to be experimentally well established that, for the great majority of experiments, verbal learning is facilitated by distributed practice and the reminiscence phenomenon, when obtained, usually occurs under massed practice conditions. The above observations have been accounted for by the concept of inhibition, although Underwood offers and prefers an interference interpretation for the differential effects of massed and distributed practice. A summary of the experimental facts established by the previously reviewed verbal learning experiments is as follows:

1. Distributed practice becomes increasingly facilitating as the length of nonsense syllable list increases.
2. Distributed practice leads to faster learning than massed practice with nonsense syllable lists of low intra-list similarity, but the facilitative effect of distributed practice does not increase with increase of intra-list similarity, although the number of trials required to learn the list increases.
3. When interference between nonsense syllable lists is low, testing for retention after 24 hours shows retention to be superior after massed

practice, and a between trial interval greater than possibly 60 seconds is not a significant variable for retention or learning.

4. On the other hand, when interlist interference is high, retention is superior following distributed practice.

5. Verbal learning may be categorised into a response-learning phase and an associative phase, and when interference occurs during the former phase distributed practice gives rise to superior results. Because of the difficulty in isolating or establishing the actual stimulus in serial learning it is necessarily difficult to distinguish between the stimulus and response process. The above difficulty found with serial learning makes it more rewarding to work with paired-associate tasks in studying the differential effects of distributed and massed practice. This is due to the relative ease of isolating the stage of interference with paired-associate learning. Underwood (1961) suggests that paired-associate learning be used in studying the differential effects of massed and distributed practice, if his inference is correct that facilitation by distributed practice is due to interference occurring in the response-learning stage of verbal learning.

Conditions of Practice Effecting Learning and/or Performance

It is an extremely difficult problem to separate out learning and performance. So called learning curves are actually curves of performance. Learning is inferred from performance. Difficulty in distinguishing whether learning or performance is affected by certain variables is illustrated by the studies of Crespi (1942) and Zeaman(1949). These authors tried to distinguish between the effects of quantity of reinforcement on learning from the effects on performance. It was shown that the amount of incentive has no effect on the time it takes for the subjects to approach their final performance level, but that it does affect the final level obtained. Because performance was found to be at a higher level with a greater amount of reinforcement this seemed to imply that learning was superior. However, when the amount of incentive was switched between the two experimental groups it was observed that performance of the groups shifted almost immediately, i.e. performance immediately shifted upwards with increased incentive and downward when incentive was decreased. If the change, corresponding to the change in incentive, had been in learning one would have expected a more gradual shift in performance. In addition, the fact that there was a reversal in performance level with change in incentive seems to imply that there was a change in motivation rather than in learning.

As mentioned or implied many times in the earlier sections of this study responding tends to build up a state of inhibition which suppresses performance or learning. In regards to massed and distributed practice the fact that it generally takes less trials to reach a given criterion by distributed than by massed practice seems to imply that learning is better by distributed practice. However, the observed gain in performance during rest periods, on motor, perceptual-motor and verbal tasks and the reminiscence effect suggest that it is performance rather than learning which is being inhibited by massed practice.

Concerning this distinction between performance and learning Hilgard and Marquis (1961, p.125) have this to say:

> The typical effect of the crowding of practice trials in time (massed practice) is to diminish performance to a degree which depends upon the degree of massing (Calvin, 1939; Reynolds, 1945; Vandermeer and Amsel, 1952; Spence and Norris, 1950). . . . Theoretically this diminution has been attributed by the Pavlovians to inhibition with reinforcement, by Razran (e.g., 1930, 1955c) to over-reinforcement, and by Hovland (1936) to inhibition of reinforcement. The evidence that what is involved is a performance factor comes from a variety of demonstrations that the effect of massed practice is temporary and that the decremental process dissipates spontaneously with rest. Reminiscence in verbal and motor learning and spontaneous recovery following extinction have both been interpreted in this way. In conditioning experiments similar evidence sometimes is obtained in a distortion of the form of the extinction curve. These functions tend to be decelerated, response reduction being rapid at first and then gradually tapering off as the base line is approached. Following massed practice, however, extinction curves occasionally show an initial rise, as if they had previously been depressed by some inhibitory mechanism.

Hilgard and Marquis then refer to an experiment of Hovland (1936) as an example of the above phenomena. This experiment of Hovland has been reported earlier in this study (p.19-20).

Woodworth and Schlosberg (1954) come to a slightly different conclusion. These authors (p.793) state:

> The logical conclusion from the various tests of learning

> in massed and spaced trials seems to be as follows. The inhibitions that accumulate in massed trials depress performance and give an exaggerated impression of poor learning. But spacing possesses a positive advantage over and above its relative freedom from the I factor.

Some of the experimental evidence used by the above authors in coming to this conclusion are as follows. In an experiment by Kimble and Shatel (1952) in which subjects performed under massed and spaced practice on a pursuit rotor with equal time given to two groups to practise, it was discovered that the massed practice group fell behind the spaced group while working on the task each day. However at the beginning of each day the massed practice group came closer to the spaced practice group in performance. The first and second trial of each day's work showed the greatest improvement. Even though the massed group improved considerably it still remained behind the spaced group which suggests there is not only some decrement in performance but also some impairment in learning. An experiment by Adams (1952), also using the pursuit rotor, showed somewhat similar results. Woodworth and Schlosberg mention an experiment by Epstein (1949) on a code learning task where retention was tested two weeks after task performance had been completed. The results showed that the massed group had improved but still remained inferior to the distributed group, again suggesting that learning was slightly superior with spaced practice. In another experiment by Norris (1953), where a rest interval was inserted at any stage during an uninterrupted 30 minute period of work pursuing a target, it was found that the group receiving this rest showed immediate improvement over the non rest group. This superiority of the group receiving the single rest period was not as great at the completion of the 30 minute work period but a marked advantage still remained. This was interpreted by Woodworth and Schlosberg as superior ability in overcoming the task because of the inserted rest interval. Finally the above authors state (Woodworth & Schlosberg, 1954, p.792-793):

> When the learning is carried to a criterion, such as one perfect recitation of a list of 12 nonsense syllables, a larger number of trials is needed if they are closely massed than if 2-minute pauses intervene between successive trials. From this fact alone we cannot infer that the massed learning has been slower than the spaced; the massed learners may have had to master the list more thoroughly in order to recite it while carrying the load of accumulated inhibition. If so, as pointed out by Hovland (1940a), a retention test 24 hours later, when the I has dissipated, should give a higher recall score for the massed group. But the opposite was the case; the spaced group gave the higher retention score. By this test, then, less is actually learned in a massed trial than in one preceded by a short rest.

On the other hand, in some experiments where the effects of massed and distributed practice have been studied, it has been observed that the difference between massed and distributed practice has completely disappeared. For instance, Kimble's (1950) subjects performed on a psychomotor task by massed and distributed practice. Significant differences occurred between the two practice groups but after a six-minute rest interval the massed practice group performed as well as the distributed practice group.

It will be recalled (p.34-35 of this study) that Underwood (1957) was unable to find reminiscence in an experiment where distributed practice aided learning, and retention after 24 hours was better with massed practice. His concluding remarks were (1957, p.143):

> The main point to be made by the present study is that

> it does not now seem justifiable to postulate a rapidly dissipating inhibition which depresses performance and does not influence <u>associative strength</u>. It should be remembered also that when interlist interference is high, retention is better following distributed practice than following massed;

Concerning reminiscence, Osgood (1953, p.511) states: "reminiscence is by no means a dependable phenomenon. Although some studies obtain it in significant quantities, others which apparently fit the necessary design do not (e.g. Shipley, 1939; Melton and Stone, 1942)." In explaining why Hovland (1940a) found better retention with distributed practice and Underwood and Richardson (1955) found better retention following massed practice, Underwood and Richardson (1955) mention that Hovland's findings were due to the great amount of interlist interference resulting from the relatively large number of nonsense syllable lists learned by his subjects. They conclude by saying "Our previous studies, as well as the present data, indicate that massing produces superior retention when interlist interference is low." (Underwood & Richardson, 1955, p.45).

<u>Summary</u>

From the various points of view outlined and the experimental evidence described, it would appear that generally there are two effects of massed practice, a temporary impairment which dissipates with rest and a smaller impairment which tends to remain even after an interval of time has been inserted before task performance is again tested. Furthermore, it would seem logical to conclude that if massed practice produces a highly significant impairment in performance, then this impaired performance would tend to interfere with learning to some slight degree. In conclusion then, until a clearer picture is forthcoming from further experiments, the safest view to hold is that massed practice generally tends to inhibit performance of a task while at the same time slightly impairing learning. Due to the rest intervals supplied by distributed practice, both the performance (especially) and learning (to a slight degree) of a task tend to be facilitated.

Inhibition and External Stimuli

Turning to the present study it is expected that some form of inhibition or negative drive (fatigue or boredom) will arise as a result of subjects being exposed to homogeneous (monotonous) stimulation (nonsense syllables) over and over again. However, it is also expected that the relatively varied incidental stimuli or novel stimuli (geometrical figures) will have the effect of dissipating the above inhibition when the subjects turn their attention consciously or unconsciously away from the nonsense syllables towards the geometrical figures. This will be the situation expected especially during the involuntary rest pauses (I.R.P.) which Eysenck hypothesizes occurs when negative drive (D-) equals positive drive (D+). The dissipation of negative drive (fatigue or boredom, i.e. some form of central inhibition) will be the reinforcement experienced when the subject turns towards the incidental stimuli. Because of this experienced reinforcement (at whatever level) the subject will tend to once again turn towards the incidental stimuli as negative drive begins to increase again. Some evidence will now be presented which tends to support the expectation that novel or external stimuli when impinging on an organism can have the effect of dissipating inhibition.

Pavlov (1927) observed that a reflex which was undergoing extinction would every now and again recover some of its earlier strength. He believed that this increase in reflex intensity was due to certain stimuli being accidentally or deliberately introduced into the experimental situation. Concerning the above phenomenon Pavlov (1927, p.61) states:

> I shall describe first of all an observation which for a long time we were at a loss to interpret. A natural conditioned reflex to meat powder, which, as we know from control experiments, after extinction recovers its initial value spontaneously in something between a half and one hour, is again extinguished to zero. This time, however, instead of waiting for the spontaneous recovery of the reflex a weak solution of acid is immediately introduced into the dog's mouth, and after the termination of the secretion produced by the acid (about five minutes) meat powder is again presented at a short distance. This time although nothing like half an hour has elapsed the conditioned alimentary reflex is found to be almost completely restored . . . We can designate this observation from a purely matter of fact point of view as consisting of a sudden removal by an extraneous reflex of the inhibitory process set up by experimental extinction.

Another experiment which demonstrates the dissipation of inhibition by presenting extra or novel stimuli is mentioned by Pavlov. In this experiment the salivary response is extinguished in a dog by presenting meat powder at a distance without the primary reinforcement of placing it in the dog's mouth. Shortly after (2 to 3 seconds) saliva production has dropped to zero at the sight of the meat powder. Pavlov then comes into the experimental room, stays for two minutes during which time he speaks. The meat powder is presented once again at exactly three minutes from the time Pavlov came into the room. It is noted that the saliva reflex is elicited this time at an intensity half its original strength.

Pavlov also has demonstrated that the application of extra stimuli has the effect of restoring immediately the positive conditioned response, which was under conditioned inhibition (in the Pavlovian sense), almost to its normal strength. Conditioned inhibition is defined as the

> suppression of the conditioned response when the conditioned stimulus is repeatedly paired with an indifferent or neutral stimulus and the unconditioned stimulus (reinforcement) is not given. The indifferent stimulus becomes the suppressor or inhibitor. The phenomenon is not that of simple extinction, for the conditioned stimulus, when not paired with the inhibiting stimulus or suppressor, elicits the conditioned response. (English & English, 1958, p.106).

Pavlov (1927) refers to three experiments of Doctor Nikolaev (1910) to illustrate the above inhibition of conditioned inhibition by means of presenting extra stimuli. Without going into the experiments in detail they can be summarized as follows. A dog was used as the subject and the conditioned alimentary reflex was salivation measured in number of drops per minute. The eliciting conditioned stimulus of the conditioned alimentary response was a rotating object and the conditioned inhibitor was a specific tone. The various extra stimuli were tactile, thermal, and the noise of a metronome.

The results of these experiments demonstrated that the conditioned inhibition of the conditioned reflex was weakened when any one of the external stimuli impinged on the organism, i.e., the eliciting capacity of the rotating object was freed to a certain extent from the inhibiting effect of the inhibiting stimulus (tone). This freeing of the conditioned stimulus (rotating object) to elicit the conditioned response was indicated by the presence of drops of salivary secretion.

Pavlov also observed that extra stimuli, when presented during the occurrence of a type of inhibition called inhibition of delay, dissipates this inhibition thus releasing the conditioned reflex. The above type of inhibition refers to the blocking of the conditioned reflex due to increasing the interval between the beginning of the conditioned stimulus and the presentation of the unconditioned stimulus or reinforcement. This reflex delay is proportional to the length of the interval between the two stimuli. Now if some external or novel stimulus which has never been associated with the particular response in question is introduced during the inhibition period of the delayed response it will be noticed that the conditioned reflex is immediately elicited.

The following is an outline of the type of experiments done by Doctor Zavadsky (1908) in regards to the above. The conditioned stimulus is tactile stimulation and the presentation of acid is the unconditioned stimulus. The conditioned stimulus is presented for a three minute period and overlaps the presentation of the reinforcing stimulus. The novel stimulus which of itself has never been associated with the conditioned reflex is the noise of a metronome. The sound of the metronome proved to be unable to elicit any salivating reflex. It was found that the tactile stimulus, i.e. the conditioned stimulus had no eliciting effect when presented alone during 1-1½ minutes; in short, the delayed reflex had been established. Now, on the next trial, when the neutral stimulus (sound of metronome) was presented during the inactivity period (inhibition period) the original secretory reflex immediately appeared. This experiment is another example of the fact that novel stimuli, when permitted to impinge upon an organism, inhibit an already existing inhibition.

A still further example of this dissipation of inhibition by the presentation of external stimuli has to do with what Pavlov referred to as differential inhibition. This form of inhibition refers to the inability of eliciting a conditioned reflex on presentation of stimuli which are rather similar to the original conditioned stimulus. It can be considered to be the opposite of stimulus generalization which refers to the fact that a conditioned response will be elicited by stimuli which are perceptually similar to a conditioned stimulus which already has the capacity to elicit the conditioned response. Now differential inhibition is obtained by continuously following the conditioned stimulus by the unconditioned stimulus but never following another perceptually similar stimulus by the unconditioned stimulus. Eventually the organism will respond only to the conditioned stimulus but not to the other similar stimulus. In short discrimination has taken place. This differentiation between somewhat similar stimuli is referred to by Pavlov as differential inhibition.

Like the other forms of inhibition already mentioned differential inhibition can undergo the process of disinhibition through the introduction of external stimuli. An experiment by Doctor Beliakov (1911) carried out on a dog is offered as an illustration of the aoove. The conditioned alimentary stimulus in this experiment was a tone of 800 cycles and a tone of 812 cycles was the differentiated or inhibited stimulus. The external stimuli, which on their own were not able to elicit the conditioned secretory reflex, were bubbling water and an odour of amyl acetate.

