SENSORY PRECONDITIONING WITH THE MENTALLY RETARDED

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CHAPTER I

THE PROBLEM

Background of the Problem

In 1939, Brogden published a study under the title "Sensory Preconditioning" which became the prototype of a novel experimental procedure leading to the establishment of a new learning phenomenon. Others (Shipley, 1933; Lumsdaine, 1937) had previously dealt with procedures approximating that employed by Brogden, but their results were interpreted within the existing framework of classical conditioning.

The phenomenon of sensory preconditioning (SPC) has been traditionally defined as the experimental procedure in which two independent sensory stimuli are contiguously and repeatedly presented to an organism and, then, a conditioned response is established to one of the stimuli. Subsequently, the other (test) stimulus is presented alone. The phenomenon is said to occur if the conditioned response transfers to the new situation despite the fact that the conditioned stimulus is now absent. This three-stage series of events embraces such known learning principles as contiguity, conditionability and transfer.

The first stage of the experimental procedure is called preconditioning (PC), the second is the conditioning or training period and the last (critical) phase is called test or transfer.

Most of the pioneer studies in the area have dealt with testing the existence of SPC in different organisms (Brogden, 1939; Karn, 1947; Reid, 1952). Over the past fifteen years, however, attempts have been made to narrow down those antecedent conditions that facilitate or retard response transfer to the test stimulus (Chernikoff and Brogden, 1949; Bahrick, 1953; Lyons, 1954; Thornton, 1956; Hoffeld, Thompson and Brogden, 1958; Wokoum, 1959; Hoffeld, Kendall, Thompson and Brogden, 1960; Wickens and Cross, 1963).

Research has also been stimulated by theoretical issues in this area and some investigators have examined more closely the relationships between SPC and Classical conditioning either in terms of an S-R or S-S analysis (Wickens and Briggs, 1951; Osgood, 1953; Bitterman, Reed and Kubala, 1953; Silver and Meyer, 1954; Coppock, 1958; Tyler, 1962). In particular, these studies focus on the principle of stimulus generalization as a possible mechanism that bridges the gap between the two learning procedures. The results appear to be conflicting and the issue remains controversial.

More experimental evidence is needed concerning the nature of the SPC process itself and its occurrence in different kinds of populations, i.e., animal, human, normal and retarded groups. The manipulation of additional independent variables may also reveal facets of the problem that have not yet been investigated.

Statement of the Problem

The main objectives of the present study are: (a) the application of the SPC paradigm in a subnormal population and (b) the investigation of the effect of unexamined antecedent conditions on the SPC phenomenon. The following issues will be studied:

(1) The absence or presence of this phenomenon in a large portion of the mentally retarded population.

(2) The influence of the organismic factor of measured intelligence.

(3) The effect of the presentation schedule of the unconditioned stimulus (UCS) in Stage II of the experimental procedure.

(4) The influence of stimulus intensity (UCS) during the second phase of the procedure.

(5) The interaction effects among the above variables.

CHAPTER II

REVIEW OF THE LITERATURE

The primary purpose of this section is to acquaint the reader with the relevant theoretical notions and experimental investigations regarding the nature and place of sensory preconditioning in the area of learning.

This review is divided into three sections. The first section will deal with some theoretical formulations that have been offered as possible interpretations for the experimental findings. The second section will be concerned with a number of empirical variables that have been investigated in the past for the purpose of teasing out those conditions that affect the organism's performance during the critical stage of the experimental procedure. Particular interest will be paid to such important issues as response measures, acquisition training, time relationships, etc. The third section will consist of a statement of hypotheses drawn from the literature and applicable to the present investigation.

I Theoretical Formulations

The possibility of learning without the presence of any apparent incentives has intrigued psychologists throughout the years. It gave rise to numerous research investigations which resulted in a number of controversies regarding the importance of reinforcement or cognition as a basic condition for learning. At least one of these controversies sprang from conflicting interpretations of the SPC effect.

Cognitive Sets or Stimulus Generalization?

The two main theoretical explanations of SPC are steeped either within the S-S or S-R traditional framework.

The S-S interpretation demands a cognitive model. It explains the phenomenon in terms of contiguity of sensory events, formation of situational sets or cognitive hypotheses during the PC stage (Brogden, 1939; Karn, 1947; Birch and Bitterman, 1949, 1951; Brown, Ulmer and Carr, 1958; Lovibond, 1959). These writers insist that the differential rate of transfer between the experimental and control groups is a direct function of contiguous interstimulus association; closeness of sensory events in space and time provides a representational structure which facilitates the attachment of special conditions from one event to the other despite the absence of reinforcement.

The S-R view postulates that connections between PC stimuli are built through the formation of implicit bonds of responses. The argument runs as follows: the PC stimuli are nothing more than unconditioned stimuli with unknown unconditioned responses (UCRs) accompanied by response-produced stimuli (i.e., sensory feedback). During Phase I, one of the PC stimuli becomes conditioned to one of the UCRs. In the training period, the other stimulus becomes a conditioned one, produces a response and stimuli from that response also become conditioned to the measured response. When the first stimulus is presented again in the third phase, it evokes the conditioned response of the second stimulus and the stimuli from this response elicit the measured response (Osgood, 1953). The important factor here is that conditioned responses are formed in the first phase of the SPC design. Osgood (1953) concedes that reinforcement is not necessary for the occurrence of the phenomenon. The process is similar to that of classical conditioning and involves one of the most fundamental principles of S-R learning: stimulus generalization by mediation of response-produced stimuli.

Evidence for or against each theory is impressive. Wickens and Briggs (1951) offered strong empirical support for their contention that SPC is a simple case of mediated stimulus generalization. During PC the Ss were required to say the word "now" to either of four conditions of light and tone presented (a) together, (b) separately, (c) light only, (d) tone only. It was found that the first two groups extinguished much more slowly during the critical phase than the latter two groups. A criticism that can be leveled against this study is that the requirement of an overt, verbal response during PC appears to do an injustice to the paradigm. One may also consider the word "now" as a set-inducing verbal response.

Coppock (1958) tested Osgood's interpretation of SPC by instituting a new phase immediately following the PC phase; during this period the first stimulus is presented alone and, consequently, any CR related to this stimulus should eventually weaken (simple pre-extinction or SPE); progressive decrement to the CR should also take place if the second stimulus precedes the first stimulus during this phase (inverted pre-extinction or IPE). It was also possible to present the two stimuli in the PC phase in such a way that the to-be test stimulus follows the onset of the to-be CS in that order (Inverted pre-conditioning or IPC). Coppock made the following predictions: (a) IPE will be greater than SPE, (b) SPE will be equal to or greater than the control group, (c) IPC will be greater than the control group, and (d) PC will be greater than the control group. All of the predictions were fulfilled with the exception of (c): the performance of the IPC group failed to show any evidence of intersensory response mediation.

A demonstration of SPC with socially meaningful verbal stimuli was carried out by Das and Nanda (1963). Two nonsense syllables were associated with names of tribes by exposing each pair together and having the subject repeat the pair in the PC phase. A favorable or unfavorable attitude was then developed towards the nonsense syllable (phase II) and finally, attitude transfer to the names of tribes was tested by having the subjects choose 10 attributes for each tribe from a randomly presented list of 10 favorable and 10 unfavorable adjectives (phase III). It was concluded that any response acquisition in SPC is similar to that of other conditioning situations in terms of stimulus generalization.

It has been already mentioned that the first demonstration of SPC was carried out by Brogden (1939). Dogs were first presented with 200 simultaneous pairs of a bell and a light (PC phase). A conditioning period followed during which the forelimb flexion withdrawal became a conditioned response to either the bell or the light (training phase). When this phase was over, the animals were exposed to the other, nonconditioned stimulus and a frequency count of transferred conditioned responses was made (test phase). It was found that the experimental groups were significantly superior to the control groups that were not presented with the first phase of the procedure. An incidental finding was that the bell was a more potent conditioned stimulus than the light. The results were theoretically interpreted in terms of associative contiguity of intersensory stimulus (S-S) events.

Birch and Bitterman (1949, 1951) present the view that sensory intergration or some type of an afferent process offers the best possible explanation of SPC. Their position is summarized clearly in these words: "When two afferent centers are contiguously activated, a functional relation is established between them such that the subsequent innervation of one will arouse the other" (1951, p. 358). This explanation is basically one of sensory contiguity and is somewhat similar to Hebb's neural associationism (1949).

