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ABSTRACT

Previous research has indicated that for discretely (paired associate) as well as continuously (sound-film) presented information, high arousal during acquisition results in poor immediate recall, but is characterized by a strong reminiscence effect. Low arousal learning results in better immediate recall with poor retention. The hypothesis that high arousal during learning results in increased long term retention, but poor immediate recall, was found tenable. Similarly, it was confirmed that low arousal facilitates improved short term retention with a typical forgetting curve. The implication of this study for the educator centers on a re-examination of the arousal state of the learner during the learning process. (Author)

Final Report
Project No. 03010
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THE EFFECTS OF EMOTIONAL AROUSAL ON SHORT VERSUS LONG TERM RETENTION OF CONTINUOUSLY PRESENTED INFORMATION

John F. Lavach
College of William and Mary
Williamsburg, Virginia 23185

February, 1971

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

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U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

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(11)

ABSTRACT

The Effects of Emotional Arousal on Short Versus Long Term Retention of Continuously Presented Information

Purpose: The purpose of this investigation was to determine if emotional arousal effects short versus long term retention of aurally presented continuous information.

Previous research has indicated that for discretely (paired associate) as well as continuously (sound-film) presented information, high arousal during acquisition results in poor immediate recall, but is characterized by a strong reminiscence effect. Low arousal learning results in better immediate recall with poor retention. The investigator restricted this study to an analysis of the auditory sense and the arousal retention phenomenon. It was hypothesized that if taped information is preceded by a simulus word of high or low emotional arousal value, as measured by galvanic skin response (GSR) and heart beat, learning and subsequent retention would be effected.

Method: Fifty subjects in five retention groups individually listened to a taped 20 minute lecture. Emotion arousing words preceded

selected passages while the subject's galvanic skin response and heart beat were recorded. Subjects were tested for retention over the critical passages.

Findings and Conclusions: The hypothesis that high arousal during learning results in increased long term retention, but poor immediate recall, was found tenable. Similarly, it was confirmed that low arousal facilitates improved short term retention with a typical forgetting curve. It is postulated that underlying the arousal retention phenomenon may be some interaction between the orienting reflex and consolidation hypothesis.

The implication of this study for the educator centers on a re-examination of the arousal state of the learner during the learning process. Also the educator must develop evaluative procedures which are effective in tapping either short term retention, long term retention, or both. Perhaps the most important implication of the arousal retention phenomenon is in its application to individualized instruction where control over arousing stimuli may be carefully monitored.

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A. Problem and Objectives

Several studies of the relationship between arousal, as measured by galvanic skin response (GSR), and retention of information learned during such aroused states have been recently conducted. Findings of these studies suggest that low arousal learning results in better short term retention than long term, while high arousal produces the opposite effect; i.e., poor short term retention with improved long term retention. Reinforcement, Hebb's reverberating circuits, and the orienting reflex are some of the constructs which have been postulated to explain the arousal-retention phenomenon.

Kleinsmith and Kaplan (1963) reported that in a study of forty-eight individually run subjects learning a list of eight paired-associate word-digits such as kiss-2, vomit-4, and dance-6, low arousal during acquisition resulted in increased short term memory while high arousal resulted in increased long term memory. Each subject was presented with eight paired-associate word-digits while simultaneously his GSR's were recorded. A decrement in skin resistance within four seconds of the onset of the stimulus was the indicator of arousal. Each of the eight paired-associate pairs was then rank-ordered into either the four "high arousal learning," or four "low arousal learning" groups. Six subgroups were tested for retention: immediate recall, two minutes, twenty minutes, forty-five minutes, one day, and one week. For retention of low arousal paired-associates, a typical forgetting curve was plotted; while for high arousal pairs, subjects demonstrated a high reminiscence effect as shown in figure 1.