After the process of differential inhibition had been established to the tone of 812 cycles the following experimental events were observed. At 12:30 p.m. a tone of 800 cycles (the conditioned alimentary stimulus) was presented and 3.5 drops of salivary secretion was elicited within a 30 second limit which in turn was followed by reinforcement. At 1:00

p.m. a tone of 812 cycles (the differentiated stimulus) was presented and no drops of salivary secretion appeared in a 30 second limit. No reinforcement followed in this case. Again the 800 cycles tone was presented (at 1:20 p.m.) resulting in three drops of salivary secretion within 30 seconds. Reinforcement was again presented. Now at 1:35 the differentiated stimulus of 812 cycles was presented along with the odour of amyl acetate. This combination resulted in two drops of salivary secretion being elicited within the 30 second period. Again no reinforcement was delivered. This experiment demonstrates again the process of disinhibition by means of an extra stimulus.

Furthermore, Prechtl (1953) in studying the mouth opening response of young birds when the mother brings food to the nest, noted that inhibition built up through continuous elicitations of the above response by the food stimulus (seed) is dissipated by the presentation of novel stimuli (shaking of the nest or imitated call of the parents). This last example of inhibition seems to the writer to be an example of what Pavlov refers to as inhibition with reinforcement. Pavlov observed that after a high number of repetitions with reinforcement the conditioned reflex very slowly passed into a state of inhibition (no longer occurred).

<u>Summary</u>

The conclusion to be drawn from the studies outlined appears to be that external or novel stimuli can on application dissipate inhibition built up in an organism. In the previously described experiments the types of inhibition which were dissipated by external stimuli are classified by Pavlov as inhibition arising from experimental extinction, conditioned inhibition, inhibition of delay, differential inhibition, and inhibition with reinforcement. The above are different manifestations of what Pavlov refers to as internal inhibition whereby the conditioned response becomes gradually inhibited under certain conditions (explained previously).

Incidental Learning Research

Inasmuch as incidental learning is an important variable in this study, it will now be discussed in relation to other variables which have bearing on the present work. First of all, does incidental learning actually take place? Inasmuch as the subjects of the present study will not be given instructions to learn the irrelevant stimuli (geometrical figures), Jenkins' (1933) study lends support to the assumption that incidental learning will take place. In other words there is such a phenomenon as incidental learning (learning stimuli in an experiment without receiving instructions to do so). Furthermore, from the results of a study by Postman and Senders (1946) concerning instruction clearness and its relationship to incidental learning, it was decided that instruction clearness results in a clear learning set and even if instructions are lacking subjects can form a latent set to learn. A study by Winnick and Wasserman (1959) tended to support Postman and Sender's conclusions. Finally an experiment by Essman (1959) showed that awareness is not necessary for learning to take place for both verbal and perceptual stimuli.

Thistlethwaite (1951) did an extensive review of latent learning and irrelevant-incentive learning experiments and concluded that a number of studies demonstrated that the above types of learning took place in the absence of reinforcement. This type of learning where the subjects were animals is somewhat analogous to the incidental learning of human subjects. In both cases the incentive for learning is not specified at the beginning of learning and both types of learning manifest themselves only on the introduction of some form of incentive reward when the subjects are later being tested for such learning.

It has been suggested several times earlier in the paper that negative drive (inhibition) tends to increase when an organism is exposed to familiar, rather monotonous stimuli over a period of time and as a result the organism will tend to seek out novel stimuli. Perhaps indirect support of the above are experiments with incidental learning which demonstrated that as drive (elicited by anxiety and incentive) increases direct learning tends to be facilitated or remain constant while incidental learning is inhibited.

Easterbrook (1959) refers to the sum of all surrounding cues that exist at any particular time, place or state and which an organism is aware of, tends toward or reacts to, as the "range of cue utilization". The use of cue range is considered to have diminished when the use of marginal or borderline cues has been lessened, while at the same time middle or core cues which are highly relevant or significant remain in use. The above change is connected with better central functioning or with continued competence under strain. In regards to the decrease in the range of cue utilization, it is considered to have taken place when the degree of incidental learning has lessened even though direct learning has stayed the same or has been bettered. Referring to a number of studies (Aborn, 1953; Bahrick, 1954; Bruner et al, 1955; Silverman, 1954; Silverman & Blitz, 1956) Easterbrook (1959) observes that the decrease in the range of cue utilization was accompanied by a drive increase. He states (1959, p.184) "When the direction of behavior is constant, increase in drive is associated with a reduction in the range of cue use." The author defines drive as

> a dimension of emotional arousal or general covert excitement, the innate response to a state of biological deprivation or noxious stimulation, which underlies or occurs simultaneously with overt action and effects its strength and course.

The same author holds that often task performance improves when the range of cue utilization is decreased due to nonessential cues being omitted. In regards to the reduction in the range of cue use Kausler and Trapp (1960) suggest that this may aid or hinder the learning of cues relevant to the task, depending however on cue complexity, but as far as peripheral cue learning is concerned, reduction in the range of cue use has a negative influence.

Studies by Bahrick (1954) and by Bahrick, Fitts and Rankin (1952), tend to support Easterbrook's contention that drive increase facilitates direct learning but hinders incidental learning. In addition an experiment done by Kausler, Trapp and Brewer (1959), which is almost a repetition of Bahrick's (1954) study, showed that the direct task was done better by the group under high drive than the group under low drive. This part of the results was in accordance with Bahrick's findings and they both support Easterbrook's generalizations. On the other hand, Kausler et al's (1959) two groups showed no difference in the learning of the incidental task, while Bahrick's high incentive group, in support of Easterbrook's (1959) contention, manifested significantly less incidental learning than the low incentive group. In an attempt to explain the difference between the incidental learning results of Bahrick's

(1954) and Kausler et al's (1959) experiments, the latter authors focus on the different means used by the two studies to increase drive. Bahrick used a positive drive (money) in his experiment while Kausler et al used an emotional drive (anxiety) as measured by the Taylor Manifest Anxiety Scale (M.A.S.) (1953) in one of their experiments and an emotional drive (anxiety) elicited by instructions, which were considered ego involving, in their second experiment. Kausler et al suggest that the form of drive they used tends to a greater degree to be oriented towards the whole experimental situation and less restricted to the central task as compared to the incentive-induced drive used by Bahrick.

Another possible factor influencing the effect of drive on incidental learning is perhaps the type of cues used in the experiment and the placement of the direct or central cues in relation to the irrelevant or incidental cues which are involved in the task presented for learning. Silverman (1954) and Silverman and Blitz (1956) found, while using induced general drive D or intrinsic anxiety as revealed by the Manifest Anxiety Scale (M.A.S.), a decrease in incidental learning. The induced drive or anxiety was produced by the presentation of the threat of electric shock. As mentioned earlier, Kausler et al's (1959) findings were not similar to those found above in regards to incidental learning. An important difference between these two studies was type of cue and cue placement. For instance, in the Kausler et al experiment, the intentional task involved learning a serial list of 14 geometric forms (seven different forms in all) and the incidental cues were seven colors which filled the geometrical forms with each form having associated with it two different colors. This resulted in very close spatial and temporal nearness. In the Silverman (1954) experiment the intentional stimuli were five black lines 0.5 inches in width and varying in height from 2.25 inches to 3.25 inches in steps of .25 inches. These stimuli were presented on a 6 by 8 inch white screen which was at eye level. The incidental stimuli were 20 two-syllable words which were repeated by a female voice. They were presented by turning on a wire recorder. The sound of the words were projected through a muffled 6-inch speaker. The intensity of the word sounds was about as loud as "subdued conversational speech". Sixty seconds after the first line was exposed, the incidental stimuli were introduced and continued up to the last 15 seconds of the experiment. In the Silverman and Blitz (1956) study the incidental cues were two digit numbers which were positioned in a memory drum window six centimeters in distance from the relevant, nonsense syllable cues. Without experimental confirmation it appears to the writer that in the Kausler et al (1959) study the particular cues used and their spatial arrangement would be more facilitating for both direct and incidental learning than the cues and their arrangement used in the Silverman (1954) and the Silverman and Blitz (1956) studies. In short, it appears to the writer that Kausler et al's stimulus situation is a relatively less complex one. Assuming that this contention is valid, it could explain why Kausler et al's high drive subjects showed no impairment in incidental learning when compared to his low drive group, while Silverman's and Silverman and Blitz' high drive groups demonstrated less incidental learning than their low drive subjects. A study by Spielberger, Goodstein and Dahlstrom (1958) lends some support to the above explanation. These authors found that the complexity of the task material requiring learning governs the relationship between the amount of anxiety, as indicated by the Taylor M.A.S. scale (1953), and the amount of incidental learning. Incidental material consisting of relatively non-complex Bender-Gestalt Test designs were exposed. The order of exposure of the designs was easiest designs in the easiest position serially and the hardest designs were presented in the hardest position serially. This presentation from easiest to most difficult was empirically established in an earlier study. The results indicated that the subjects who had high M.A. S. scores demonstrated greater incidental learning with the easy tasks and the low anxiety subjects superior performance with the more difficult tasks.

In an experiment by Aborn (1953) an attempt was made to discover what effect experimentally induced failure has on subjects' memory score who are later tested for retention of stimuli which they had a set to learn and the same stimuli learned incidentally. The set to learn group were those given instructions to memorize the stimuli and the incidental learning group were those given no instructions to memorize the stimuli. Appropriate control groups, where the attempt to induce failure experimentally was omitted, were set up for the set to learn and incidental learning groups. Results indicated that those groups who were given instructions to memorize showed no inhibitory effects due to the ego threat of failure. However, in the incidental learning group (no instructions to memorize) the ego threat of failure led to a significantly smaller memory score than the incidental control group. The removal of threat led to some improvement for the above group.

Continuing along the above theme, Combs and Taylor (1952, p.420) state:

> According to Snygg and Combs, the rationale of the maladjustive state is roughly as follows: The perceptive field of the threatened individual becomes restricted to the area of the threat he perceives. Hence, unable to select his perceptions from a wider field, he behaves compulsively, or repeatedly behaves in a nonadjustive fashion. With his perceptive field narrowed to the field of the threatening object or event, he is unable to select from his perceptive field more adequate behavior. Apparently, the greater the degree of threat to self perceived by the individual, the more pronounced is the restricting effect upon the individual's perceptive field.

The authors consider that the above effect has been strongly supported in regards to traumatic situations but it is not certain whether this effect occurs when the individual experiences slight threats to the organization of self. An experiment was carried out to test the above. It was discovered that when mild, social threats are applied, subjects required a longer time to translate sentences into a simple code and made greater errors in translation.

Summary

The experimental data just reviewed indicate that a phenomenon known as incidental learning actually occurs. Specifically, incidental learning discussed in the previous review refers to the learning of stimuli by subjects who have not been prepared through instruction to do so. In addition, a fair amount of evidence was presented supporting the contention that as drive (anxiety, incentive) increases incidental learning or awareness of or sensitivity to exterioceptive stimuli decreases. Finally, there was some indication suggesting that an important variable influencing the relationship between incidental learning and drive is task complexity. For instance, in one study high anxiety subjects tended to do better on incidental learning with easy tasks while low anxiety subjects performed better with more complex tasks, and as the complexity of the incidental learning task increased, incidental learning decreased for all subjects, observed as a single group.

Reinforcing Effects of Novel Stimuli

Most people have experienced the tendency of seeking out novel stimuli or at least a change in stimuli when they have felt bored or fatigued from performing some monotonous, repetitive task or from being exposed to the same or very similar stimuli for too long a period of time. Perhaps this is how the saying, that "a change is as good as a rest", came about. Some support will now be offered for the expectation of the present study that as negative drive builds up due to increasing reactive inhibition or stimulus satiation, incidental learning increases. This support will come from experiments which suggest that novel stimuli tend to be sought after or are reinforcing under certain situations. Reinforcing stimuli in the above context refer to stimuli which on presentation to an organism increase the probability of the occurrence of a response which the stimuli follow.

Glanzer (1953, p.337) in introducing his experiment states:

> It has been repeatedly demonstrated that rats, when running successive trials in a maze consisting of two equally preferred paths, show a strong tendency to change choice of paths regularly from trial to trial. This phenomenon has been labelled spontaneous alternation.

In explanation of the activity of spontaneous alternation Glanzer (1953, p.338) presents a postulate of stimulus satiation ("boredom-like effect"):

> Each moment an organism perceives a stimulus-object, a quantity of stimulus satiation is developed to it. The effect of this satiation is to reduce the organism's tendency to respond to that stimulus object. The longer the organism perceives the stimulus-object, the greater the amount of satiation developed and, conversely, the

> amount diminishes as a function of increasing time spent away from the stimulus-object.

To discover whether spontaneous alternation is alternation of responses or stimuli, Glanzer exchanged between trials the cues that differentiated two pathways of a two-alternative maze. If it had been responses that were being alternated the subjects would have alternated pathways from trial to trial even though the external stimuli of the pathways had been switched each trial. On the other hand, if the organisms had been alternating stimuli, then they should have continued to choose the same pathway each trial because of the new set of cues associated with the pathway from trial to trial. The results indicated that the subjects (rats) showed a significant tendency to repeat rather than alternate their choice of pathways. In short the rats went where there were new stimuli rather than alternating responses (went right, then left, etc.).

In addition Montgomery (1952), using rats as subjects, ran an experiment to discover whether spontaneous alternation could be interpreted as alternation of responses or places (stimuli). Stimuli in a T-maze were exchanged between trials so that stimuli which were on one side of the subject in one trial would be on the other side on the next trial. This change in stimuli was done by the use of a cross-maze which could be turned into two T-mazes by shutting doors on each side of the choice point and starting the subjects in a counter balanced order from opposite sides of the cross-maze. It was discovered that the subjects alternated places to a significant degree while alternation of turns was at chance level. When stimuli, which corresponded with particular pathways in a two-alternative maze, were switched between trials the subjects tended to travel down the same pathway rather than switch paths.

This experiment again suggests that organisms tend to seek out novel or different stimuli rather than remain with or turn to the same stimuli repeatedly.

In a somewhat similar experiment to the above, using rats as subjects performing in a T-maze, Rothkopf and Zeaman (1952) present results which support both the reactive inhibition and stimulus satiation hypotheses. These authors conclude (1952, p.255):

> 1. Rats undergo adaptation to external cues during exposure. They prefer to respond to stimuli to which they are less adapted. Hence they will alternate "places" in an equal reward T-maze situation.
> 2. Responding leads to a fatigue-like state (Ir). Rats prefer to make less "fatigued" responses. Hence, they will tend to alternate "responses" in an equal reward T-maze situation.
>
> 3. "Response" alternations reduce Ir-drive and cause an improvement of alternation with practice.