Lovibond (1959) also examined the effect of a subvocal mediating response on SPC and found--in opposition to the Wickens and Brigg's study (1951)--that this mediation was not essential for the demonstration of SPC. Under conditions favorable only to the formation of direct S-S linkages, a second experimental group was required to make one type of explicit verbal response to the PC stimuli during the PC phase, and different explicit verbal responses to these stimuli in phases II and III. There was no significant difference between the two experimental groups, but the response level of the combined experimental groups was significantly higher than that of the combined control groups. Lovibond surmised that a process of S-S linkages best accounts for SPC with stimulus-producing responses playing a secondary role.

An ingenious experimental test of the concept of sensory integration was made by Tyler (1962). By controlling or suppressing responding during training, he was able to exclude any overt responses. Training consisted of having the subjects describe nonsense words without pronouncing them. One group was verbally reinforced by praise during training and another was not. In the test phase, the same words were exposed tachistoscopically and thresholds for correct word-spelling were measured. The measure of S-S strength was based on the minimum "information" necessary to evoke indexing (i.e., suppressed) responses. Thresholds were significantly lower for previously exposed words than for control words showing that S-S learning has taken place. Reinforcement (i.e., praise) had no effect on the strength of sensory integration and it was questioned whether it was necessary for the formation of afferent organizations.

Whereas most of the presented evidence is indirectly related to the problem of SPC as an independent paradigm of learning, a few studies have directly compared the model of Classical conditioning to that of SPC. Bitterman, Reed and Kubala (1953) presented a group of subjects with pairs of intrasensory stimuli in phase I, to be followed by a 10-trial conditioning phase of either stimulus. Finally, the nonconditioned stimulus was presented alone 10 times (transfer test), and then, the conditioned stimulus was presented alone the same number of times (extinction test). The statistical analysis between the Classically conditioned stimulus and the SPC stimulus in terms of GSRs showed no clear-cut difference between the two situations. The investigators concluded that the SPC response tendency was as strong as that of Classical conditioning. However, one may raise the question that the SPC design of the study was superficial since both stimuli impinged on the same sense modality (i.e., vision).

Another similarity between SPC and Classical conditioning appears to be that of time relationships. The forward arrangement of the two intersensory stimuli during the PC phase has been found to be superior to any other arrangement (i.e., simultaneous, delayed, backward). Silver and Meyer (1954) have shown that both experimental designs operate under the same laws with respect to the temporal factor. Their findings have led them to believe that SPC can be explained within a theory of a situational stimulus complex along the lines developed by Osgood (1953).

Comments on the Nature of SPC

The experimental evidence from both camps is impressive. Is SPC a simple case of mediated stimulus generalization (MSG) or is it an independent phenomenon of learning subscribing to separate S-S principles? The answer may be found by paraphrasing Seidel's own words in his 1959 review of SPC: "What this over-all comparison of SPC and MSG indicates is that, although both paradigms yield similar transfer effects in some instances, SPC alone appears to be governed by a different set of laws from that of Classical conditioning" (p. 71). This set of laws appears to be based on the (a) unnecessary presence of specific, overt responses, (b) absence of reinforcing agents in phase I, (c) small number of PC presentations, and (d) contiguous association of S-S linkages in the PC phase.

II Empirical Evidence

A number of factors will affect performance in SPC. Some of these factors are anticipated by theory, but many of them are revealed only by empirical studies. A variety of such variables and their relation to SPC will be discussed in this section.

Response Measures: The existence of a new phenomenon requires an accurate and reliable measurement of the dependent variable. The response measures not only reflect a numerical estimate of the effect of experimental manipulations on performance, but they also define operationally the process under consideration. The response measures of the same phenomenon may vary in both nature and scope and it is possible that they may not correlate with each other. Therefore, it is no surprise that a given event may be demonstrated by one response measure, but not by another in a given area of endeavor. The area of SPC is no exception.

Brogden (1942) tested the occurrence of the previously discovered phenomenon of SPC with humans employing the GSR measures of magnitude, latency and frequency. The greater magnitude, shorter latency and greater frequency of response during the training phase did not transfer to the critical stage of the procedure. As will be indicated later, the GSR is easily contaminated by many irrelevant, extraneous variables and this may explain the failure of this investigator to obtain significant results. In a subsequent study, Brogden (1947) made key depression a conditioned response to light by threat of shock during the second phase followed by posttests to tone and light in the critical phase. Both frequency and latency measures differentiated significantly between experimental and control groups.

Karn (1947) also studied the SPC effect in humans using frequency of response as the dependent variable. The experimental group gave a total of 75 transferred responses to the test stimulus, whereas the control group gave a total of only 9 transferred responses. Again, frequency of response was found to be a valid index of SPC.

Another ingenious way of measuring the SPC phenomenon was devised by Brogden (1950) employing an absolute threshold of auditory acuity as an additional response measure to frequency of responses. Subjects were exposed to 10 trials of a 1,000-cps tone; each time the tone was presented, the illumination of the room increased slightly (phase I). The experimental treatment consisted of 30 trials of tone at the same intensity level as that of the tone given in phase I. Finally (phase III), an absolute threshold was determined for the tone with the light in combination and for the tone alone. The threshold was measured by a modified method of constant stimuli and the method of limits. This method proved more sensitive in discriminating between the two groups than frequency counts. However, one year later, Brogden and Gregg (1951) reported a study with six variations in procedure again using thresholds of auditory acuity as a dependent variable. Despite some facilitation of auditory acuity under some conditions, no significant differences were found among these experimental variations. The investigators concluded that the threshold method was not in any way superior to the traditional measures of frequency and latency. Apparently, the effectiveness of any response measure depends to some extent on the type of the apparatus employed and the variability of the response under study.

By Way of Summary

The response measures of frequency and latency appear to be good and reliable indicators of SPC. The employment of GSR measures is questionable. The response index of frequency seems to have an advantageous position over that of latency both in terms of operational simplicity and reliability.

The Problem of Controls: The presence of a control group in the SPC situation is a check against the confounding effects of unrelated phenomena and environmental factors on the dependent variable. Its basic purpose is to isolate the performance change brought about by the simultaneous or near-simultaneous presentation of the two inter-sensory stimuli in phase I of the design. It is imperative that SPC must be shown to take place in the absence of cross-modal generalization. This has been traditionally controlled for by the omission of the two stimuli in the PC phase (Brogden, 1939; Karn, 1947). Reid (1952), however, has suggested that this type of control is not sufficient because of differential treatment of the critical stimulus in the experimental and control groups, i.e., the experimental group receives more experience with the test stimulus than the control group. To prove this view, Reid (1952) carried out a study in a modified Skinnerian situation with disk pecking as the required instrumental response. The experimental group was exposed to buzzer and light simultaneously during PC; the control group was also exposed to the PC phase, but the two stimuli were presented in a nonpaired way. With this control, the difference between the two groups was not significant.

In a study cited above (Silver and Meyer, 1954) evidence was found suggesting that Reid's criticism is invalid; even when Reid's control group was employed, the experimental group differed significantly from it. These results were subsequently verified in a number of studies (Brogden and Gregg, 1951; Finochio, 1954; Lovibond, 1959; Wokoum, 1959). It seems then evident that the factor of differential exposure to the test stimulus is not an important one, since the overwhelming majority of studies have obtained a significant SPC effect over and beyond the presence of this control condition.

Manipulating Variables

After the establishment of the SPC phenomenon employing a number of response measures, investigators turned their attention to the antecedent conditions and examined the effectiveness of their variation on these measures.

Acquisition Training: This is an important variable in many learning situations. Thompson (1958) was the first investigator to show that level of acquisition has an important influence on the generalization gradient within the same sensory modality, the amount of generalization decreasing with increased acquisition training; animals trained to a 90% response level to a 250-cps tone showed a sharp decrease in generalization with increasing frequency with almost no generalization occurring to stimuli of 2,000-cps or higher. Animals trained to a 20% acquisition level gave the greater relative generalization, while animals trained to a 55% acquisition level gave a smaller amount of generalization. These results are consistent with those obtained by the same researcher in a subsequent study (Thompson, 1959): it was shown that both relative and absolute generalization across a sensory modality decreased with an increment in acquisition level from 55% to 90%. Apparently, the less the acquisition training, the greater the cross-modal generalization will be.