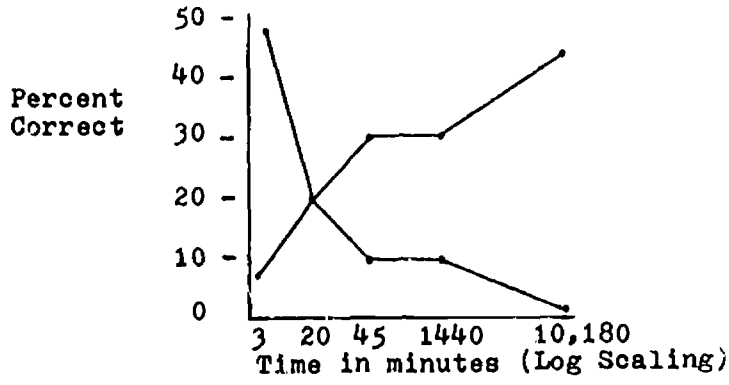


FIG. 1

Interaction effect of arousal and time on recall of paired associates. (After Kleinsmith and Kaplan, 1963)

In a similar study, Kleinsmith and Kaplan (1964) examined the same phenomenon using six nonsense syllables having zero association value. These were paired as in the previous study with six individual digits. Each of the thirty-six subjects first saw the nonsense syllable alone for four seconds followed by the same nonsense syllable and a single digit. Arousal was measured by GSR deflection and retention was examined over two minutes, twenty minutes, and one week. Findings indicate that for immediate recall, digits paired with low arousal nonsense syllables were retrieved four times more often than digits paired with high arousal nonsense syllables. However, retention of high arousal nonsense syllable-digit pairs increased 100% at twenty minutes and 200% at one week.

Butter (1969) replicated the Kleinsmith and Kaplan investigations and corroborated their findings; paired-associates learned under low arousal resulted in better short term retention and paired-associates learned under high arousal resulted in better long term retention. In an additional investigation

examining the relationship between arousal and concreteness-imagery, Butter found an additional effect. High concreteness-imagery nouns were associated with low arousal and poor long term retention, while low concreteness-imagery nouns were associated with high arousal and increased long term retention.

The application of these findings to a classroom situation is not immediately apparent because the studies cited were concerned with discretely presented information while classroom instruction is typically characterized by continuously presented information as in lecture, film, etc. In an attempt to determine whether the same phenomenon holds for a classroom environment, Levonian (1967) studied arousal level and subsequent retention in eighty-three driver-education students who watched a ten-minute traffic safety film containing scenes which would generate high arousal. Recording GSR's while the film was shown, the experimentors, with the aid of a computer, analyzed the subject's GSR to each of the 16,080 frames of the film. A fifteen item yes-no retention test was administered after the film was shown and again, unannounced, one week later. Results suggested that for continuously presented information, as with discretely presented information, subjects forget material learned under low arousal and experience reminiscence for information learned under conditions of high arousal.

Levonian maintains that there are significant implications to education concerning the potentiality of these findings. Educators, he claims, are interested in long term retention, but their measures are usually of the short term variety. Here the implication is if student A outperforms student B on

a short term test, it is possible that an opposite effect could be expected over a longer period of time if the arousal-retention hypothesis holds. It may be possible, therefore, for an instructor to precede highly critical information which must be retained with an appropriately selected vocabulary in order to induce an arousal state. Similarly, an instructor could present such highly critical information only when an aroused state is experienced by the subject, whatever its cause.

In the preceding studies, information was presented to the subject primarily through the modality of vision. Still unexplored is the sense of audition, a highly important channel of sensory reception in the instructional-communication process. It is the purpose of this study to re-examine the Levonian findings for continuously presented information and, further, to analyze the relationship between emotional arousal and short versus long term retention of aurally presented information. It is hypothesized that for the conditions stated above, high arousal during acquisition will be marked by a strong reminiscence effect while low arousal during acquisition, the opposite will be true; that is, a typical forgetting curve will be observed. Diagrammatically the hypotheses may be represented as in figure 2.

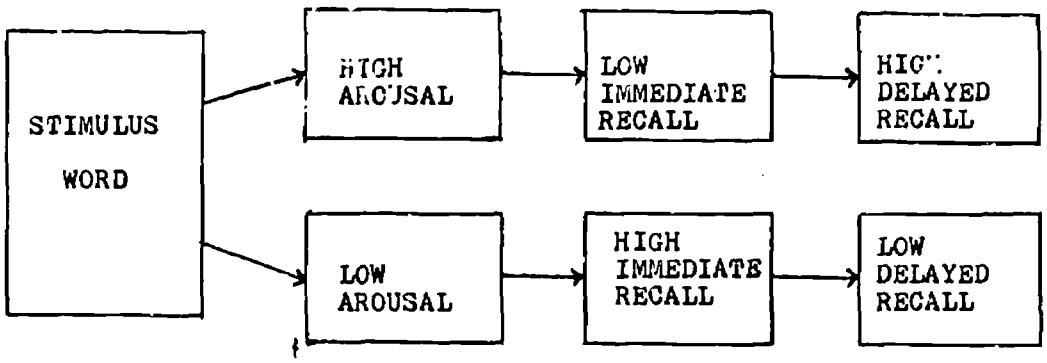


FIG. 2

Predicted effect of high arousal versus low arousal on long term versus short term retention of continuously presented information