Again in a study by Butler (1953) the reinforcing effects of exteroceptive stimulation are demonstrated. Five rhesus monkeys were trained on a color-discrimination problem with the chance of looking through a window for 30 seconds being an incentive. Each subject was placed in a box which had only slight illumination; the box itself had opaque walls. The monkeys were exposed to two cards, each of a different color. If the subject put light pressure on the correct card he was rewarded with the opportunity to explore visually part of the laboratory. The animals were able to learn the correct discriminative response and performed efficiently throughout a number of daily sessions with the only reinforcer being visual exploration. It is suggested by Butler that this motive of visual-exploration is not derived from "other motivational or drive states".

In another experiment by Marx, Henderson, and Roberts (1955) rats were placed in a Skinner box which contained a bar which, when pressed, resulted in a mild illumination for a few seconds. The rate of bar pressing on the test session (bar pressing followed by illumination) was found to be significantly higher than the bar pressing rate on the last pretest session (bar pressing not followed by illumination). The authors attribute this difference to the illumination being positively reinforcing and give the interpretation that "stimulus change or novelty" can act as a positive reinforcer.

A further experiment along the same lines was performed by Myers and Miller (1954) to demonstrate that animals satiated on food and water can learn a new response if this response is followed by an opportunity for exploration or activity. They ran the above experiment hoping to shed light on somewhat unexpected results from a previous experiment. These results were that a group of naive male albino rats which were satiated and thought to be unrewarded and which had no previous training in drive-acquisition learned a new habit of bar pressing as rapidly as other groups which did have training in drive-acquisition before testing. Drive-acquisition refers to the process whereby neutral stimuli have acquired drive value by demonstrating that they will motivate the learning of a new habit. In this experiment the neutral stimuli took on drive value by being associated with hunger drive reduction. This was assumed to have happened when satiated animals demonstrated new learning when all traces of food had been removed from the experimental apparatus.

Referring to the second experiment the animals, while satiated and in the absence of food, were given less taming than in the first experiment. Taming in this experiment refers to the picking up of each animal once a day, one-half hour before the feeding time, from its home cage and placing it in another small cage which contained a small, 3-gr. pellet of wet ground Purina Chow. Once the pellet was eaten the animal was placed again in its home cage. This arrangement was set up to test the possibility that it was the considerable amount of handling, taming and feeding of the group of animals which had no drive-acquisition training that led to their learning. A group of fifty satiated naive male rats after the taming procedure were broken up into five subgroups consisting of 10 animals each and were placed randomly into various experimental situations. The following is a brief description of the experimental arrangements:

(a) One group was placed in a white compartment and had to learn to press a bar to get into the black compartment.

(b) Another group was placed in the black compartment but with the same set up as the above group.

(c) The next group, when they pressed the bar resulting in a door which separated black and white compartments being dropped, were unable to enter or see into the black compartment because of the existence of a white wooden board behind the door.

(d) A fourth group received all their trials (18) in one afternoon (massed practice). The situation in other ways was the same as that for the white to black group.

(e) The last group was organized exactly like the massed group except that their trials were spaced at one each day (distributed practice).

The results showed that satiated and nonrewarded subjects mastered the learning problem of bar pressing to get into either the black or white compartment. However, experimental group (c), which could not attain visual or actual entry into the black compartment as a result of their responding in the white compartment, showed no evidence of learning. The animals in the massed experimental group did not learn either although the spaced group did. The authors (Myers & Miller, 1954, p.433) state that the above results "suggest that the act of seeing or exploring the other compartment, or perhaps experiencing the change between the two compartments (irrespective of the direction of change), produces the reinforcement."

Speaking about the failure of the massed group to learn Myers and Miller (1954, p.434) state:

> Though some inferiority of the massed group would be expected from the principle of reactive inhibition, the magnitude of the difference found in this experiment suggests that other factors may be operating. If learning were motivated by a relatively weak drive of exercise, exploration, or curiosity, it is possible that this motivation might be satiated or extinguished by the massed practice and not have enough chance to recover during the short time between trials. Montgomery and Berlyne have shown that a rat's tendency to investigate a new stimulus object decreases rapidly with continued exposure and shows little recovery during a short interval of non-exposure but considerable recovery during a 24-hour interval. Thus, the satiation of an exploratory drive during massed trials but recovery during spaced ones may account for the difference in the second experiment. If an exploratory tendency can produce learning like other drives such as hunger, and also show a similar pattern of satiation and recovery, these functional parallels to already known drives would help to justify its classification in the same category with them, namely as a drive.

In explanation of the results of their study Myers and Miller (1954, p.434) have this to say:

we believe it is possible that confinement produces anxiety, restraint is frustrating, or monotony arouses a drive of boredom. Indeed, the observation of small children who are required to sit absolutely still, the reports of prisoners subjected to solitary confinement, and the difficulty of Bexton, Heron, and Scott in retaining Ss in their experiment on the effects of decreased sensory variation would indicate that such conditions can produce strong motivation. Therefore, we suggest that drives produced by homogeneous or monotonous stimulation, enforced inaction, etc., may be reduced by sensory variety, freedom of action, etc., and that such drive reduction is the reinforcement involved in learning for "exploratory", "manipulatory", and "exercise" rewards.

Summary

To summarize, the experimental evidence indicated that rats in order to avoid or decrease stimulus satiation tend to go where there are new stimuli and will alternate places to a significantly greater degree than the responses used to get there. In addition it was demonstrated that alternation behavior of rats is motivated by both response-produced inhibition and novelty of external stimuli. Finally evidence was presented which demonstrated that novel stimuli can act as a reinforcer for new learning. The importance of the above experimental facts for the present study is that they offer some support to the assumption that organisms when in a monotonous or familiar, rather restricting environment probably experience some form of negative drive (inhibition) and/or stimulus satiation which tends to be dissipated to some degree by being exposed to novel or different stimuli.

Summary of Research Findings

1. The experimental literature presents evidence that for most psychomotor and verbal learning tasks some distributed practice results in superior performance as compared to performance under massed practice.

2. The phenomenon of reminiscence is observed in both psychomotor and verbal learning tasks under highly massed practice conditions.

3. Less resistance to extinction tends to occur when extinction trials are massed. However, extinction resistance increases when the same trial interval length is used in conditioning and extinction.

4. The effects of massed practice in a great many experiments consist of a temporary performance impairment which dissipates with rest (reminiscence) and a more lasting impairment. This would seem to imply that impaired performance due to massed practice results in a slight learning decrement, as well as a temporary performance decrement.

5. A number of experimenters, in accounting for the superiority of distributed practice over massed practice and the reminiscence phenomenon, postulate some inhibitory process which builds up under massed practice and dissipates with rest.

6. Experimental evidence indicates that novel or external stimuli impinging upon an organism can dissipate existing inhibition.

7. A review of experiments on incidental learning indicates that the learning of stimuli without receiving any instructions to do so does occur. The existence of a negative relationship between amount of

incidental learning and degree of drive (incentive, anxiety) was supported by a number of studies. High anxiety subjects tend to do better on relatively easy incidental learning tasks while more complex tasks are performed better by low anxiety subjects.

3. Rats tend to go where there are novel stimuli and both response-produced inhibition and novel stimuli appear to be the situation which arouses or elicits the motive leading to alternation behavior in rats. In addition, a number of studies suggest that new learning can take place when novel stimuli are offered as reinforcement.

OUTLINE OF THE PROBLEM

The problem of this study is to find out whether subjects that have been instructed to learn stimuli under massed practice conditions will show, when tested, a greater amount of incidental learning (described on page 2) as compared to subjects who have been instructed to learn stimuli under distributed practice conditions.

It is predicted in view of the previously outlined experimental findings that there will be a positive relationship between massed practice and the amount of incidental learning.

The main hypothesis is as follows: Incidental learning (learning of geometrical figures) will be significantly greater statistically while performing a relevant task (learning of nonsense syllables) under conditions of massed practice, than when performing the same task under distributed practice conditions.

The rationale underlying this hypothesis is based on the general findings, as reviewed here, that verbal learning is slower under massed practice as compared to distributed practice conditions. Experimenters have tried to explain this difference in speed of learning by postulating that under massed practice conditions inhibition and stimulus satiation build up more rapidly and dissipate more slowly, thus impairing learning efficiency. In terms of the inhibition theory outlined by Eysenck, described in the Theoretical Background (pages 4-14) of this study, once the inhibition (negative drive) equals positive drive, an involuntary rest pause takes place (the subject ceases responding to the task giving rise to inhibition). The stimulus satiation theory holds that an organism, when exposed to similar (monotonous) stimuli, develops a need for new stimuli and as a consequence seeks them out (supported by experiments on pages 60-66). During the involuntary rest pause it is assumed that the organism will respond, voluntarily or involuntarily to different or novel stimuli. Therefore, it is postulated that during the involuntary rest pause inhibition and stimulus satiation are dissipated, freeing the subject to respond again to the task which it has been motivated to perform. This last postulate receives support from experiments described on pages 45 -50.

The main hypothesis in terms of the just-outlined rationale is therefore based on the following assumptions:

(i) Inhibition and stimulus satiation will accumulate as the subjects attempt to learn nonsense syllables under massed practice.

(ii) When the amount of inhibition reaches a point where it neutralizes positive drive it is expected that a corresponding need for different or novel stimuli will exist.

(iii) The different geometrical figures placed to the right of the nonsense syllables, within visual sensory reception, will supply the stimulus novelty needed which should elicit the subject's response or attention.

(iv) This need for and response to novel stimuli (geometrical figures) will be reflected in the degree to which the geometrical figures are learned (i.e. incidental learning).

A corollary to the main hypothesis is that the need for and response to new stimuli will be greater under massed practice than under distributed practice because inhibition and stimulus satiation are not expected to build up to the same extent because of the greater likelihood that dissipation of the above conditions will take place during the rest intervals inserted between the trials of the distributed practice condition.

It might be suggested that the irrelevant stimuli (geometrical figures) will distract or interfere with the learning of nonsense syllables, thus resulting in impaired performance of this task. First of all, it is assumed that due to the contrast in the nature of the relevant and irrelevant stimuli, and since the subjects have not received any instructions to learn the irrelevant stimuli (Type II Incidental Learning Experiment, Postman, 1964, see pages 2-3), only a small degree of interference or distraction will occur from the geometrical figures in the learning of the main task. This minimum distraction from the irrelevant stimuli is postulated to occur in the following manner. The geometrical figures may act in such a manner as to draw the subject's attention away from the central task from time to time, hence slow down performance on this task, especially under distributed practice. If this distraction were to reach significant proportions it would be reflected in poorer performance on the main task under distributed practice, when the irrelevant stimuli are present, than when these stimuli are absent. Under massed practice, the assumption that the subject's attention would be periodically drawn to the irrelevant stimuli, would be expected to have a positive effect such as dissipating inhibition and/or stimulus satiation resulting in improved performance on the main task. In fact, because of the postulated build up of inhibition and stimulus satiation (a fatigue and boredom like subjective experience) under massed practice, it is expected that the subjects will have a greater need for, or less resistnace to being distracted, or giving their attention to the relatively novel geometrical figures in order to lessen the negative drive built up from responding to the monotonous nonsense syllables, i.e. to dissipate the boredom and/or fatigue like subjective feeling, the subjects will tend to seek out novel or different stimuli thus avoiding the stimuli and performance giving rise to the above subjective feeling(mentioned in the rationale for the main hypothesis). If the above dissipation were to reach significant proportions it would seem logical to expect that it would be reflected in superior performance on the main task, under massed practice, in the presence of the irrelevant stimuli as compared to when these stimuli are absent.

Additional hypotheses formulated from the above discussion on the effects of the geometrical figures acting as a distraction from the learning of nonsense syllables are:

(a) The learning of nonsense syllables will be faster under massed practice when the geometrical figures are <u>present</u> as compared to when these stimuli are <u>absent</u>.

(b) Central task performance will be inferior under distributed practice conditions in the presence of irrelevant stimuli than in their absence.

The independent variables, i.e. those which are manipulated by or are under the control of the experimenter, are: 1) the conditions of practice in learning the nonsense syllables, namely, massed and distributed practice, and 2) the presence or absence of the geometrical figures under the two practice conditions.

The dependent variables are subjects' responses as measured by 1) the number of nonsense syllables learned in a given number of trials, under both conditions of practice, in the presence and absence of the geometrical figures, and 2) the amount of incidental learning as measured by two methods of recall. The measures of recall will consist of (a) "free" recall (Postman, 1964), whereby the subjects will be requested to reproduce by drawing, in any sequence, as many of the geometrical figures as they can remember, and (b) recall of the correct paired associate arrangement of nonsense syllables with geometrical figures as used in the stimuli presentation part of the experiment.

CHAPTER II

EXPERIMENTAL DESIGN

Selection and Description of Subjects

The subjects of this study consisted of 60 persons randomly chosen from the grade nine female students of Catholic Central High School, London, Ontario. They were between the ages of 13 and 15 inclusive, naive to the formal rote learning situation and had I.Q. scores ranging from 90 to 140. These I.Q. scores were obtained from a group I.Q. test known as the Dominion Tests - Quick-Scoring Group Test of Learning Capacity - Form A, Intermediate. This test was standardized on an Ontario school population consisting of 17 schools in both urban and rural areas of Ontario (Buros, 1953). Hovland (1951), in his review of the literature on the relationship of individual differences and learning, refers to a number of studies which show relatively high correlations between learning and intelligence. Other studies are mentioned by the same author which indicate that learning tends to improve with increase in age up to maturity. As a result of the above findings it was considered necessary to insure that none of the four groups of the present study differed to a significant degree in the variables of intelligence and age.

The I.Q. scores and chronological ages in months are shown in Table 5 of Appendix A. As indicated by Table 6 of Appendix A, no significant difference was obtained between the mean I.Q. scores of the four groups. Furthermore, it was concluded, on inspection of Table 5, that it was highly unlikely that a significant difference existed between the mean ages of the various groups.

Randomization was accomplished by assigning a number to each person making up the above population, mixing these numbers in a box, then drawing the numbers one at a time until 60 were obtained. As each was taken out it was assigned alternately to four different groups with the first subject being arbitrarily placed in the first of the following groups, the second subject in the next group and so forth. The four groups were:

(a) The massed practice group with irrelevant stimuli

(b) The massed practice group without irrelevant stimuli

(c) The distributed practice group with irrelevant stimuli

(d) The distributed practice group without irrelevant stimuli

Groups (a) and (c) were the experimental groups and (b) and (d) were the control groups.