Stimulus Similarity: Kendall and Thompson (1960) attempted to determine the effect of stimulus similarity on SPC in line with Thompson's (1958, 1959) previous findings. Cats were given 20 pairs of a 2-sec., 2,000-cps tone followed by a 2-sec., 250-cps tone. The last tone was then conditioned to a response to an acquisition level of 90%. Following this training, animals were divided into subgroups and were given 20 trials a day at 250, 500, 1,000, 2,000, 4,000 and 8,000 cps frequencies. The interesting finding was that the pretraining group showed significantly more responses then its control at the 2,000 and 4,000 cps frequencies only. It was concluded that the effect of stimulus similarity on SPC appears to be all-or-none in character rather than graded.

Number of PC Trials: Related to the problem of acquisition training is that of the number of PC trials in phase I of the experimental procedure. There is little direct information on this issue, but the available evidence strongly suggests that the function is discontinuous. In a study reported by Hoffeld, Kendall, Thompson and Brogden (1960) it was found that the magnitude of SPC increased up to 4 trials, declined to an approximately uniform level for 8, 10, 20, 40 and 80 trials, increased again at 200 trials and then declined again at 400 and 800 trials. In studies reported earlier (Brogden, 1939; Karn, 1947; Brogden and Gregg, 1951) it was indicated that the number of trials in the PC phase had no appreciable effect on the rate of response acquisition and transfer. Evidently, SPC bears no simple relationship to the number of PC trials.

Time Relationships: In any type of conditioning situation the temporal element is very important. Lyons (1953) exposed rats to six PC arrangements: (a) light and buzzer simultaneously, (b) onset of light preceding onset of buzzer by 0.7 secs., (c) light and buzzer presented randomly, (d) light only, (e) buzzer only, (f) neither light nor buzzer (i.e., apparatus habituation). All animals were then trained to jump a barrier at the sound of a buzzer to avoid shock. Similar training to a flashing light followed. One finding directly related to the time element was that the simultaneous presentation of buzzer and light was not less effective than the condition in which the onset of light preceded the onset of the tone. Hoffeld, Thompson and Brogden (1958) showed that the magnitude of the SPC effect is greatest if the to-be CS precedes the other stimulus by more than four seconds, but ends simultaneously with it. Similar results were obtained in other studies (Silver and Meyer, 1954; Wickens and Cross, 1963): the forward SPC presentation in phase I facilitates a greater number of transferred responses in phase III than either the simultaneous or the backward presentation. Wickens and Cross (1963) delimited the forward preconditioning situation even further by showing that the most effective inter-stimulus difference was 400 msec., the least effective was 600 msec. These interesting findings seem to indicate that the magnitude of SPC is not a continuous function of the to-be CS and the to-be test stimulus interval. Rather, the SPC function tends to approximate that of Classical conditioning.

Stimulus Intensity: There is very little information regarding the effect of stimulus intensity on SPC. Thornton (1958) exposed one group of rats to intersensory stimuli of high intensity and another group to intersensory stimuli of low intensity in numerous PC trials. Four control groups were presented with a high intensity stimulus or a low intensity stimulus from either modality during preconditioning. Some of the groups were then conditioned under high or low unimodal stimulation. In the third phase, transfer training was carried out by presenting the other stimulus under high or low intensity. The SPC effect was only present in the group which was preconditioned with the paired presentation of low intensity stimuli, conditioned to a low intensity auditory stimulus and tested under a low visual stimulus. Wokoum (1959) investigated the intensity of the stimulus given first and the stimulus presented second in an overlapping, forward manner during the PC phase. It was found that the intensity of the stimulus presented first in the PC phase was inversely related to the amount of SPC, whereas the intensity of the stimulus presented second was curvilinearly related to the amount of SPC. According to these results, it appears that increasing the intensity of the stimulus presented second during preconditioning may produce a facilitative effect on SPC. Neither of these investigators has manipulated the intensity of the UCS.

Motivational Variables: The question of the effect of motivational states on the SPC effect has been examined by two investigators. Bahrick (1953) trained his rats to make an avoidance running response to a buzzer after a great number of paired presentations of buzzer and light. The same training was instituted with respect to the light during the critical test phase. One group of animals was deprived of food for 14 hours (high food deprivation), a second group was not deprived (satiated) and a control group was deprived of food for 14 hours. The first experimental group (high food deprivation) showed a significantly greater number of SPC responses than the other two groups. An attempt by Seidel (1958) to verify these findings resulted in conflicting evidence. However, the two studies differed somewhat in procedure: Seidel deprived his animals of food for 22 hours in the PC phase and then he established a hurdle-jumping conditioned response under the following conditions: (a) 22 hours of food deprivation, (b) 17 hours of water deprivation, and (c) no deprivation. A control group learned the avoidance response under 22 hours of food deprivation. The results showed that extinction to the test stimulus was slower in the experimental groups than the control group, but the experimental groups did not differ significantly among themselves. Seidel's findings seem to indicate that differential states of deprivation during the process of SPC do not necessarily facilitate or retard response transfer. That is to say, the elicitation of a mediating autonomic response under various drive states appears to have no particular bearing on SPC.

Effect of Instructions: Only one study has been reported in the literature regarding the effect of different instructions on the magnitude of SPC. Chernikoff and Brogden (1949) divided their subjects in three groups in accordance with the kind of instructions they received. The instructions were given immediately following the PC phase. Briefly, the first group of subjects was told to respond to the CS; the second group was instructed to respond to the CS, but not to the other stimulus; the third group was told that the CS would be followed by the other stimulus and was asked to do whatever seemed natural. Only the first group was significantly different from the control group. The subject's task was to press a key by threat of shock in phase II of the SPC design. The effect of instructions on SPC appears to be as important as in other types of learning phenomena.

Summary of Empirical Findings Related to Manipulation of Antecedent Variables

The results presented in the preceding pages afford a few tentative conclusions regarding the influence of variable manipulations on the SPC phenomenon. They may be summarized as follows: (a) cross-modal generalization tends to decrease with increased acquisition training, (b) the effect of stimulus similarity on SPC appears to be all-or-none in character, (c) response transfer is facilitated most by a small number of PC trials, (d) forward presentation of the to-be CS increases resistance to extinction in the third phase, (e) low intensity intersensory stimuli lead to a greater number of transferred responses than high intensity stimuli do, (f) the effect of high vs low deprivation states during pretraining and conditioning has not been clearly established, and (g) variation in instructions has a definite influence on SPC, but the data are extremely limited for any generalized conclusions.

III Hypotheses to be Tested

A review of the past findings seems to indicate a lack of information concerning the existence of SPC in intellectually retarded populations and suggests the following hypotheses to be investigated in the present study:

1. That the SPC phenomenon exists in the institutionalized mentally retarded population.

2. That mildly retarded (measured intelligence Level II) individuals, as opposed to moderately retarded (measured intelligence Level III) individuals, will show a stronger SPC effect. (See Appendix A for levels of measured intelligence.)

3. That the presentation schedule of a noxious, aversive UCS on a partial as opposed to a continuous presentation will lead to

a greater number of transferred responses.

4. That intensity of the UCS, in terms of low or high, will influence performance in the test phase.

5. That there will be interaction effects among these variables.

CHAPTER III

METHOD

This investigation is concerned with the existence of SPC in retarded subjects and the effects of various factors on this phenomenon.

The independent variables under study are: (a) Levels of measured intelligence (Level II, S.D. units: 2.01-3.00; Level III, S.D. units: 3.01-4.00); (b) Schedule of presentation of the noxious UCS (partial vs continuous; (c) intensity of the UCS (weak vs strong).

The dependent variable consists of a frequency count of finger-flexion conditioned responses during the last stage of the experimental procedure.

Division of subjects into experimental vs control groups as an additional factor in the experiment, produces a four-dimensional factorial design (2x2x2x2).

The study will be discussed under four headings: (a) Subjects, (b) Apparatus, (c) General Design, and (d) Procedure.

Subjects

One hundred and twelve mentally retarded subjects (60 males and 52 females) were randomly selected from the population of Parsons State Hospital and Training Center, Parsons, Kansas. The chronological age range was 14 to 20 years. Half of the subjects rated at Level II of measured intelligence, whereas the other half rated at level III of measured intelligence.