B. Procedure

Subjects, after having been informed that the purpose of this study was to measure physiological reactions to auditory stimuli, and that they would receive a full report and explanation at the conclusion of the investigation, were audiometrically tested. After an initial ten-minute period during which the subject's GSR and heart-beat were permitted to stabilize, he was informed that for the next one minute a recording of the alphabet would be played. This permitted the subject to adjust to auditory stimulation before the actual continuous information was presented. A taped lecture of approximately 20 minutes, recorded by a professional radio announcer, was played for each of the fifty individual, randomly selected undergraduate and graduate students at the College of William and Mary. The lecture, consisting of continuously presented factual information from a United States Supreme Court decision, contained selected critical passages to be tested for retention. Preceding each of these segments, a word judged in previous studies to have high or low arousal value was presented. The words selected were: vomit, rape, kiss, dance, swim, money, exam, and love. The experimentor simultaneously listened through a duplicate set of earphones and was aware of the presentation of the high or low arousal term to the subject. At that point the subject's GSR was recorded by finger electrodes over a four second period while the cardiotachometer made a graphical representation of heart-beat. This procedure was repeated for the duration of the tape, resulting in the pairing of high and low arousal words with the presentation of factual information

associated with this event. The subject's GSR's were then ranked from high to low, as were the results of the cardiotachometer. Samples of each are appended at A. *

Subjects, having been randomly assigned to one of five recall groups, were then examined for retention of the critical information. An eight item fill-in questionnaire, with items appearing in the same order as they were presented on the tape, was administered to Group 1 immediately after the acquisition session; Group 2, one hour later; Group 3, at a one day interval; Group 4, at one week; and Group 5 at one month. Groups 2, 3, 4, and 5 were not told of the intent to test their retention. The percent of items correctly recalled for each of the experimental conditions were recorded. A copy of the examination is appended at B.

* Although samples of GSR and cardiotachometric reports are appended, the latter was found to be an ineffective measure of arousal and the results were not included in the analysis of data.

TABLE I

Raw Scores for Recall Groups

Immediate

Subject No.	HA+	HA-	LA+	LA-
1	0	4	3	1
2	1	3	3	1
3	1	3	4	0
4	2	2	3	1
5	2	2	2	2
6	3	1	3	1
7	1	3	3	1
8	0	4	4	0
9	1	3	2	2
10	0	4	2	2
Mean	(1.2)	(2.9)	(2.9)	(1.1)

One Hour

1	1	3	3	1
2	1	3	2	2
3	2	2	1	3
4	2	2	3	1
5	0	4	1	3
6	2	2	1	3
7	2	2	3	1
8	2	2	3	1
9	1	3	2	2
10	1	3	2	2
Mean	(1.4)	(2.6)	(2.1)	(2.0)

TABLE I (contd.)

One Day

Subject No.	HA+	HA-	LA+	LA-
1	1	3	1	3
2	1	3	1	3
3	1	3	2	2
4	1	3	2	2
5	2	2	2	2
6	1	3	1	3
7	1	3	4	0
8	0	4	3	1
9	1	3	2	2
10	1	3	2	2
Mean	(1.0)	(3.0)	(2.0)	(2.0)

One Week

1	2	2	1	3
2	2	2	3	1
3	1	3	1	3
4	2	2	2	2
5	2	2	2	2
6	2	2	2	2
7	2	2	2	2
8	3	1	1	3
9	1	3	2	2
10	2	2	2	2
Mean	(1.9)	(2.1)	(1.8)	(2.2)