Method

The following list of ten nonsense syllables was presented to the subjects by means of a memory drum whereby each syllable appeared, one at a time, in the window of the above instrument: BES, RUL, SAR, BIL, ROS, LUB, SEL, BOR, LIS, RAB. The above nonsense syllables were the same as those used in Underwood and Richardson's (1958) study. The reason this particular nonsense syllable list was chosen for the present study was because the above authors found that this combination of high meaningfulness (93.33 to 100% association value, Glaze, 1928) and high similarity (four consonants each being used five times, all vowels used twice) demonstrated the greatest facilitation in learning by distributed practice when compared to massed practice. The four lists used in these authors' study to discover this relatively greater facilitation by distributed practice were a high meaningfulness, high intralist similarity list (used in this study); a high meaningfulness, low intralist similarity list; a low meaningfulness, high intralist similarity list; and a low meaningfulness, low intralist similarity list. Inasmuch as the present experiment depends on building up inhibition while learning a nonsense syllable list under massed practice, it was expected that the above first list would fulfill this need. The rationale behind the above expectation is based on the experimenter's assumption that the relatively high degree of learning facilitation under distributed practice found with the first list described, suggests that the distributed practice condition allowed the inhibition built up during performance to dissipate during the rest intervals. On the other hand, the massed practice condition did not allow for the dissipation of the accumulated inhibition. A further reason for using this particular list was because Underwood and Richardson's (1958) subjects were naive to rote verbal learning experiments as were the subjects of this experiment. Naive subjects in the present experiment were those who never had any experience learning nonsense syllables presented by means of an apparatus. Specifically, none of these subjects had ever seen a memory drum previous to this experiment, none were aware of what a nonsense syllable was, and all subjects denied having ever participated in an activity of this nature.

The incidental stimuli were presented in the memory drum window in such a way that they appeared on the right of the nonsense syllables at a distance of one and a quarter inches. The right side was chosen because people usually read from left to right. As a result, it was assumed that the right side would be more facilitating for incidental learning. The particular distance between the nonsense syllables and the irrelevant stimuli replicated as closely as possible (limited by the width of memory drum window) the distance between incidental and relevant stimuli used in the Silverman and Blitz (1956) experiment (reported on page 56). The exact distance used by the above authors was six centimeters and incidental learning did occur.

The incidental stimuli consisted of ten geometrical figures; seven of them were those used by Bahrick (1954) in his experiment on incidental learning reported on page 54. Since the experimenter required a total of ten figures to pair with the ten nonsense syllables, three additional figures were arbitrarily constructed. The type of geometrical figures used in the experiment were as follows:

The seventh, eighth and ninth were those figures constructed by the writer.

Hovland (1938b) has shown that the faster the rate of presentation of a serial list (described on pages 30-31) of a paired-associate list (Hovland, 1949), the greater the facilitation of learning by distributed practice. Concerning the above experiments, Hovland makes use of an inhibitory concept in explaining these results.

In the present experiment, the massed practice groups were exposed to the stimuli at a two-second rate of presentation, with four seconds between trials; the distributed practice groups were exposed to the stimuli also at a two-second rate of presentation with sixty seconds between trials. This two-second rate of presentation was expected to facilitate the build up of inhibition with massed practice. This was also the presentation rate used by Underwood and Richardson (1958) in their study mentioned on pages 75-76. However, where the present experiment used a four-second interval between massed trials Underwood and Richardson used an eight-second interval. This modification was made on the experimenter's assumption that there would be a smaller degree of dissipation of inhibition, which has been postulated to accumulate under massed practice, in using this shorter interval between trials.

Even though Underwood (1961) has generally found 30 seconds as effective as longer rest intervals between trials in demonstrating learning facilitation by distribution, this study used a 60-second interval between trials to increase the likelihood that most of any existing inhibition would be dissipated. Speaking about distributed practice rest intervals, Underwood and Richardson (1955, p.44) state: "When interlist interference is low, the length of intertrial interval beyond a certain minimum (possibly 60 seconds) is not an important variable in either acquisition or retention." The interlist interference mentioned above refers to that arising from the letters used in other nonsense syllable lists learned by subjects. The greater the number of nonsense syllable lists previously learned, the greater is the interference occurring from the letters used in the previously learned lists with the letters being used in the learning of a particular nonsense syllable list of an ongoing experiment.

Criterion of Learning

A pilot study was carried out to ascertain at what particular trial or trials the greatest difference would be found in the number of nonsense syllables correctly recalled, under massed and distributed practice. It was postulated that at the above particular trial or trials the amount of inhibition would have reached its peak under massed practice. The subjects in the pilot study were required to learn the nonsense syllable list presented on page 75 to a criterion of one perfect recall of the whole list. Those subjects who reached this criterion in less than 50 trials were given additional trials until trial 50 was attained.[1] Not willing to assume that the subjects would be able to correctly recall the nonsense syllable list on additional trials beyond the trial when the list was first correctly recalled, the experimenter required that all subjects be presented the list up to trial 50 inclusive, irrespective of whether one perfect anticipation had been reached earlier or not. It was expected that the great majority of

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[1] Although trial 50 was arbitrarily decided upon, its choice was related to a small pre-pilot study experiment with five acquaintances of the experimenter who were exposed to the nonsense syllables on page 75 under massed practice conditions described on page 76. Trial 50 was well beyond the number of trials it took four out of five subjects to reach one perfect anticipation of the nonsense syllable list. The remaining subject took 40 trials to reach this criterion level.

subjects would be able to reach the criterion of one perfect recall of the nonsense syllable list within 50 trials.

Two important conditions to note about the pilot study are described below:

1. The first ten subjects of control group (b) and control group (d) (see page 75) of the main experiment made up the massed practice and distributed practice groups respectively of the pilot study.
2. The massed and distributed practice groups of the pilot study were formed and run under exactly the same experimental conditions as the control groups (b) and (d) of the main study except for a difference in the learning criterion.

The above two conditions made it experimentally possible for the results of the two pilot study groups to be incorporated as part of the total results of the respective control groups. However, only the number of nonsense syllables learned by the two groups of the pilot study up to and including trial 30 were used as part of the results of control groups (b) and (d). The reason for the above will become obvious to the reader from what follows.

The pilot study showed the greatest difference between massed and distributed practice in the number of nonsense syllables learned, at trials 30 and 31 (see Fig. 3, Appendix B) - trial 30 rather than trial 31 was chosen as the criterion level for the experiment proper because of the relative ease of working statistically with an even number. This finding provided a means of equalizing the exposure time of both the central and irrelevant stimuli, for all subjects of the main experiment. The above equality in exposure time was necessary to conclude that the difference in amount of incidental learning, if significant, was due to the particular conditions of practice rather than exposure to the incidental stimuli for different periods of time. This very likely would have been the case if the criterion level had been the first trial where complete learning of the nonsense syllable list had occurred. Due to differences in learning ability the subjects would have taken various numbers of trials to master the learning task. In addition the massed practice group would be expected to require a greater average number of trials to learn the list than the distributed practice group. Actually, the pilot study indicated that the massed practice group required an average of 43 trials to reach the criterion of complete learning of the nonsense syllable list, whereas, the distributed practice group required an average of 28 trials to reach the same criterion. It was shown by means of a t-test that the difference between the above average number of trials was significant beyond the .05 level of confidence. This information has been summarized in Table 1 below.

If the subjects were not given some task to perform during the intervals of distributed practice, they could voluntarily or involuntarily review the nonsense syllables and thus faster learning could occur. As a result, it could be argued that the reason that distributed practice facilitates learning is because the subjects review the data during the rest periods, while the massed practice subjects do not have as great an opportunity for review. This would invalidate the assumption that greater learning facilitation under distributed practice results from the dissipation of inhibition during distributed practice trial intervals.

Table 1

A Comparison of the Mean Number of Trials to Learn a Nonsense Syllable List under Massed and Distributed Practice

	Massed		Distributed		df	t
	Mean	SD	Mean	SD		
Trials	43	14.6	28	7.1	18	2.78*

* P .05 = 2.10
** P .01 = 2.88

In order to reduce this opportunity for reviewing the data, subjects were required to perform some neutral task, established by the experimenter, during the intertrial intervals. Some of the rest interval tasks used in previous studies have been counting numbers, color naming, and cancelling symbols. Underwood and Richardson (1958) had their subjects do a symbol cancellation task during the intertrial intervals of distributed practice. This same symbol cancellation task was used in the present study with the distributed practice subjects, during the 60-second interval between trials, under the assumption that the opportunity for reviewing the nonsense syllables would be eliminated or at least greatly reduced. However, there was no way of knowing positively that the above assumption was in fact true.

The suggestion might arise that the interpolated task could interfere with the learning of the main task. Osgood (1953), in his review of the literature on transfer and retroaction, refers to a number of experiments which present evidence indicating that retroactive interference and negative transfer tend to occur when the similarity between the interpolated task and the learning task increases. The above author summarizes this evidence in the following law: "When both stimulus and response members are simultaneously varied, negative transfer and retroactive interference are obtained, the magnitude of both increasing as the stimulus similarity increases." (Osgood, 1953, p.529). The same author (p.520) defines transfer and retroaction as follows:

> Transfer refers to the effect of a preceding activity upon the learning of a given task; retroaction refers to the effect of an interpolated (intervening) activity upon the retention of a task previously learned. Both effects may vary in degree and direction: facilitative transfer is called positive transfer and interfering transfer is called negative transfer. Although retroactive facilitation is commonly and acceptably used for positive retroaction, the term "retroactive inhibition" has unfortunately been applied when negative retroaction has been found.

Osgood prefers to use the term "retroactive interference" in place of "retroactive inhibition".

Reference is made by Osgood to Ammons (1947) and Irion (1948) who explain the loss in retention of a learning task during the rest period, by means of a loss of performance set. This loss is more pronounced when the rest interval is filled with dissimilar activities.

Referring to the present experiment, it would seem that because of the difference in the symbols and nature of the interpolated task as compared to the symbols and nature of the main task, it would be correct to consider the similarity between these tasks as low. Concerning the similarity between interpolated and learning tasks, Postman (1964, p.173) states:

> It should be noted that interpolated materials of varying degrees of similarity to the original learning materials have been used. When the interpolated activity involves the recall of other items from the same list, as in experiments in which length of retention interval is coordinated with order of recall, the similarity is high. In other situations, e.g., when the interval after presentation of a verbal item is filled with counting backwards, the similarity is low.

The same author holds that it is not safe to assume that interpolated tasks only act to limit rehearsal. He mentions that even when high dissimilarity has existed between the interpolated task and the main learning task, experiments have demonstrated significant amounts of retroactive inhibition. From the above discussion on the effects of interpolated activity on a learning task, it would seem necessary to conclude that some degree of interference does take place even when the two tasks have low similarity. Although there is a tendency, under distributed practice conditions, for the interpolated task to interfere with the main learning task, this interference appears to affect the main task performance to a lesser extent than massed practice conditions. This is suggested by the general superiority of distributed practice over massed practice.

In the present experiment, performance of the symbol cancellation task requires the subject to draw a line through certain symbols randomly arranged in rows on a sheet of paper. Three different key symbols to the left of each row denote the symbols through which lines are to be drawn. The following is an example of a row of these symbols including three key symbols on the left.

+ % $ ½ + # ? @ ¢ * $ & % & # @ ? ¢ ½ + $ % * ? @ # $ ¢ ½ * & + %

Procedure

The learning procedure consisted of the list of nonsense syllables being presented in a constant order on the memory drum by the anticipation method, i.e. each syllable had to be spelled out loud just before it actually appeared in the presentation window of the memory drum, if the response was to be judged correct.

Each subject was taken into a well-lighted, relatively small office and was seated comfortably before the memory drum. Facing each subject was a bare beige colored wall. The memory drum was situated on a desk (54" X 33"), four inches from the front edge with approximately equal table distance on each side. Noises, consisting of muffled voices, bells, students moving from class to class between periods, public address announcements (three occurrences) and traffic sounds, were uncontrolled during the experimental sessions. Although the public address system was disconnected in the experimental room it still could be heard from the other rooms.

The following standard instructions were read to each subject, and all questions pertaining to the instructions were answered before the experiment started.

> You have been chosen to take part in an experiment in learning. Our task is to gain information on the speed of learning nonsense syllables by high school students. A nonsense syllable is a combination of letters that has no meaning. The following combination of letters "FEV" is an example of one nonsense syllable. A group of 10 nonsense syllables will be presented, one at a time, in the window of a memory drum, and your task is to anticipate each syllable by spelling it out loud just before it appears in the window. However, inasmuch as you have never seen the nonsense syllables before, you will not be able to begin anticipating them until after the first

> trial. When you begin you will first see three little stars; this will be the cue to tell you the first nonsense syllable of the list is about to appear. The appearance of each nonsense syllable will be the cue for you to spell out the next syllable before it actually appears in the window. This is the procedure you follow for the whole list of syllables, and for each trial. You will continue anticipating the syllables by spelling each one out loud just before it appears in the window until you are told to stop.
>
> Now over here is the memory drum and here is the memory drum window in which the nonsense syllables will appear. If you have any questions I will answer them now. Once the experiment starts you must not ask any questions as they can not be answered.

In addition to the above instructions the distributed practice subjects were told the following.

> There will be a 60 second interval between each trial. During this interval you will be presented with several sheets of paper which will have written on them rows of symbols. Before each line on the left hand side of the page, there will be three key symbols. These key symbols are the ones which tell you what symbols in each row you are to draw a line through with your pen.

The distributed practice subjects were then shown a symbol cancellation sheet and required to work on the first row of symbols to ensure that they understood what to do.

In order to insure a smooth transition from the learning of nonsense syllables to symbol cancellation and from cancellation to learning, the subjects were told to turn immediately to the symbol cancellation task when they saw the stars and to turn immediately back to the learning task when the experimenter said "okay".

A record of the number of nonsense syllables correctly anticipated on each trial up to and including trial 30 was kept for all subjects.

Immediately after the criterion of 30 trials (determined by means of the pilot study) was reached by each subject in anticipating the nonsense syllables, the subject was asked to reproduce on a sheet of paper (11" X 8½"), by drawing, in any order, as many geometrical figures as he could recall. This procedure was a free recall measurement of incidental learning. The specific instructions were as follows:

> Here is a sheet of paper on which you are to draw, in any order you wish, the figures that were to the right of the nonsense syllables and which appeared in the memory drum window along with the nonsense syllables. Draw as many of the figures as you can recall. You will have three minutes to complete this task.

The above three minute period was chosen as it was thought to be a reasonable amount of time for the subjects to complete the task. Also the time period of two minutes used by Neimark and Saltzman (1953) in a recognition procedure influenced the present experimenter in his choice of a time period.

Immediately after the three minutes were up the subject was given another sheet of paper (11" X 8½"), at the top of which were the geometrical figures arranged in a different order from that used in the experiment proper, and down the left side were the nonsense syllables arranged in the same order as they were presented on the memory drum. The subjects were instructed to make a check mark in the appropriate square, which corresponded to the correct combination of geometrical figure and nonsense syllable as was presented during the trials on the memory drum. In short, this second method was a recall of serial position measurement of incidental learning. A more complete discussion of these two methods (free recall and recall of serial position) was reported on page 73. For the above recall of serial position measurement of incidental learning the following instructions were given.

> On this sheet of paper you will see in the column on the

> left the 10 nonsense syllables in the same order as they were presented on the memory drum. In the row at the top of the paper are the figures, which appeared to the right of the nonsense syllables when they were presented in the window of the memory drum. However the figures as arranged on this sheet of paper are not in the same order as they appeared with the nonsense syllables when presented to you. Your task is to make a check mark in the appropriate square which connects up each nonsense syllable with its correct figure as they were presented to you on the memory drum.