Measured intelligence as used in this paper refers to the Parsons adaptation of the AAMD classification[1] which is based on standard deviation units of each IQ score from the mean of scores and includes a range of intelligence quotients rather than just a single score. Appendix A indicates the five Levels of measured intelligence both in terms of standard IQ scores and range of IQ values on various test instruments.

After the subjects were selected according to Levels of measured intelligence, they were then randomly divided into four equal groups: two experimental and two control groups. Table I presents the population characteristics of these groups.

Each of these four groups was subdivided according to the treatment conditions to which it was randomly assigned. These treatment conditions were: (a) presentation schedule of UCS (partial *vs* continuous) and (b) intensity of UCS (weak *vs* strong). There were 16 treatment groups as shown in Table II.

The Apparatus

The apparatus consisted of three separate units; two of these units were located in the experimental room whereas the third unit was situated in the adjoining control room. The equipment in the

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[1]Heber, R. *A Manual on Terminology and Classification in Mental Retardation.* Monograph Supplement to *Amer. J. Ment. Defic.*, Second Edition, 1961.

TABLE I

CHARACTERISTICS OF THE FOUR MAIN GROUPS

		LEVEL III		LEVEL II	
		Exper.	Control	Exper.	Control
CA[1]	Mean	16-5	16-7	17-2	16-7
	SD	1.62	1.58	1.86	1.88
	Range	14-0/20-8	14-0/19-8	14-0/20-2	14-0/20-9
Standard IQ[2]	Mean	3.61	3.68	2.47	2.51
	SD	.26	.26	.31	.35
	Range	3.06-4.00	3.13-4.00	2.00-2.93	2.00-2.93
Sex	Males	15	14	15	16
	Females	13	14	13	12
	N	28	28	28	28

[1]In years and months.

[2]Since the reported IQ scores were not necessarily obtained on the same test instrument, each score was converted into a standard (z) IQ score for each subject in the four groups and the mean and standard deviation of these values were computed.

experimental room was composed of: (a) a finger-flexion conditioning device with two auxiliary hand restrainers and (b) a panel containing the two intersensory stimuli.

The finger-flexion conditioning device was a fabricated box-like metal structure having the appearance of a miniature stall. Two innerlaced U-shaped polished copper electrodes rested on a rectangular plexiglass board at the front base of the structure. Electrical stimulation of the subject's finger was mediated by passage of a current between the electrodes and the outward side projections of the metal stall. Electric current was fed to the copper electrodes by two multiconducting cables connected with the shock stimulus of the main unit in the adjoining control room through a small opening on the wall separating the two rooms. A movable no. 10 metal wire was located directly above the plexiglass platform running parallel to the length of the subject's finger. A small oval metal strip was attached midway (in crosswise fashion) to this wire for the purpose of avoiding unrecorded conditioned responses. This metal wire terminated at the other end of the fabricated box-like structure bent at various places along the way. The inverted end of this wire pressed down on a set of flexible electrical contact switches (2-in. by ¼-in. each). Every time the subject's finger was raised a conditioned response was registered on an electronic counter located in the control room. Another contact switch just below the first functioned as an indicator of the position of the finger throughout the course of the experiment by activating a red light on the panel of the main unit in the control room. This assured

E that the subject's finger was resting on the electrodes. This check was necessary in order to eliminate subjects showing continuous finger-flexion, unconditionability or superficial conditioning. Both switches were covered with celluloid insulation plates. An auxiliary malleable leather belt attached to an adjustable metal platform was situated in front of the device; this belt was strapped around the subject's wrist preventing him from removing his hand during the conditioning period. A metal restrainer with a curvilinear bend was located directly behind the leather belt operating as an additional hindrance making it impossible for the subject to flex his hand knuckles or in any way avoid the shock stimulus except by finger-flexion. The conditioning device was built on a 12-in. by 15-in. board attached to a 12-in. table-sized stage fastened to the experimental table be means of rivets. It was located directly in front of the subject and was turned sideways in an approximate 35° angular position so that the subject's right hand rested comfortably on the table. For pictures of this unit, see Appendix B_1 and B_2.

The second unit of the equipment was also located in the experimental room and consisted of a 13-in. by 20-in. rectangular three-dimensional panel containing the two intersensory stimuli of light and buzzer. The panel was at a distance of eight feet, eye-level from the subject. The front surface of the panel was covered with white masonite paper at the center of which there was a red automotive lens (diameter: 3 inches). The source of the light was a 6-volt, GE-87 automotive lamp situated directly behind the reflector lens.

The sound was emitted by a small-sized Dixie buzzer operating on a 6-volt DC supply located within the rectangular panel just parallel to the automotive lamp of light. The sound pressure level reading of the buzzer was 69 db RE: 0.0002 µbar as measured on the linear scale of a Brüel & Kjaèl-type 2203 sound level meter. See Appendix C for an illustration of this unit.

An attempt was made to equate the intensity of the light to that of the buzzer by three independent observers. Since there was no definite agreement among these observers, arbitrary, seemingly equivalent magnitudes were selected. These values remained the same throughout the experimental session.

The main unit of the apparatus was found in the control room. It was composed of three Hunter decade interval timers, model 111A and a Lafayette-type timer which functioned as a stepping relay for shock delivery. The first Hunter timer controlled a 4-sec. presentation of light and buzzer (stage I) while the second timer regulated the intertrial interval across all three stages. The third timer was responsible for the 2-sec. presentation of light during stage III of the experimental procedure. All timers operated automatically and independently of each other with the exception of the second timer which was manipulated by E from trial to trial; the intervals varied randomly from 10 to 25 seconds. This variation of time intervals between trials was instituted for the purpose of eliminating any possibility of temporal conditioning. Each timer was accompanied by auxiliary relay contacts; one of these contacts performed the task of mediating one experimental stage after the other without interruption. A selector relay with contact plates provided a friction-type rotary movement and made it possible to deliver electric shock on a preselected partial or continuous basis. Additional relays controlled the number of trials of shock exposure (stage II) and light presentation (stage III). The source of shock was a model 350 Hunter shock stimulus with a voltage capacity from 0 to 100 volts AC controlled by a selector knob on the front panel. Safety was insured by a 5 milliampere fuse. The line frequency of shock was 60 cps. All instruments of this unit were protected by a wooden box standing 10-inches high, 24-inches wide and 20-inches deep. An automatic electronic counter on the top of this box registered the frequency of conditioned responses during the last stage of the experimental session. For pictures of this unit, see Appendix D_1 and D_2.

General Design

The SPC paradigm involved three basic phases: In the first phase, the subjects were exposed to a simultaneous, paired presentation of two intersensory stimuli (i.e., buzzer and light) repeatedly. In the second phase, the finger-flexion response was conditioned to the sound of a buzzer under differential factorial arrangements of shock presentation and intensity as previously discussed (see also Table II). During the third phase, the test stimulus (i.e., light) was presented alone for a number of times.

The experimental groups were exposed to all three phases of the SPC design, while the control groups were presented only with phase II and III of the design. The omission of phase I in the control

TABLE II

PROFILE OF EXPERIMENTAL TREATMENTS

Groups[1]	Treatment	E-C	MI Level	Schedule of Shock Delivery	Shock Intensity
1	$A_1B_1C_1D_1$	E	III	Contin.	Strong
2	$A_1B_1C_1D_2$	E	III	Contin.	Weak
3	$A_1B_1C_2D_1$	E	III	Partial	Strong
4	$A_1B_1C_2D_2$	E	III	Partial	Weak
5	$A_1B_2C_1D_1$	E	II	Contin.	Strong
6	$A_1B_2C_1D_2$	E	II	Contin.	Weak
7	$A_1B_2C_2D_1$	E	II	Partial	Strong
8	$A_1B_2C_2D_2$	E	II	Partial	Weak
9	$A_2B_1C_1D_1$	C	III	Contin.	Strong
10	$A_2B_1C_1D_2$	C	III	Contin.	Weak
11	$A_2B_1C_2D_1$	C	III	Partial	Strong
12	$A_2B_1C_2D_2$	C	III	Partial	Weak
13	$A_2B_2C_1D_1$	C	II	Contin.	Strong
14	$A_2B_2C_1D_2$	C	II	Contin.	Weak
15	$A_2B_2C_2D_1$	C	II	Partial	Strong
16	$A_2B_2C_2D_2$	C	II	Partial	Weak

[1]Seven subjects per group

groups constituted a control for intersensory stimulus generalization.