The subjects also had three minutes to do this task, and at the end of this time some check was made to see if the subjects had made any deliberate attempt to learn the irrelevant stimuli. All timing throughout the experiment was done by means of a stop watch.

All subjects were asked at the end of the experiment how they felt about it, then thanked for their effort and requested not to mention what took place to anyone.

Analysis of Results

1. The analysis of variance technique of analyzing data yields F-ratios. If any of these prove to be significant, further testing by means of a t-test is required to discover between which groups or sets the significant differences occurred.

A comparison of the amount of relevant learning, i.e. the number of nonsense syllables correctly anticipated by the two experimental and two control groups was made. This was done by means of a complex analysis of variance on three factors (conditions of practice, presence or absence of incidental stimuli, and blocks of trials) with repeated measures on the last factor. Winer (1962, p.337) suggests using this type of analysis of variance where there is a three-factor experiment with repeated measures on only one of the factors. Before the analysis of variance was performed, Cochran's test (Winer, 1962) for homogeneity of variance was applied to the data.

2. The difference between the amount of incidental learning of the massed and distributed practice groups was compared by means of a t-test (Guilford, 1956). Since it was predicted that incidental learning would be greater under massed practice than under distributed practice, a one-tail test was used, thereby increasing the probability of obtaining support for the main hypothesis. (Weinberg & Schumaker, 1962).

By convention the five per cent level and the one per cent level of confidence are adopted in psychological experiments. For the purposes of this study, a difference at or beyond the five per cent level of confidence was considered as suggesting significance, but requiring further confirmation, as is conventional in this type of study. By accepting the .05 rather than the .01 level of confidence the probability of committing a Type one error (saying there is a difference when in fact there is not) was increased. However, the consequences of committing this error in the present type of experiment would not likely be considered as having serious consequences.

CHAPTER III

RESULTS

The mean scores of the number of nonsense syllables correctly anticipated per block of trials by the four groups (massed practice group with irrelevant stimuli, massed practice group without irrelevant stimuli, distributed practice group with irrelevant stimuli, distributed practice group without irrelevant stimuli) are depicted graphically in Fig. 1. Before carrying out an analysis of variance, the data were subjected to Cochran's (Winer, 1962) test for homogeneity of variance. The result, C = 0.296, did not reach the critical value (C = .4834) at the .01 level of significance, thus increasing confidence in the use of the analysis of variance technique in the present study.

The results of the analysis of variance are presented in Table 2. An F ratio significant beyond the .01 level of confidence was obtained for conditions of practice. In view of the above significant F ratio, t-tests were applied to the massed and distributed practice groups. In doing so, the within group variance (Table 2) was used in computing the standard error of the difference. The above procedure is suggested by Guilford (1956) when homogeneity of variance exists. An inspection of Table 3 and Fig. 2 indicates that the differences between the two control groups and between the distributed-control and massed experimental groups were significant at the .01 level of confidence, and the

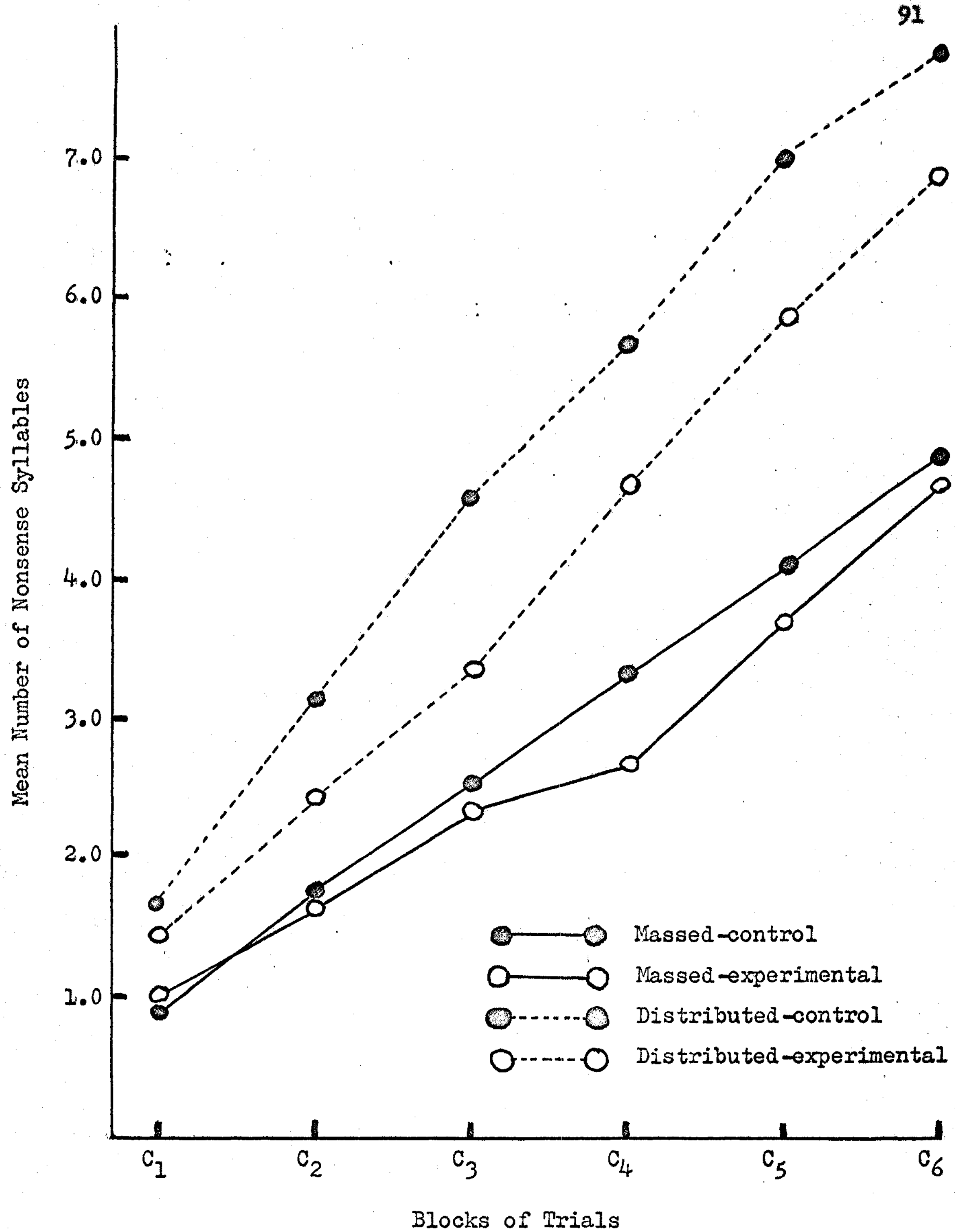

Fig. 1. Mean number of nonsense syllables anticipated by the four groups (massed practice group without irrelevant stimuli, massed practice group with irrelevant stimuli, distributed practice group without irrelevant stimuli, and distributed practice group with irrelevant stimuli) per block of trials.

Table 2

Analysis of Variance of the Learning of Nonsense Syllables in the Presence and Absence of Irrelevant Stimuli under Massed and Distributed Practice Conditions

Source	Sum of Squares	df	Mean Square	F
Between subjects	1026.75	59		
Practice (M vs. D)	271.10	1	271.10	21.13 **
Treatment (I vs. nI)	29.36	1	29.36	2.29
Practice X Treatment	7.85	1	7.85	
Within groups	718.44	56	12.83	
Within subjects	1310.72	300		
Trials	979.47	5	195.89	201.95 **
Practice X Trials	54.10	5	10.82	11.15 **
Treatment X Trials	5.20	5	1.04	1.07
Practice X Treatment X Trials	1.32	5	0.26	
Within groups	270.63	280	0.97	

** Significant at the .01 level of confidence.

Table 3

A Comparison of Intentional Learning between Massed and Distributed Groups

Source	df	t
Between 2 control groups	56	3.93 **
Between 2 experimental groups	56	2.62 *
Between massed-control and distributed-experimental groups	56	2.25 *
Between distributed-control and massed-experimental groups	56	4.31 **

* P. .05 = 2.01
** P. .01 = 2.67

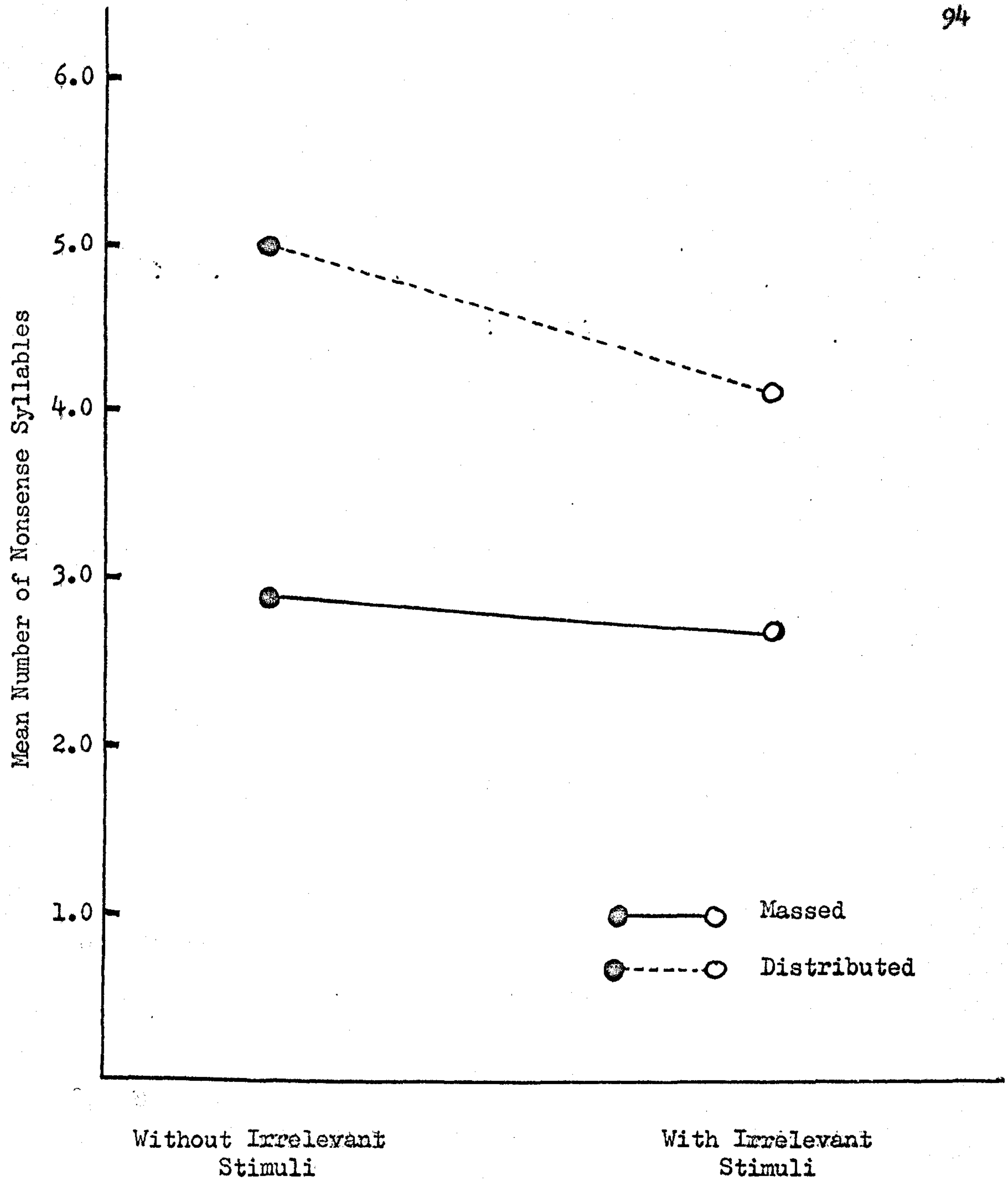

Fig. 2. Comparison of learning under massed and distributed practice in the presence and absence of irrelevant stimuli.

differences between the two experimental groups and between the massed-control and distributed-experimental groups were significant at the .05 level of confidence.

Again inspection of Table 2 shows that no significant effect on learning was found attributable to the presence of irrelevant stimuli, nor was there any significant difference in learning as a result of the interaction between conditions of practice and treatment (irrelevant stimuli vs. no irrelevant stimuli).

Finally, as shown by Table 4, a one-tailed t-test of the mean difference in the amount of incidental learning under massed and distributed practice as measured by the free recall method approached significance at the .05 level of confidence.

Table 4

A Quantitative Comparison of Incidental Learning under Massed and Distributed Practice

	Massed		Distributed		df	t
	Mean	SD	Mean	SD		
Incidental learning	2.6	1.54	1.6	1.63	28	1.67

* P .05 = 1.70 (one-tailed test)

In conclusion, (1) a significant difference was found between the massed practice groups and the distributed practice groups in the learning of nonsense syllables, (2) there was no significant difference in the learning of nonsense syllables in the presence or absence of irrelevant stimuli, (3) practice conditions did not interact with the presence or absence of irrelevant stimuli to affect nonsense syllable learning, (4) a one-tailed t-test indicated no significant difference in the amount of incidental learning under massed and distributed practice; however, the difference that was obtained did approach the .05 significance level.

CHAPTER IV

DISCUSSION OF RESULTS

The superiority of distributed practice conditions to massed practice conditions in the number of nonsense syllables correctly anticipated as shown in Table 3 and Fig. 2 is not surprising since virtually all previous experiments have found this to be the case. With reference to the main hypothesis, viz. that incidental learning will be greater under massed practice than under distributed practice, it was not supported at the prescribed level of confidence. However, since the difference in the amount of incidental learning, as measured by a one-tailed t-test, almost reached the .05 level of significance ($t = 1.67$), this result is in the predicted direction.

It was predicted, hypothesis (b), that the learning of nonsense syllables would be inferior (smaller amount learned in 30 trials) under distributed practice conditions in the presence of irrelevant stimuli than in their absence. Inspection of Fig. 1 and Fig. 2 shows that the distributed practice condition with irrelevant stimuli present resulted in less learning than the same condition without irrelevant stimuli, but the analysis of variance, Table 2, yielded a nonsignificant F value, thus indicating that this difference between the two distributed practice groups did not reach an acceptable level of significance. Contrary to hypothesis (a), viz. that the learning of nonsense syllables will be faster under massed practice when the geometrical figures are present as compared to when these stimuli are absent, the above F value also indicates that there was no significant difference in the amount of nonsense syllables learned by the two massed practice groups.

Due to the very different relevant tasks, varied incidental learning situations and stimuli, and the differences in subjects and procedure, a meaningful comparison of the amount of incidental learning in the various experiments (reviewed on pages 52-59) with that of the present study is extremely difficult. However, with one exception, the mean incidental learning scores of the above experiments are considerably larger than those of the present investigation.