Statistically, a four-factor analysis of variance design was produced by the division of subjects into experimental and control groups, measured intelligence Levels and variations in shock presentation schedule and intensity during the second phase of the experimental procedure.

Procedure

Each subject was taken to the semisoundproofed experimental room and was asked to be seated on a chair directly in front of the table where the finger-flexion conditioning device was located. When the subject was seated the following instructions were given (these instructions were similar for both experimental and control groups):

> You are going to hear a buzzer. Do you know what a buzzer is? (If the subject did not know, E explained.) You are also going to see a red light over there (E shows). Now, I want you to put your middle finger in here like this (E shows). Later on, you are going to feel a tingling in your finger. You may avoid this tingling by letting your finger fly up. Just relax, listen to the buzzer, look at the light and let your finger do what it wants to do. O.K.? I am going to put this belt around your wrist so that your hand can stay in place.

Upon completion of the instructions, the subject's right hand was strapped to the table with the middle finger resting on the two U-shaped copper electrodes inside the finger-flexion conditioning unit. The investigator then left the experimental room, closed the door separating the two rooms, switched off the ceiling light and proceeded with the experiment.

The procedure was as follows: All subjects in the experimental groups were given the first phase of the SPC paradigm which consisted of 25 simultaneous, paired presentations of buzzer and light with a time duration of four seconds for each trial. Phase I was not given to the control groups.

In phase II, each subject was given 32 finger-flexion conditioning trials with the buzzer serving as a conditioning stimulus and electric shock as an unconditioned stimulus. The buzzer had a 2-sec. duration; shock was presented for 0.2-sec. following the onset of the buzzer in a forward Classical conditioning arrangement. This short exposure to electric shock made it possible to prevent habituation to the unconditioned stimulus (Lyons, 1953). Electric shock was scheduled on a continuous (shock every time), or partial (shock every third time) presentation during conditioning training. The intensity of electric shock also varied during this period in terms of weak (low intensity shock) or strong (high intensity shock). Crude mean values for weak and strong electric shocks were determined during a pilot study as 15 and 45 volts, respectively. Both experimental and control groups were presented with phase II.

In phase III, the red light was presented alone ten times. The duration of the light was two seconds on each trial. Both experimental and control groups participated in phase III.

The time interval between the three phases was fifteen seconds, while the interval between presentations of the intersensory stimuli within each phase, varied randomly from ten to twenty-five seconds.

During the conditioning period, the possibility of response training was maximally insured by employing a criterion of at least four consecutive conditioned responses out of the last six presentations of the 32-trial conditioning period.

In addition, the chance occurrence of a superficially conditioned response pattern during the test phase was greatly minimized by instituting a criterion of six out of a possible ten transferred responses. Subjects showing a random pattern of responses during this phase were eliminated.

The response measure employed in this investigation was frequency; i.e., the number of times each subject flexed his finger to the presentation of the light in phase III. Frequency of responses was recorded by an electronic counter.

The experimental session lasted for about twenty minutes for subjects in the experimental groups and fifteen minutes for subjects in the control groups.

CHAPTER IV

RESULTS

This chapter deals with the statistical treatment of the obtained response frequencies. An analysis based on an extension of a three-factor dimensional analysis of variance discussed by Edwards (1960) was the major statistical technique employed. The variables under manipulation were: (a) experimental vs control groups, (b) measured intelligence Level II vs measured intelligence Level III, (c) partial presentation of UCS vs continuous presentation of the same stimulus and (d) a low intensity UCS vs a high intensity UCS.

An application of Barlett's test of homogeneity to the data showed the absence of any significant departure from homogeneity ($p > .05$). This result was also verified by an application of Hartley's Fmax test.

Table III depicts the summary of the analysis of variance of the four factors indicated above in various treatment arrangements. These factors and their interactions form a 2x2x2x2 factorial design.

It is obvious from Table III that the only F value that attained statistical significance ($p < .01$) was that of the first factor: the experimental groups showed a significantly greater number of transferred responses than the control groups. This is also evident from Figure 1;

TABLE III

SUMMARY OF THE ANALYSIS OF VARIANCE (2x2x2x2)

	Source of Variance	SS	df	MS	F
A	Exp. vs. Control	54.3214	1	54.3214	7.4772**
B	Intelligence Level	11.5714	1	11.5714	1.5928
C	Schedule of UCS	5.1428	1	5.1428	--
D	Intensity of UCS	8.0357	1	8.0357	1.1061
AxB	Exp. x Intelligence	17.2857	1	17.2857	2.3793
AxC	Exp. x Sched. UCS	3.5714	1	3.5714	--
AxD	Exp. x Intensity UCS	2.8929	1	2.8929	--
BxC	Intell. x Sched. of UCS	4.3214	1	4.3214	--
BxD	Intell. x Intens. UCS	2.2857	1	2.2857	--
CxD	Sched. UCS x Intens. UCS	3.5714	1	3.5714	--
AxBxC	Exp. x Intell. x Sched. UCS	4.3220	1	4.3220	--
BxCxD	Intell. x Sched. UCS x Intens. UCS	0.3216	1	0.3216	--
AxCxD	Exp. x Sched. UCS x Intens. UCS	0.5716	1	0.5716	--
AxBxD	Exp. x Intell. x Intens. UCS	0.0001	1	0.0001	--
AxBxCxD	Exp. x Intell. x Sched. UCS x Intens. UCS	0.0349	1	0.0349	--
Error	Within Cells	697.4286	96	7.2649	--
	Total	815.6786	111		

**p = < .01

performance in phase III is significantly higher in the combined experimental groups than the combined control groups. It is also interesting to observe that the initial presentations of the test stimulus elicit the largest number of transferred responses.

None of the other factors, main effects and interactions approached significance. Hence, we have no reason to believe that the group means of one factor differ significantly from one another. The lack of any interactions suggests that the four factors function independently of one another.

From inspection, it became apparent that the differences between the eight treatment subgroup means of the experimental groups were not uniform. As a result, it was decided to test for possible significant mean frequencies among these groups by applying a separate analysis of variance to this portion of the data (Table IV).

It can be seen from Table IV that none of the treatment means deviated significantly from the others with respect to any differential effectiveness on the dependent variable. (An additional analysis was applied to the same data by means of Duncan's New Multiple Range Test showing the same results. See Appendix E.)

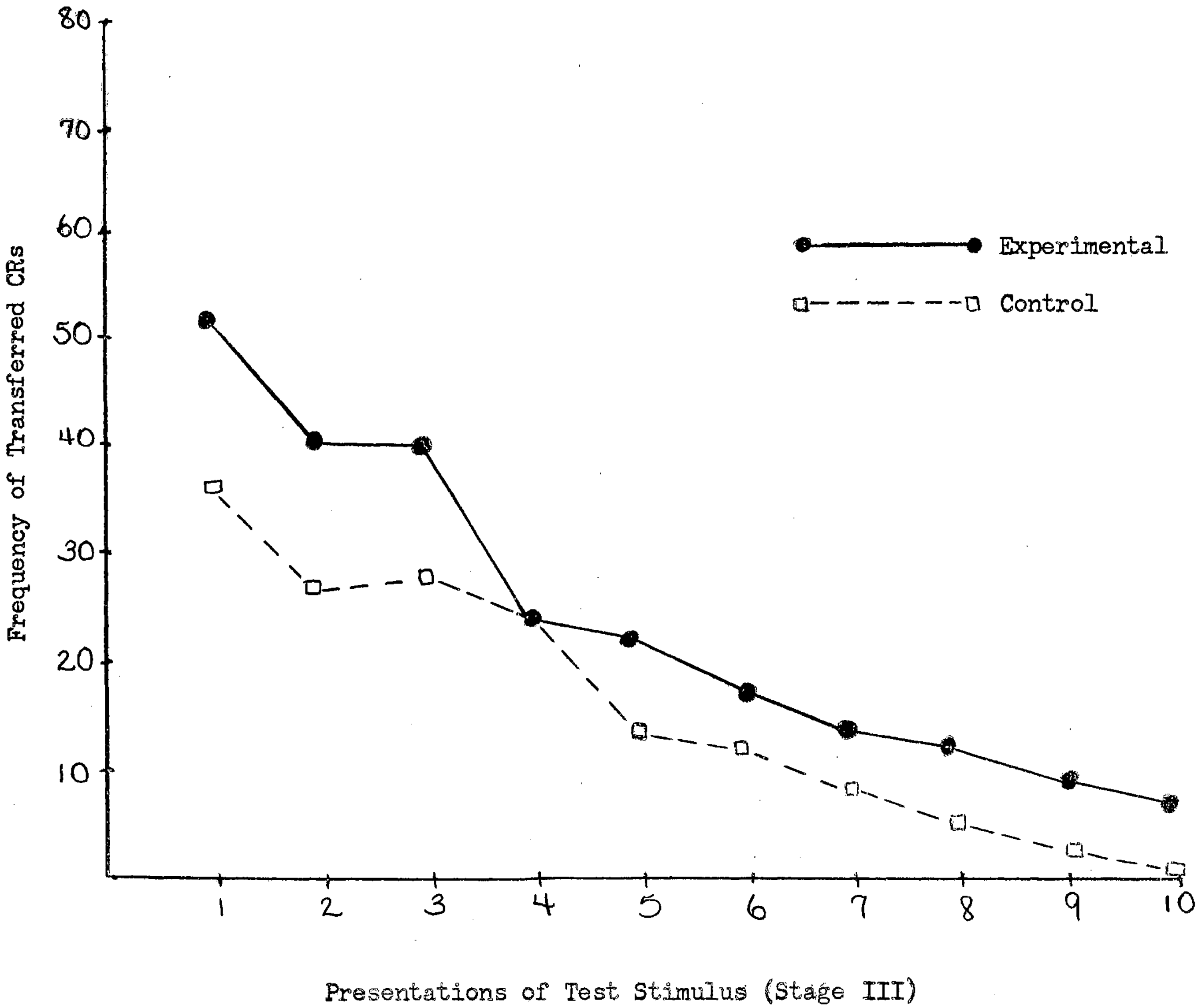

Fig. 1 Performance curves for SPC based on the frequency of transferred CRs per each consecutive presentation of the test stimulus.

TABLE IV

SUMMARY OF THE ANALYSIS OF VARIANCE
(Experimental Groups)

Source of Variance		SS	df	MS	F
B	Intelligence Level	28.571	1	28.571	3.213
C	Schedule of UCS	8.643	1	8.643	--
D	Intensity of UCS	10.288	1	10.288	1.157
BxC	Intell. x Schedule	8.643	1	8.643	--
BxD	Intell. x Intensity	1.143	1	1.143	--
CxD	Sched. x Intensity	.643	1	.643	--
BxCxD	Intell. x Sched. x Intensity	.069	1	.069	--
Error	Within Cells	426.857	48	8.893	
	Total	484.857	55		

CHAPTER V

DISCUSSION OF RESULTS

The present investigation was conducted for the purpose of testing the existence of the SPC phenomenon with a segment of the institutionalized mentally retarded population under a number of treatment conditions.

One of the most important findings of this study reveals that such a phenomenon is present in intellectually retarded individuals. This is indicated by the significantly higher incidence of transferred conditioned responses by subjects in the experimental groups who were exposed to phase I of the procedure over the subjects in the control groups who were not presented with this phase. These results are in agreement with those of previous investigators with human subjects (Karn, 1947; Brogden, 1947; Coppock, 1958). However, the present findings extend the applicability of the SPC phenomenon to a mentally subnormal population.

It was indicated earlier (Chapter II) that at least two main theoretical formulations have been offered to account for the SPC effect. The S-S analysis is built on the concept of situational sets formed by the contiguous association of two intersensory events during the PC phase (Brogden, 1939). The S-R position holds that unobserved conditioned responses are formed in the first phase of the SPC design in terms of sensory feedback or self-stimulation produced by a mediation process (Osgood, 1953). Whereas both of these theories have their merits, neither seems to be comprehensive enough to incorporate the findings of this study with mentally retarded human subjects.

The present investigator is inclined to favor a stimulus trace interpretation of the SPC effect along theoretical lines developed by Ellis' (1963) experimental work on learning. Briefly, this theory advances the position that a stimulus trace (s_t) and a central nervous system (CNS) integrity (n_i) are useful constructs that can be assumed to underline a majority of learning situations based on a short-memory mediation process. The s_t can be empirically defined, on the one hand, by the properties of the antecedent stimulus (i.e., duration, amplitude, intensity, etc.) and on the other, by the immediate consequence of the behavioral event produced by the impinging stimulus. Organismic variables (i.e., IQ scores) may offer tentative definitions of n_i. It is hypothesized that any stimulus that is strong enough to arouse an organism's receptor system will produce changes in the electrical activity of the cerebral cortex leading to reverbatory neural circuits. The duration and extent of these afterchanges will depend mainly upon the presence or absence of a CNS impairment. Ellis (1963) presents evidence to show that the relationship(s) between s_t and n_i is a very important one and that the closer the proximity of any two stimuli in time the higher will be the subnormal's learning efficiency.

If we now extend Ellis' theoretical notions to the area of SPC, it becomes evident that certain assumptions can be made regarding the nature of the phenomenon with respect to a subnormal population. It can be assumed that the temporal, consecutive joining of the two intersensory stimuli in stage I of the procedure initiated a dual process of neural traces which persisted for some time after the visual and auditory receptors ceased to be stimulated. When one of the two stimuli (i.e., buzzer) became the conditioned stimulus in stage II, the memory trace of the nonconditioned stimulus (i.e., light) also acquired the properties of a conditioned stimulus because of the continuation of electrical neural activity from the first phase. On a subsequent occasion, the same conditioned response was given to the critical stimulus whose neural trace had already been conditioned. The control groups were obviously at a disadvantage since there was no trace carry-over of the test stimulus from the second to the third stage of the procedure by virtue of the fact that a dual process of neural reverberations was never established and a paired stimulus trace familiarization never occurred.

It has been already pointed out that differences among the various treatment means proved to be negligible and there was no superiority of one treatment condition over the other. Apparently, the combination of all treatments was effective in producing the SPC effect rather than any individual treatment alone.

The failure to obtain significant treatment effects may be due to a number of reasons some of which can be briefly discussed here.

Despite the lack of heterogeneity in the data, it is evident that a large within-cell variance exists which seems to indicate that the same treatment condition did not affect all subjects in an equal manner. Apparently, the differences produced by the treatment conditions were not constant from subject to subject within each group; i.e., some subjects overresponded to the test stimulus, whereas others responded only minimally or not at all. When this state of affairs is obtained by the differential response of each subject to the same stimulus, it usually generates a large amount of experimental error. If this is the case, the probability that an unknown subject-treatment interaction has occurred becomes high, having an adverse influence on the variables directly manipulated by the experimenter.

This is not foreign to other investigations. Previous research experiences with the mentally retarded has shown that the observed response inconsistency from subject to subject is generally the rule rather than the exception, in many studies of learning. There may be present in the subject a host of organismic variables that may have had an unknown indirect influence on the amount of transferred responses in stage III. Among these may be organicity, anxiety, suggestibility, attitude, motivation, etc.

The lack of any significant differences between the two levels of measured intelligence was not very surprising. Recent studies on Classical conditioning have shown the absence of any reliable relationship between IQ level and conditionability or extinction (Birch and Demb, 1959; Franks and Franks, 1960; Cromwell, et al, 1961).

It is born out that organic, maturational and genotypical intersubject variations play a predominantly larger part in the process of many conditioning situations than do IQ scores arranged in terms of standard deviation units. Evidently, the SPC paradigm is also subject to the same interpretation.

From S-R theory, one would expect that the partial presentation of the unconditioned noxious stimulus will lead to a significantly superior number of transferred responses than the continuous presentation of the same noxious stimulus. Lewis (1960) presents some evidence to show that a negatively reinforcing stimulus (i.e., electric shock) prolongs resistance to extinction more when presented intermittently than continuously. The results of the present study do not show any evidence that the partial presentation of the aversive unconditioned stimulus (i.e., electric shock) was more effective in producing the SPC effect than the continuous presentation of the same stimulus. This would seem to imply either one of two possibilities: (a) SPC functions independently of the principle of partial reinforcement or (b) the presentation of a noxious stimulus does not follow the same predicted direction as that of a positively reinforcing stimulus. Since this variable has never been manipulated before within the SPC framework, no definite answers can be given as to which of these two possibilities would be more tenable.