Without a suitable criterion, i.e. a number of experiments using similar subjects, materials, tasks, and procedure, it is extremely difficult to gauge the relative difficulty (relative to other similar experiments) of the intentional learning task, and its facilitation of or interference with incidental learning. If it is assumed that the intentional task in the present study was experienced as comparatively difficult, and if sufficient evidence can be presented to indicate that the subjects of this experiment performed under high anxiety, then the findings (pages 56-57) of Spielberger, Goodstein, and Dahlstrom (1958) suggest a possible explanation for the small degree of incidental learning obtained. In the above authors' experiment on incidental learning it was found that a group of high and low anxious subjects recalled relatively easy stimuli 75% of the time, complex stimuli 36% of the time, and stimuli intermediate in difficulty 64% of the time. Performance of the high anxiety subjects on the complex stimuli was inferior to that of the low anxiety subjects. Related to the above, Silverman's (1954) study showed that subjects performing on both a difficult and an easy intentional task under high anxiety manifested a lower degree of incidental learning than subjects performing the same tasks under relatively low anxiety (low in comparison to the high anxiety subjects). Furthermore, incidental learning was greater when the intentional task was relatively easy than when it was difficult. These two studies indicate that (a) when the intentional and irrelevant tasks are relatively complex, incidental learning tends to be inhibited, (b) high anxiety also tends to interfere with incidental learning.

As indicated previously, there is reason to believe that anxiety may have played an important role in limiting the amount of incidental learning in the present study. This effect of high anxiety on the amount of incidental learning (as reported on pages 53-58) has received fairly substantial confirmation. It will be recalled (pages 53-54) that Easterbrook (1959) suggested that a decrease in the range of cue utilization takes place under increased drive (e.g. high anxiety) and the above range decrease is considered to have occurred when the degree of incidental learning has lessened. Using animals as subjects Bruner, Matter and Papanek (1955) discovered that high motivation (food deprivation) restricts the use of cues (decrease in "breadth of learning"). In addition, Combs and Taylor (1952) demonstrated with human subjects that, in a situation which the authors considered to be mildly threatening, their subjects' performance was negatively effected: more errors and more time was required to perform the task. The above threatening situation consisted of coding sentences which the experimenters judged to be "repugnant or embarrassing" to their subjects. Finally, as reviewed previously, experiments by Bahrick, Fitts and Rankin (1952); Bahrick (1954); Aborn (1953); Silverman (1954) and Silverman & Blitz (1956), employing human subjects, obtained results supporting Easterbrook's postulated relationship between high drive and incidental learning. In revealing this negative relationship between high drive and the amount of incidental learning, the first two experiments made use of a positive incentive drive (money) and Aborn (1953) used anxiety drive (induced failure). Anxiety drive (induced threat of shock) was also utilized by Silverman (1954) and Silverman and Blitz (1956), in their respective studies. In addition Silverman and Blitz found the above mentioned negative relationship between high anxiety (as measured by the Taylor Scale of Manifest Anxiety (1953)) and amount of incidental learning.

Overt manifestations which could be interpreted as signs of anxiety were observed in the subjects during testing in the present study. For instance, a number of subjects made self-depreciating remarks when they responded incorrectly; some tended to wipe their hands periodically on their clothes; others had trembling hands or quavering voices and a few even displayed tears. Comments made after the experiment were: "What a stupid test!", "Is this related to intelligence?", "What does this tell you about me?", "Could this be used to place me in the four-year programme?" Other subjects, who did not spontaneously volunteer any observations, when asked how they felt about the experiment said that they found it difficult; that it made them nervous and they were relieved when it was all over. In short, it was the experimenter's impression that most of the subjects were anxious during the testing and some were highly anxious.

The presence of anxiety under these conditions is probably not unexpected since grade nine students generally lack sophistication concerning psychological experiments. The lack of sophistication of the subjects in the present experiment is implied in their previously mentioned, rather naive statements. In addition, grade nine students tend to experience the new high school situation, under normal circumstances, as relatively stressful in comparison to the generally more relaxed, less demanding environment of the elementary school. If the impression is correct that the subjects of this study were generally performing, under a fair amount of anxiety, a task which they experienced as relatively difficult, it would seem reasonable to conclude that this combination of factors played an important part in influencing the degree of incidental learning. Intuitively, it would also seem that subjects performing under the rather demanding massed practice conditions (no rest interval) would be in a relatively greater anxiety eliciting situation. This would be expected to have a more marked adverse effect on incidental learning.

Consistent with the assumptions underlying the hypotheses of the present investigation (page 70) it would seem that the more frequent and intense the need for novel stimuli is, the greater the possibility of incidental learning occurring. Since inhibition was expected to be at its asymptote at approximately trial 30 (based on the pilot study findings, page 80) it would be expected that the need for novel stimuli would also be at a high level. As a result, it could be argued that it would have been more advantageous for the purposes of the present experiment to have had the four groups perform for a number of trials beyond trial 30. This would appear to be a valid procedure as long as there is not a great difference in the number of subjects of the four groups that have correctly anticipated all the nonsense syllables on a number of trials previous to trial 30. The above exception to continuing practice on the intentional task after the subjects have correctly anticipated the whole list of nonsense syllables a certain number of times is based on the expectation that, there would tend to be an increasing loss in motivation and interest with each successive trial. Although the subjects would probably continue to perform the task to meet the demands of the experimenter, the above assumed decrease in motivation and interest would very likely be experienced as an increasing feeling of boredom or monotony. It would seem reasonable to assume that the above postulated change in the subjects' set-to-learn would be correlated with an increase in the probability of the subjects seeking novel stimuli (increased awareness of geometrical figures). This in turn would be expected to result in greater incidental learning in the group which had the most subjects who experienced the greatest degree of boredom or monotony by trial 30. If this assumption is correct it would be highly difficult to interpret any difference in amount of incidental learning between the two experimental groups as a function of practice conditions.

It will be recalled (page 30) that inhibition was greatest for the massed practice group of the pilot study at trials 30 and 31. The above conclusion was based on the assumption that inhibition is at, or close to its asymptote, where the greatest difference occurred in the mean number of nonsense syllables anticipated on two consecutive trials, between the massed and distributed practice groups. Since the greatest difference between the two control groups and the greatest difference between the two experimental groups of the main study resulted from averaging the mean scores obtained on trials 25 and 26 (control groups) and the mean scores obtained on trials 23 and 24 (experimental groups) and subtracting each massed practice average from its corresponding distributed practice average, it would appear that inhibition approached its asymptote five and seven trials earlier for the massed-control and massed-experimental groups respectively than for the massed group of the pilot study. If the above assumption concerning the trials where inhibition is at or close to its maximum for the three massed practice groups (massed-experimental group, massed-control group, and massed group of pilot study) is valid, then it would seem reasonable to conclude that the subjects of the experimental massed group had the benefit of performing for a number of trials (seven) beyond the point where inhibition was close to its highest point. Thus the procedure (suggested on pages 101-102) postulated to facilitate an increase in incidental learning seems to have been met to some degree.

The fact that the greatest difference in the number of nonsense syllables learned under massed and distributed practice occurred at different trials for the various groups (pilot study groups, experimental and control groups of main study) might be explained as follows: extraverts supposedly build up inhibition faster and to a greater extent than introverts (Eysenck, 1957). Since this variable was not controlled in the present study, it could very well be that the above three groups differed in the number of extraverted subjects. This could explain why inhibition approached its asymptote at different trials for the various groups.

On examining the data it was discovered that two subjects of the massed-control group; two subjects of the massed-experimental group; nine subjects of the distributed-control group and four subjects of the distributed-experimental group, reached the criterion of one perfect anticipation by the 30th trial.

This difference between the two distributed practice groups as compared to no difference between the two massed-practice groups might be interpreted as follows: the presence of irrelevant stimuli tends to distract or interfere with the learning of the intentional task (learning of nonsense syllables) under distributed practice conditions. However, the fact that the learning of the relevant stimuli under massed practice did not show any impairment in the presence of the irrelevant stimuli suggests the conclusion that the irrelevant stimuli, in addition to functioning as a distractor, also act as a dissipator of inhibition. In effect, it is implied that the strength of the distracting and dissipating functions are such that they cancel each other out, hence the lack of a significant difference between the two massed practice groups in the number of subjects reaching the criterion of one perfect anticipation by trial 30. Inasmuch as distributed practice supposedly allows for inhibition to be dissipated during the rest intervals, then the irrelevant stimuli should function only in a distracting capacity. This is reflected in the fact that less than half as many subjects of the distributed-experimental group reached the above criterion by trial 30 in comparison to the number of subjects that reached this criterion in the distributed-control group.

In the present experiment there is no way of telling whether the symbol cancellation task (used to prevent rehearsal during the rest intervals of distributed practice) facilitated, interfered with, or had any effect on the direct learning or on the incidental learning of the distributed practice experimental group. Proactive and retroactive inhibition are usually obtained when the proactive and retroactive tasks consist of stimuli and responses which are similar but different to those of the main learning task. These proactive and retroactive tasks as indicated by much of the literature require that the subjects attempt to learn them. The above learning would be expected to lead to a much greater degree of the above forms of inhibition than would an activity quite dissimilar to the main learning task which held the subjects' attention but did not require learning. It would seem that an interpolated task like that described above would be a great deal more unlikely to interfere with incidental learning since the subjects have not been instructed to learn the irrelevant stimuli. Speaking about the effects of interpolated tasks as possible causes of interference, Postman (1964, p.173) has this to say:

> It is clearly hazardous to assume that interpolated activities merely serve to prevent rehearsal and do not function as effective sources of interference over short retention intervals. The objection to this assumption is not removed when the learning materials and the interpolated stimuli are highly dissimilar. In conventional rote-learning studies substantial amounts of retroactive inhibition have been obtained even when the intertask similarity was low. Such interference appears to be largely a matter of

> "generalized response competition", i.e., the S's tendency to persist in the performance of the interpolated task when required to recall the original list (Newton and Wickens, 1956; Postman and Riley, 1959). Performance decrements owing to a loss of set are very likely to occur in experiments on short-term retention in which Ss are required to switch rapidly from one activity to another. . . . The fact that the kinds of activities which are used to fill the retention intervals also produce significant proactive effects likewise points to the presence of interserial interferences.

Speaking about the similarity of the interpolated task, the same author (Postman, 1964, p.173) states:

> When the interpolated activity involves the recall of other items from the same list, as in experiments in which length of retention interval is coordinated with order of recall, the similarity is high. In other situations, e.g., when the interval after presentation of a verbal item is filled with counting backwards, the similarity is low.

Although Postman refers above to the effect of interpolated responses on the short term retention of a task, it would seem to the writer that Postman's "generalised response competition" explanation of interpolated task interference could also apply, but to a lesser degree, to longer rote learning activities. It would seem reasonable to expect even less "generalised response competition", if any, by a dissimilar non-learning interpolated activity, with incidental learning. In addition, it could be argued that the set to perform the interpolated responses could through generalization make the subjects more aware of the irrelevant stimuli, resulting in some or all of any existing effects of response competition interference being cancelled out.

From the foregoing discussion it would seem reasonable to conclude that the interpolated task of the present investigation had very little, if any, effect on incidental learning. However, to increase the experimental control over any possible effects of interpolated responses on incidental learning, under the conditions of the present experiment, it would be necessary to make use of the results gleaned from a series of experiments where the stimuli and responses of the interpolated activity were varied as to similarity with those of both the main and incidental tasks holding all other variables constant.

Turning again to the present experiment, perhaps the only tentative conclusion concerning the effect of the interpolated task on incidental learning would be that the presence of the "cross" symbol in the symbol cancellation task might facilitate the recall of this same symbol in the incidental learning task. Since only the distributed-experimental group would benefit from this double-exposure, so to speak, it would follow that the incidental learning of the above geometrical figure would be greater in this group than in the massed-experimental group. Supporting the above Brown (1954) has shown, as one would expect concerning intentional learning, that incidental learning increases with an increase in the number of presentations of stimuli. This double-exposure of the "cross" symbol should also result in the distributed-experimental group manifesting greater incidental learning of this figure than any of the other figures. Neither of these expectations was substantiated since this figure was recalled (free recall) once by the distributed-experimental group and once by the massed-experimental group. Analysis of the results obtained by the serial recall method indicated that this geometrical figure was never paired with its corresponding nonsense syllable by the distributed-experimental group and only twice by the massed-experimental group. Furthermore, six figures were recalled more frequently and eight figures were correctly paired more often with their corresponding nonsense syllables than was the "cross" geometrical figure by the distributed-experimental group.

The large within group variance (Table 2) may reflect important individual differences which should have been controlled in the present study. For instance, in a future experiment it would be well to control for individual differences arising from personality factors such as anxiety and introversion-extraversion. Referring to the personality variable "introversion-extraversion", Eysenck (1957) reviews a number of experiments: Eysenck, 1957; Treadwell, 1956; Broadbent, 1956; Claridge, 1956; Furneaux, 1955; Cain, 1942, which tend to support his theory that extraverts when performing a monotonous or routine task build up inhibition more quickly and to a greater degree than introverts. This introversion-extraversion factor could lead to difficulties in interpreting the results of the present study. For instance, if it were unknown to the experimenter that one of the experimental groups was significantly weighted in extraverted subjects this could lead to a difference in the amount of incidental learning of the two groups. Consistent with the assumptions underlying the hypotheses (outlined on page 70), this greater degree of inhibition (resulting from a difference in the number of extreverts) is expected to be associated with a greater need for novel stimuli. The present experiment predicts that the above need for novel stimuli will result in more incidental learning. The amounts of incidental learning resulting from a difference in the degree of extraversion of two groups would mask the expected differential degree of incidental learning resulting from the conditions of massed and distributed practice.

The same problem could result from the uncontrolled factor of anxiety, which as pointed out previously, appears to be an important variable influencing the degree of incidental learning. In short, it is quite possible that the important variables of anxiety and introversion-extraversion, since they were not controlled in the present investigation, could have been the reason for the predicted findings not reaching an acceptable level of statistical significance.

In future experiments adequate controls could be introduced by using suitable tests or questionnaires so as to match each subject on the above relevant personality dimensions. A possible way of limiting the degree of anxiety arising from the experimental situation, would be to require the subjects (previous to the main experiment) to take part in one or two simple experiments, similar in nature to that of the main investigation. At the same time it would be necessary to reassure the subjects that these experiments have nothing to do with passing, intelligence, or changing of courses, etc. The above procedure would be expected to increase the experimental sophistication of the subjects, thereby reducing anxiety.

Certain experiments (Kimble, 1950; Wasserman, 1951) present evidence to support the contention that high motivation should allow for a greater accumulation of reactive inhibition, thus postponing the occurrence of the automatic rest pause. If the above relationship between motivation and inhibition is valid, it would seem reasonable to assume that, if this involuntary rest pause does not occur as often due to high motivation, then the turning towards or sensitivity to novel stimuli would also be decreased. This decrease in sensitivity or need of novel stimuli would result in less incidental learning. A possible suggestion for minimizing both motivation and anxiety, thereby increasing incidental learning (Type II) would be to omit from the instructions requirements to learn the stimuli of the main task (nonsense syllables) while at the same time making certain that the subjects are aware of and react to these stimuli. This might be done by having the subjects perform a suitable orienting task (e.g., pronouncing the stimuli). The above would be similar to the Type I learning procedure. Postman (1964, p.186) states: "In Type I the S is exposed to the stimulus materials but given no instructions to learn. Following the exposure his retention is tested unexpectedly." The orienting task is the means whereby the subjects are exposed to the stimuli. The arrangement of the irrelevant stimuli (geometrical figures) would remain the same as in the present study. To illustrate further, it seems reasonable to postulate that the following non-learning instructions - the purpose of this experiment is to discover whether practising pronunciation on a list of nonsense syllables will improve or hinder reading - would be less motivating and less anxiety producing than the learning instructions - the purpose of this experiment is to see how fast high school students can learn a list of nonsense syllables (instruction used in present investigation).

Since a number of studies indicated that the amount of incidental learning tended to be smaller when the intentional and irrelevant tasks were difficult (pages 98-99) than when these tasks were easy, it would seem that by not requiring the subjects to learn the stimuli of the main task this would significantly reduce the difficulty of this task. In addition, the learning of the irrelevant stimuli (the Type II incidental learning procedure) would probably be facilitated by increasing the meaningfulness of these stimuli. Postman (1964) refers to a number of experiments which support the last mentioned relationship.

In another experiment, more mature, experimentally sophisticated college students could be used since these students would probably find this experiment less complicated and less stressful than grade nine high school students.

Since a number of authors (Deese, 1958; Woodworth & Schlosberg, 1954; and Postman, 1964) refer to certain experiments which suggest that recognition is often a more sensitive indicator of retention than recall, it might be more beneficial to use this method to replace the less sensitive serial recall measure in any future experiment concerned with measuring incidental learning.

Finally, in an experiment such as the present one where the irrelevant stimuli were expected to play such a crucial role, it would be important to insure that all other extraneous stimuli, which might function as dissipators of inhibition, are controlled. This could be achieved by using a sound proof room, free of all visual stimuli except for colorless, unpatterned walls. If possible, noiseless apparatus would be an important control to include in a future experiment.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The present experiment was undertaken in order to discover whether there was a relationship between conditions of practice and incidental learning. Specifically it was predicted that there would be a positive relationship between massed practice and the amount of incidental learning. The subjects making up the experiment were 60 grade nine female students controlled as to age and intelligence. These subjects were randomly assigned to the following four groups: (a) the massed practice group with irrelevant stimuli present, (b) the massed practice group without irrelevant stimuli, (c) the distributed practice group with irrelevant stimuli, and (d) the distributed practice group without irrelevant stimuli. The first and third groups comprised the experimental groups while the second and last groups made up the control groups.

The materials used to test the above prediction consisted of a nonsense syllable list made up according to a combination of high meaningfulness and high similarity. Situated one and a quarter inches to the right of each nonsense syllable was a different geometrical figure. The ten nonsense syllables made up the relevant learning stimuli while the ten corresponding geometrical figures made up the incidental learning stimuli. The relevant learning task was to spell out correctly each nonsense syllable before it appeared in the window of a memory drum. In short, this was a rote-learning, serial anticipation task. Incidental learning in this experiment was based on Postman's (1964) description of Type II, class two incidental learning reported earlier on page 2.

The following assumptions (supported by various experiments) underlying the present study were that the learning of the nonsense syllable list by massed practice would give rise to negative drive (inhibition) and/or stimulus satiation which in turn would be associated with a need for novel stimuli (geometrical figures). As the subjects sought for (voluntarily or involuntarily) the novel stimuli two effects were expected to occur. The postulated inhibition and stimulus satiation would be dissipated and incidental learning would increase. The above dissipation would be reflected in greater relevant task learning by the massed practice group in the presence of irrelevant stimuli as compared to the massed practice group in the absence of irrelevant stimuli. Since the subjects learning under distributed practice were able to dissipate any existing inhibition during the rest intervals of this practice condition it was assumed that there would be less need for these subjects to seek out novel stimuli, hence there would be a smaller degree of incidental learning in the distributed practice group with irrelevant stimuli in comparison to the massed practice group with irrelevant stimuli. This increased incidental learning of the massed experimental group as compared to the distributed practice experimental group would be reflected in a greater number of geometrical figures learned as revealed by a free recall and serial recall test given when the criterion of 30 presentations of both the nonsense syllables and corresponding geometrical figures was reached. This criterion of 30 presentation trials was arrived at previous to the experiment proper by means of a pilot study. It was assumed that the trial or trials, where the greatest difference in the number of nonsense syllables learned, between the massed and distributed practice groups of the pilot study, would indicate where inhibition was at or near its asymptote under massed practice.

Conclusions

Although a significant difference was obtained between the massed and distributed practice groups, there was no statistically significant evidence to support the main hypothesis that incidental learning would be greater under massed practice than under distributed practice. However, the results obtained were in the expected direction. In addition, no significant difference occurred in the amount of relevant stimuli learned between the two massed practice groups or between the two distributed practice groups although there was some suggestion that the irrelevant stimuli played some part in impairing relevant learning under distributed practice. This was reflected in the fact that two subjects of both the massed control group and massed experimental group reached the criterion of one perfect anticipation of the list of nonsense syllables by the 30th trial while nine subjects of the distributed control group and only four subjects of the distributed experimental group reached this criterion. The above was interpreted in the following manner: "the presence of irrelevant stimuli tends to distract or interfere with the learning of the intentional task (learning of nonsense syllables) under distributed practice conditions. However, the fact that the learning of the relevant stimuli under massed practice did not show any impairment in the presence of the irrelevant stimuli suggests the conclusion that the irrelevant stimuli, in addition to functioning as a distractor, also act as a dissipator of inhibition. In effect, it is implied that the strength of the distracting and dissipating functions are such that they cancel each other out, . . . Inasmuch as distributed practice supposedly allows for inhibition to be dissipated during the rest intervals, then the irrelevant stimuli should function only in a distracting capacity." (quotation from page 104 of Discussion).

It was suggested in the Discussion that the variables of anxiety and introversion-extraversion which were uncontrolled in this study may have been the cause of the results obtained not reaching statistical significance. The following suggestions - matching subjects on the personality variables mentioned above, increasing their experimental sophistication, preventing extraneous stimuli from impinging upon the subjects so as to dissipate inhibition, and using certain methods to facilitate incidental learning, would be important additions to use in a future experiment that attempts to investigate the relationship between incidental learning and conditions of practice.

APPENDIX A

Table 5

Chronological Ages and I.Q. Scores for All Subjects Comprising the Four Groups

Control Groups				Experimental Groups			
Massed		Distributed		Massed		Distributed	
C.A.	I.Q.	C.A.	I.Q.	C.A.	I.Q.	C.A.	I.Q.
159	109	160	113	153	133	186	104
164	132	169	96	174	121	185	96
178	94	162	109	179	96	168	109
179	104	163	121	156	120	169	115
184	101	171	105	171	104	169	107
171	96	174	98	163	118	167	106
162	124	174	109	179	93	174	102
177	114	169	100	169	103	162	94
169	122	171	101	168	105	160	139
165	108	161	109	175	102	178	99
183	94	172	112	180	99	173	101
167	122	173	97	171	105	166	116
172	109	179	94	161	116	167	102
159	140	167	117	162	118	182	115
188	91	170	102	169	104	173	95
Means							
171.8	110.7	169.0	105.5	168.7	109.1	171.9	106.7
Standard Deviations							
9.01	14.04	5.28	8.27	7.28	11.11	8.34	10.71

Table 6

A Comparison of the Mean I.Q. Scores

Source	df	t
Between 2 control groups	28	1.19
Between experimental groups	28	.58
Between 2 massed groups	28	.29
Between 2 distributed groups	28	.33
Between massed-control and distributed-experimental groups	28	.85
Between distributed-control and massed-experimental groups	28	.77

* P .05 = 2.05

APPENDIX B

Table 7

Pilot Study

Number of Nonsense Syllables Correctly Anticipated during Trials 1 to 13 under Massed Practice Conditions

	Trial												
Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13
EN	0	2	0	1	0	0	1	1	1	1	1	0	1
EP	3	3	2	0	3	4	3	3	3	5	6	5	7
MP	3	4	2	3	1	4	1	2	4	3	5	6	7
CH	0	0	0	0	0	3	0	0	0	0	0	0	3
MA	2	1	1	0	0	0	1	0	1	3	0	1	0
DP	0	1	0	1	1	3	3	2	2	3	3	5	2
MB	0	0	1	2	0	1	0	2	1	1	3	3	3
MK	0	0	1	2	0	1	0	1	0	1	0	0	0
MC	0	0	1	0	1	0	1	0	0	2	1	2	4
VH	0	0	1	1	1	1	0	1	1	1	0	1	2
Total	8	11	9	10	7	17	10	12	13	20	19	23	29

(Table continued on next page)

Table 7

Pilot Study
Number of Nonsense Syllables Correctly Anticipated during Trials 14 to 26 under Massed Practice Conditions

	Trial												
Subjects	14	15	16	17	18	19	20	21	22	23	24	25	26
EN	1	2	2	4	4	1	7	3	5	3	4	5	7
EP	6	5	5	7	7	7	9	9	7	9	9	8	9
MP	4	3	7	5	7	8	6	7	6	10	10	10	7
CH	0	0	0	0	0	0	0	0	1	0	1	0	2
MA	0	0	3	0	4	3	5	5	6	2	6	8	6
DP	2	2	2	2	6	7	1	3	2	4	2	4	4
MB	3	5	1	5	4	5	4	7	9	6	9	8	6
MK	1	1	0	0	1	0	0	0	0	0	1	1	1
MC	1	2	1	2	2	3	4	4	4	2	2	3	5
VH	0	2	1	1	1	2	2	1	2	3	4	2	3
Total	18	22	22	26	36	36	38	39	42	39	48	49	50

(Table continued on next page)

Table 7

Pilot Study
Number of Nonsense Syllables Correctly Anticipated during Trials 27 to 39 under Massed Practice Conditions

	Trial												
Subjects	27	28	29	30	31	32	33	34	35	36	37	38	39
EN	9	7	4	6	3	6	9	8	10	9	10	9	8
EP	10	9	8	8	10	10	9	9	10	8	10	10	10
MP	9	10	9	9	9	10	9	9	10	10	10	10	10
CH	1	1	0	0	0	2	0	1	2	2	3	3	4
MA	4	7	8	6	10	10	10	8	10	10	10	10	10
DP	6	5	5	2	0	3	3	1	2	7	3	4	9
MB	6	7	5	7	7	8	7	6	9	6	7	7	10
MK	1	0	2	0	0	4	1	0	2	4	0	6	3
MC	2	5	6	5	4	4	5	6	7	6	2	7	6
VH	2	3	1	4	4	5	2	3	6	6	5	3	4
Total	50	54	48	47	47	62	55	51	68	68	60	69	74

Table 8

Pilot Study
Number of Nonsense Syllables Correctly Anticipated during Trials 1 to 13 under Distributed Practice Conditions

	Trial												
Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13
AG	2	3	4	4	4	6	5	6	2	6	7	8	6
CH	3	3	4	2	1	1	3	4	5	5	5	3	4
CS	0	0	1	1	1	3	1	2	3	4	3	3	4
AJ	0	1	1	3	2	3	3	2	3	3	5	6	8
CR	3	2	1	3	2	4	2	2	5	4	4	2	7
JO	1	1	1	2	2	4	3	1	1	4	2	2	1
JS	1	1	1	1	3	2	4	5	4	5	5	8	6
CG	0	0	1	1	1	3	3	1	2	2	4	6	7
JD	1	4	3	4	4	6	2	3	6	6	5	5	5
MV	0	0	2	1	3	0	1	0	1	2	4	4	4
Total	11	15	19	22	23	32	27	26	32	41	44	47	52

(Table continued on next page)

Table 8

Pilot Study

Number of Nonsense Syllables Correctly Anticipated during Trials 14 to 26 under Distributed Practice Conditions

	Trial												
Subjects	14	15	16	17	18	19	20	21	22	23	24	25	26
AG	9	4	6	8	9	9	10	9	9	10	10	10	9
CH	4	3	4	6	5	6	4	8	9	9	7	9	6
CS	3	5	5	5	5	7	7	4	5	5	5	6	8
AJ	8	4	6	4	8	5	8	9	9	8	10	10	7
CR	5	5	7	6	7	6	6	6	6	6	7	6	10
JO	1	4	4	7	5	7	3	7	3	7	7	5	8
JS	6	6	6	7	5	4	5	4	6	5	7	9	9
CG	2	5	3	5	5	6	5	4	6	7	6	6	8
JD	6	9	9	10	10	7	10	10	10	7	10	10	10
MV	1	3	4	6	7	7	8	8	6	6	8	9	7
Total	45	48	54	60	66	64	66	69	69	70	77	80	82

(Table continued on next page)

Table 8

Pilot Study

Number of Nonsense Syllables Correctly Anticipated during Trials 27 to 39 under Distributed Practice Conditions

	Trial												
Subjects	27	28	29	30	31	32	33	34	35	36	37	38	39
AG	8	9	10	9	10	10	10	10	10	10	9	10	9
CH	7	10	10	9	10	10	8	10	10	10	10	10	10
CS	7	9	8	9	9	8	7	7	6	9	10	10	8
AJ	9	8	10	10	9	10	10	10	10	9	9	10	10
CR	9	10	9	10	10	10	10	10	10	10	10	10	10
JO	8	5	8	7	8	9	7	8	10	9	10	10	10
JS	10	6	8	8	9	10	9	10	10	9	10	10	10
CG	7	7	8	7	8	7	9	8	8	8	9	7	8
JD	10	10	10	10	10	10	10	10	10	10	10	10	10
MV	10	6	6	10	10	10	9	7	9	5	9	10	10
Total	85	80	87	89	93	94	89	90	93	89	96	97	95