Our results also show that the subjects did not perform differentially under the two intensities of the electric shock stimulus. Thus, it cannot be said that strong shock yielded a better transfer of conditioned responses than weak shock. This again appears to be contrary to S-R expectations which would hold that the more potent the intensity of the unconditioned stimulus, the greater the conditionability and resistance to extinction (Spence, 1962). It can be argued that the nature of the unconditioned stimulus results in subjective magnitudes which do not correspond on one-to-one basis with the actual stimulus magnitudes. Stevens (1958) has shown that at the high current values the growth of sensation is not as steep as in the lower current values. Obviously, the psychophysical magnitude grows more rapidly than the stimulus magnitude in terms of an approximate power function relationship. The question of stimulus adaptation is ruled out from the present investigation since the 2/10 of a second shock duration is unlikely to permit any adaptation process to take place. With respect to theory, our data are not conclusive enough to permit any reliable generalizations.

The upshot of this discussion appears to imply that subnormal individuals with moderate and mild levels of intellectual retardation are capable of consolidating stimulus traces during a relatively short period of time. This consolidation seems to be a function of the temporal pairing of two intermodal stimuli in an antecedent situation. However, the interindividual variability within each group strongly suggests - in agreement with the Ellis' hypotheses - that stimulus trace deficits do exist in a differential manner from subject to subject according to the locus, nature and extensiveness of a CNS insult.

Suggestions for Future Research

The present results raise a number of questions regarding future work in the area of SPC. Since this type of paradigm has never been applied to a subnormal population in the past, it will be of interest to duplicate the same experimental procedure with a similar population which has been differentiated not in terms of IQ scores, but rather, according to definite etiological categories (i.e., organics vs nonorganics). It is suspected that the variability shown within the treatment groups may be due to this factor. Also, an additional control group should be present in order to equate familiarity of the test stimulus with the to-be conditioned stimulus.

More work is needed, preferably with larger groups, for the purpose of elucidating the obtained nonsignificant treatment effects with respect to schedule of presentation and intensity of the unconditioned stimulus on normal subjects; this will afford a direct comparison between the subnormal and normal groups. It will also be of interest to compare groups with different time pairings of the two intersensory stimuli in stage I. If possible, a quantitative equivalence of these stimuli should also be attempted. The number of conditioning trials in stage II is another variable that can be manipulated. One also wonders what will happen if the interstage time interval is increased so that long-term memory will become a key variable.

CHAPTER VI

SUMMARY AND CONCLUSIONS

This investigation was designed to explore the applicability of the SPC phenomenon to a subnormal population under a number of previously unexamined conditions during the second phase of the SPC paradigm. More specifically the following questions were raised:

1. Does the SPC phenomenon exist in a portion of the subnormal, institutionalized mentally retarded population?

2. Do mildly retarded (Measured Intelligence Level II) individuals as opposed to moderately retarded (Measured Intelligence Level III) individuals show a SPC effect of a stronger strength?

3. Would the schedule of a noxious, aversive UCS on a partial as opposed to a continuous presentation have any definite bearing on the phenomenon?

4. What will be the influence of a high intensity *vs* a low intensity UCS on the final test phase?

5. What are the interaction effects of these variables?

For the purpose of investigating these questions, 112 subjects, Measured Intelligence Levels II and III, were randomly allocated to a factorial design containing sixteen treatment groups. The SPC paradigm involved three basic stages: In the first phase the subjects of the experimental groups were exposed to a simultaneous paired presentation of two intersensory stimuli (i.e., buzzer and light) repeatedly. In the second stage, the finger-flexion response was conditioned to the sound of a buzzer under differential factorial arrangements of shock presentation and intensity. During the third stage, the test stimulus (i.e., light) was presented alone for a number of times. The control groups were not exposed to the first stage of the experimental procedure (this constituted a control of cross-modal generalization).

The findings indicated the existence and applicability of the SPC phenomenon with a subnormal population. However, the individual treatment combinations did not show any differential superiority with respect to each other. It was found that: (a) individuals functioning at the mild range (Level II) of intellectual retardation did not respond significantly more than individuals functioning at the moderate range (Level III) of retardation. (b) Presentation of the UCS (i.e., electric shock) on a partial (e.g., intermittent) schedule did not lead to a significantly higher number of transferred responses than the presentation of the same stimulus on a continuous schedule. (c) The groups experiencing a strong electric shock (UCS) did not perform better than the groups receiving a weak electric shock. (d) No interaction effects among the treatment factors were evident.

An attempt was made to integrate the SPC effect within Ellis' theory of stimulus trace. Also, a number of assumptions were made to account for the ineffectiveness of treatment variables.

Whereas the present results appear to argue that the conditions during the training stage have little bearing on SPC, the generality of this statement will depend upon future work in this area.

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APPENDICES

APPENDIX A

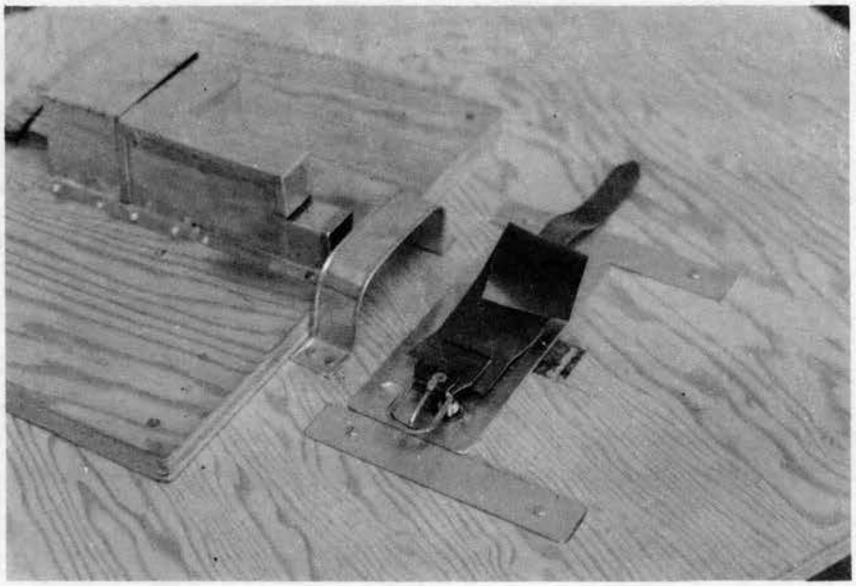
LEVELS OF MEASURED INTELLIGENCE

Conversion of I.Q. Scores According to Standard Deviation Values

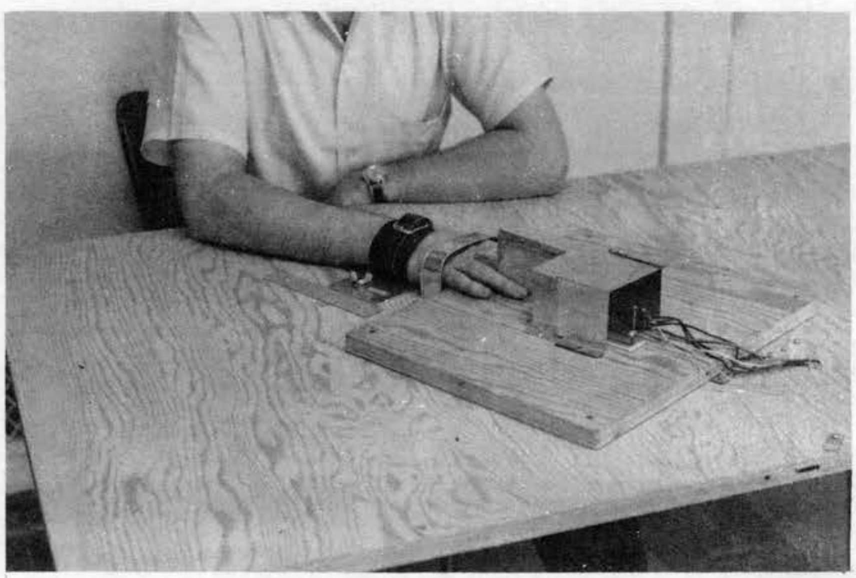
Level	Range of Level in S.D. Units	W-B I & II WISC & WAIS	Stanford Binet Forms L & M	Arthur Adaptation of Leiter	Arthur Point Scale Form I	Draw A Person Test	Vineland
-I	-1.01 to -2.00	84-70	83-68	83-68	83-67	77-61	88-78
-II	-2.01 to -3.00	69-55	67-52	67-52	66-50	60-48	77-67
-III	-3.01 to -4.00	54-40	51-36	51-36	49-33	47-36	66-56
-IV	-4.01 to -5.00		35-20	35-20	32-16	35-25	55-45
-V	-5.0		20	20	16		44-0

Considerations of the conditions under which testing occurred, special handicaps in the testing situations, projective test evidence concerning intellectual efficiency or personality factors that might have introduced artifact into the measurement results, and similar clinical judgments are to be used in assigning those levels. In cases with the results of two or more tests indicating different levels, the strongest (i.e., the more comprehensive, the more valid, the more reliable) test is to receive more weight in assigning the level.