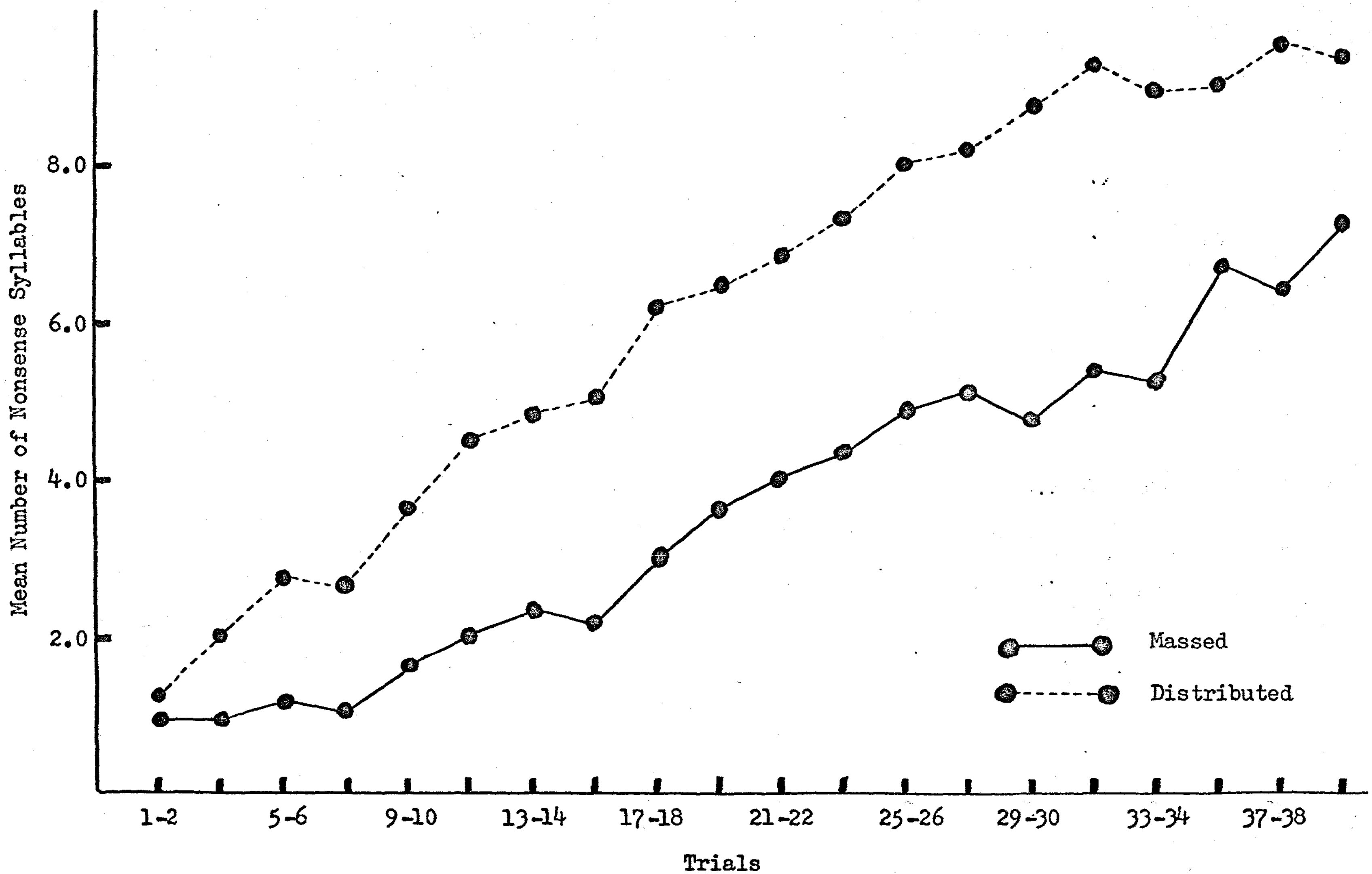

Fig. 3. Mean number of nonsense syllables anticipated by the massed and distributed practice groups of the pilot study.

APPENDIX C

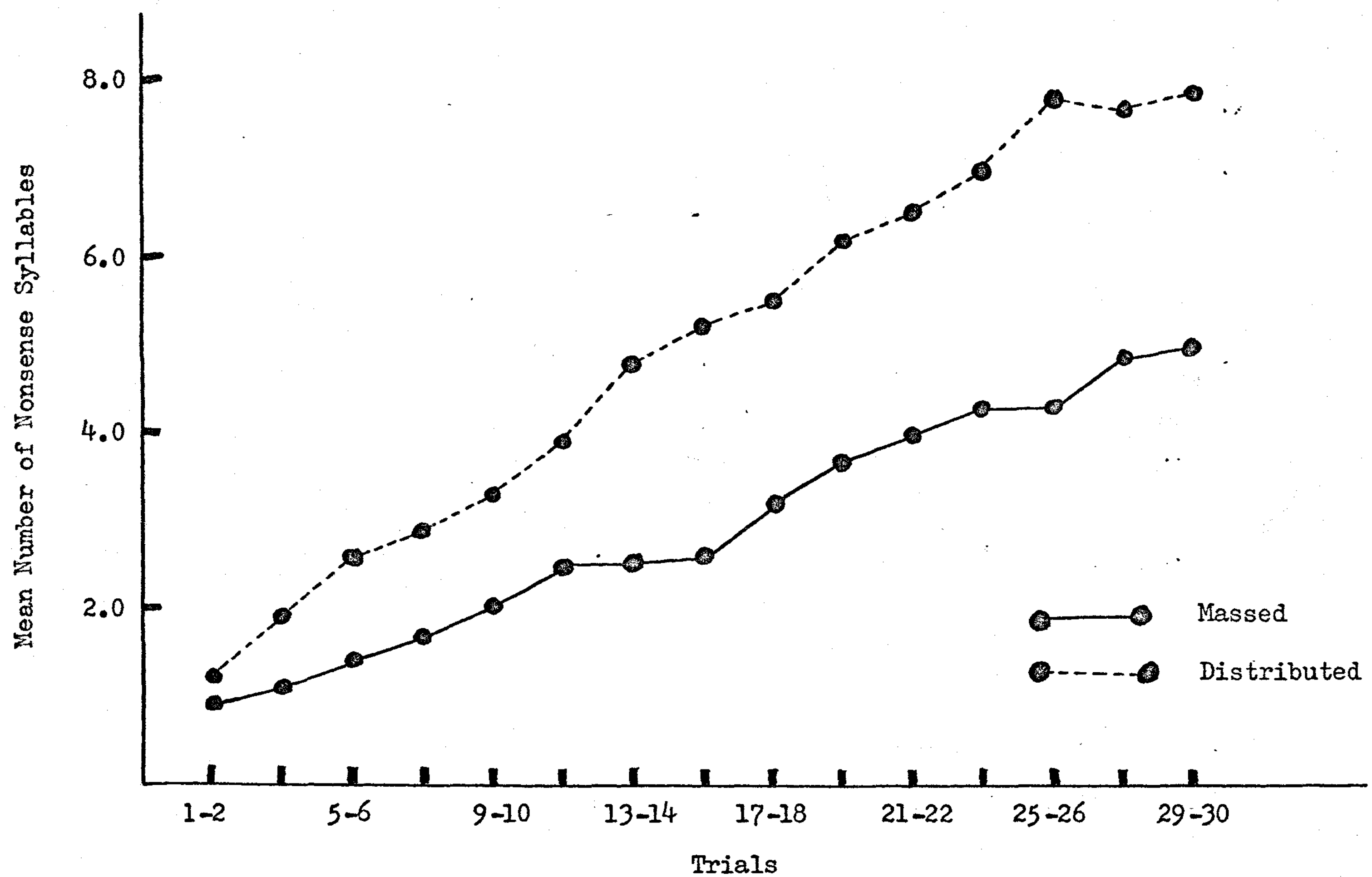

Fig. 4. Mean number of nonsense syllables anticipated by the control groups of the main study.

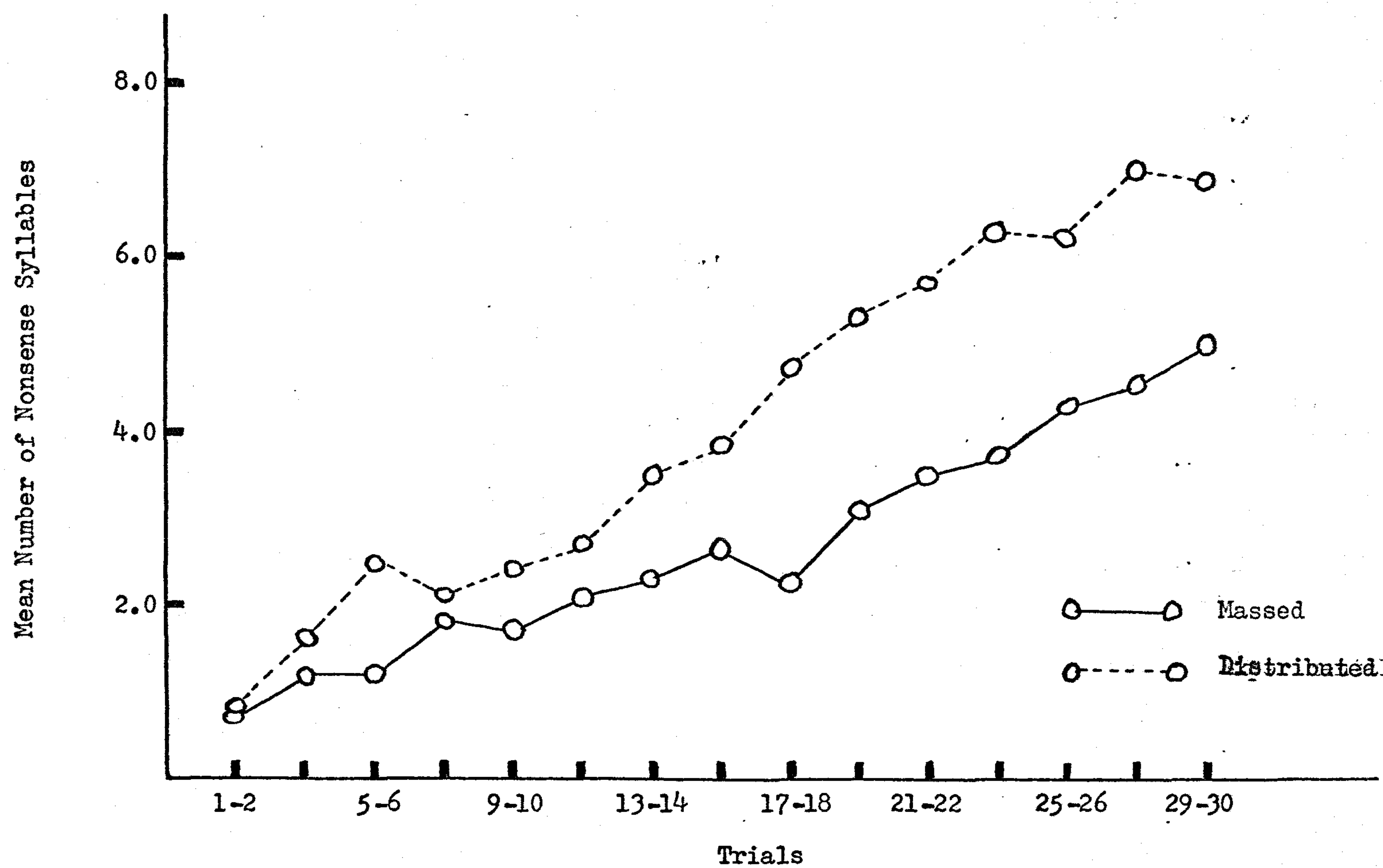

Fig. 5. Mean number of nonsense syllables anticipated by the experimental groups of the main study.

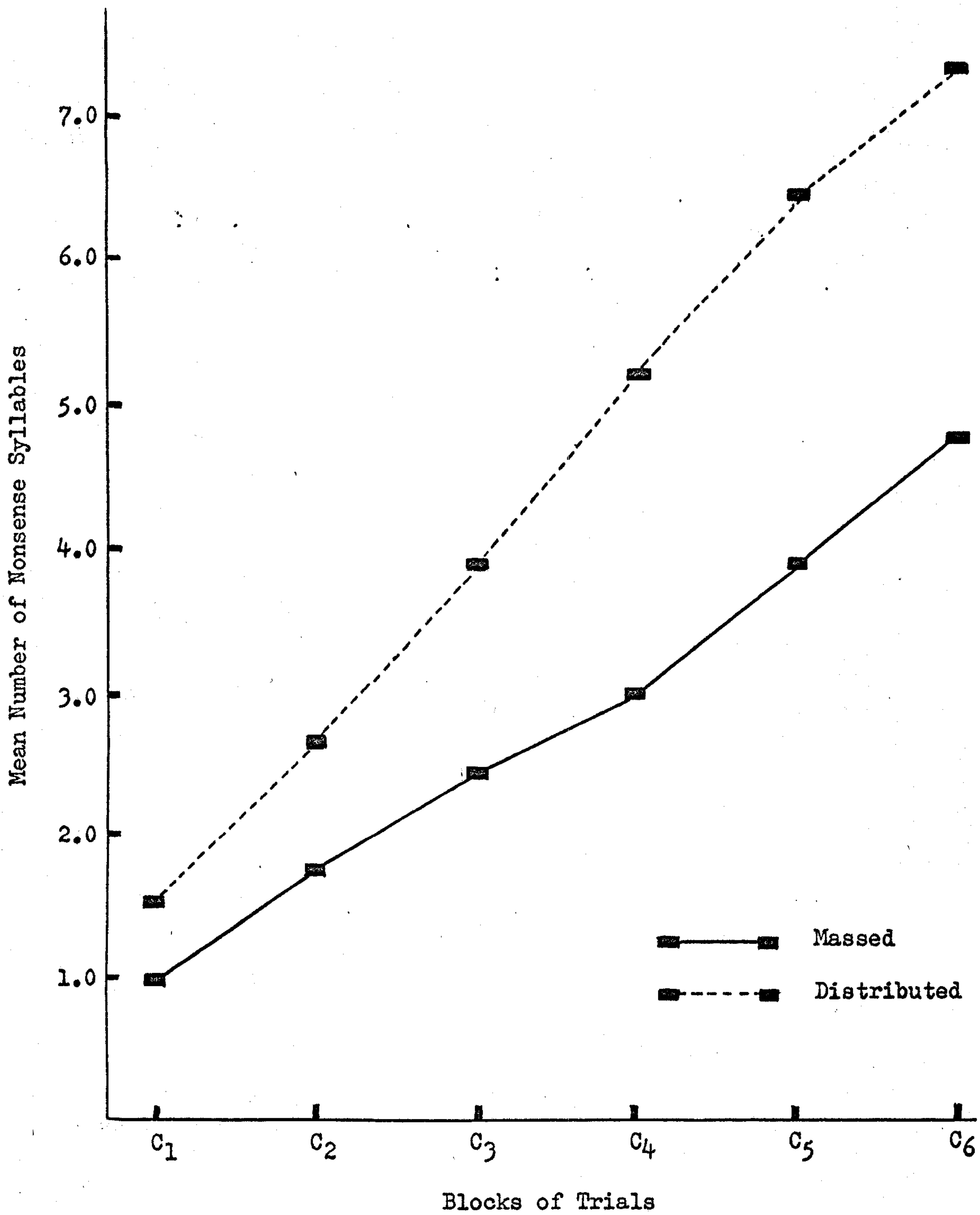

Fig. 6. Comparison of two massed practice groups with two distributed practice groups.

APPENDIX D

Table 9

Incidental Learning under Massed and Distributed Practice by Free Recall of Geometrical Figures and Recall of Serial Position of Geometrical Figures

Massed Practice		Distributed Practice	
Free Recall	Recall of Serial Position	Free Recall	Recall of Serial Position
4	1	0	1
0	0	3	0
4	1	4	1
3	0	1	2
2	2	0	1
3	0	0	1
2	1	3	0
0	3	0	2
2	1	0	1
4	1	0	0
4	1	4	0
5	2	4	1
3	1	3	1
3	1	1	2
0	1	1	0
Means			
2.6	1.1	1.6	0.9
Standard Deviations			
1.54	0.72	1.63	0.68

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