APPENDIX B

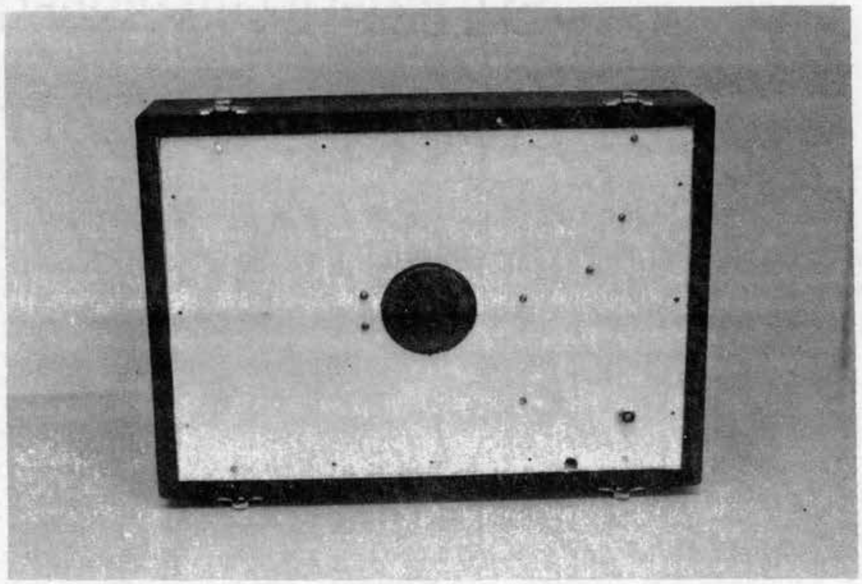


1. Slanted view of the finger-flexion conditioning unit from S's side.



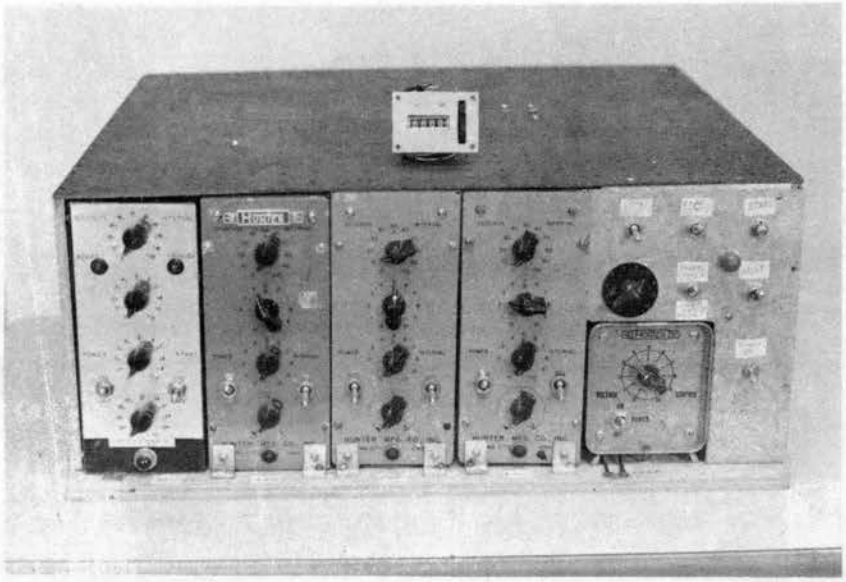
2. Side view of the same unit with the S's middle finger inserted into the finger stall

APPENDIX C

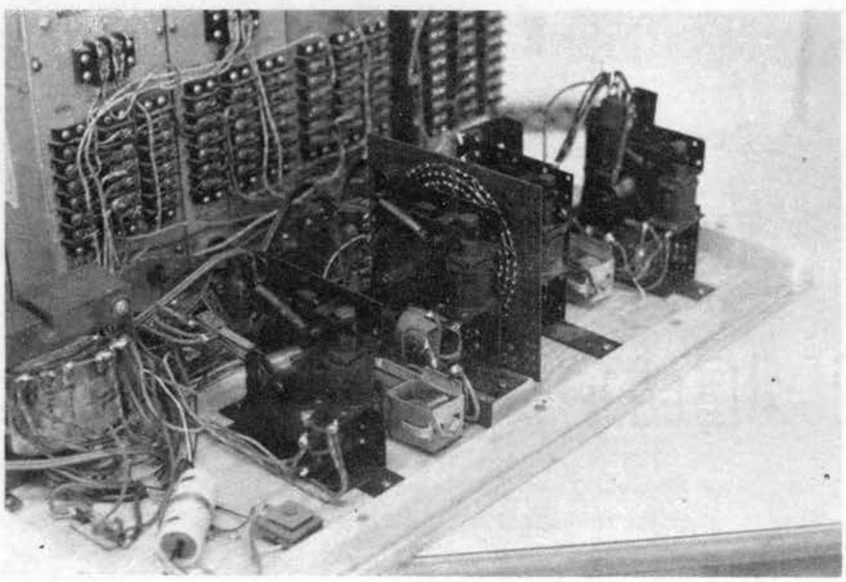


Front view of the panel containing the buzzer and the light. The round disc-like figure in the middle provided the reflector lense for the light.

APPENDIX D



1. Front view of the control unit showing the four interval timers, shock stimulus, electronic counter and the activity light.



2. Rear view of the same unit exposing the auxiliary and selector relays along with contact plates.

APPENDIX E

DUNCAN'S NEW MULTIPLE RANGE TEST

-- Experimental Groups --

	Means	(1) A 3.000	(2) B 3.286	(3) C 3.571	(4) D 3.571	(5) E 3.857	(6) F 4.571	(7) G 5.000	(8) H 6.286	Shortest Significant Ranges*	
A	3.000		.286	.571	.571	.857	1.571	2.000	3.286	R_2	3.209
B	3.286			.285	.285	.571	1.285	1.714	3.000	R_3	3.367
C	3.571				.000	.286	1.000	1.429	2.715	R_4	3.480
D	3.571					.286	1.000	1.429	2.715	R_5	3.559
E	3.857						.714	1.143	2.429	R_6	3.616
F	4.571							.429	1.715	R_7	3.672
G	5.000								1.286	R_8	3.718
H	6.286										

*R values are computed at $\alpha = .05$

APPENDIX F

ORIGINAL DATA FREQUENCY SCORES

Experimental Groups — Control Groups

	A_1								A_2							
	B_1				B_2				B_1				B_2			
	C_1		C_2		C_1		C_2		C_1		C_2		C_1		C_2	
	D_1	D_2	D_1	D_2	D_1	D_2	D_1	D_2	D_1	D_2	D_1	D_2	D_1	D_2	D_1	D_2
	1	2	6	4	3	3	10	2	1	0	4	2	0	0	5	0
	1	1	7	1	4	2	2	8	4	2	3	3	2	2	2	1
	3	0	8	5	4	1	9	3	6	0	5	1	5	0	2	2
	5	9	0	1	3	4	3	9	2	8	6	8	3	7	5	3
	6	1	3	4	10	2	10	9	2	3	4	0	2	5	2	5
	8	3	2	2	5	3	6	3	2	6	0	0	4	3	0	5
	1	7	1	4	3	10	4	1	0	3	0	4	3	1	6	0
Σ	25	23	27	21	32	25	44	35	17	22	22	18	19	18	22	16
M	3.57	3.29	3.86	3.00	4.57	3.57	6.39	5.00	2.43	3.14	3.14	2.57	2.71	2.57	3.14	2.29

A = Experimental vs Control; B = Intelligence Levels; C = Schedule of UCS Presentation

D = Intensity of UCS

VITA

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