One Month

1	2	2	2	2
2	2	2	2	2
3	3	1	1	3
4	1	3	0	4
5	1	3	1	3
6	2	2	0	4
7	2	2	1	3
8	2	2	1	3
9	2	2	0	4
10	2	2	1	3
Mean	(1.9)	(2.1)	(0.9)	(3.1)

TABLE II

Retention Scores for High Arousal Groups

Subject Number	1	2	3	4	5
1	0	1	1	2	2
2	1	1	1	2	2
3	1	2	1	1	3
4	2	2	1	2	1
5	2	0	2	2	1
6	3	2	1	2	2
7	1	2	1	2	2
8	0	2	0	3	2
9	1	1	1	1	2
10	0	1	1	2	2
ΣX	11	14	10	19	19
ΣX^2	21	24	12	39	39
n	10	10	10	10	10
$\bar{X}$	1.1	1.4	1.0	1.9	1.9

TABLE III

Retention Scores for Low Arousal Groups

Subject Number	1	2	3	4	5
1	3	3	1	1	2
2	3	2	1	3	2
3	4	1	2	1	1
4	3	3	2	2	0
5	2	1	2	2	1
6	3	1	1	2	0
7	3	3	4	1	1
8	4	3	3	2	1
9	2	2	2	2	0
10	2	2	2	2	1
ΣX	29	21	20	18	9
ΣX^2	89	52	48	36	13
n	10	10	10	10	10
$\bar{X}$	2.9	2.1	2.0	1.8	.9

C. Results

The data presented in Tables I through III were analyzed by analysis of variance. Tables IV summarizes the results:

TABLE IV

Analysis of Variance of Post-Test Scores

Source	SS	df	MS	F	P
Arousal Level	4.00	1	4.00	3.33	.05
Retention Interval	4.40	4	1.10	.91	NS
Arousal Level X Retention Interval	23.60	4	5.90	4.91	.05
Within	50.30	40	1.2		
Total	82.30	49			

The analysis of variance of recall scores showed the Arousal Level X Retention Interval interaction to be statistically significant ($F=4.91$, $P<.05$). The main effect of arousal level was also significant ($F=3.33$, $P<.05$), while the main effect of the retention interval was not significant ($F=.91$). The significant interaction is attributable to the fact that for immediate recall the critical information preceded by a low arousal stimulus word results in significantly superior recall than that associated with information following high arousal stimuli.

Similarly, the low significance of the retention interval may be explained with the same argument. That is, as time passes, a typical forgetting curve would be anticipated. However, under arousal conditions, the reminiscence effect seems to counter the typical forgetting curve with the result

being increased long term memory under one set of conditions, and increased short term memory under the other.

As may be seen in Table V, low arousal subjects tested immediately after the acquisition session remembered almost three times as much critical information as high arousal subjects. Over time, however, recall of critical information associated with low arousal conditions displays a characteristic forgetting curve until after thirty days the high arousal subjects, although experiencing some forgetting, remember twice as much as their low arousal counterparts. Therefore, after a one month period there is a complete reversal of recall characteristics, with high arousal acquisition conditions resulting in statistically significant (t=3.70, $P<.01$) gains.

TABLE V

t - values for high arousal and low arousal subjects in five retention intervals

Source	df	t	P
High Arousal<Low Arousal Immediate Recall	9	4.39	<.01
High Arousal<Low Arousal One Hour	9	2.33	<.05
High Arousal<Low Arousal One Day	9	2.61	<.05
High Arousal>Low Arousal One Week	9	.43	NS
High Arousal>Low Arousal One Month	9	3.70	<.01

Based on the hypotheses stated, it was predicted that the high arousal group would outperform the low arousal group at thirty days, reversing the pattern found at immediate recall. Similarly, it would be argued that at one week the high arousal group should begin to show greater recall while the low arousal group should begin to show a strong forgetting effect. This was corroborated by a difference in mean scores which was not significant, $t=.43$.

Retention scores for each of the fifty subjects in the high arousal versus low arousal groups were next examined through the application of Duncans Range Test, the summary of which appears in Tables VI and VII.

TABLE VI

Summary of Duncan's Range Test

Applied to Retention Scores of High Arousal Group

Source	Means	Difference	P
30 Day vs 1 Week	1.9-1.9	0	NS
30 Day vs 1 Day	1.9-1.0	.9	.05
30 Day vs 1 Hour	1.9-1.4	.5	NS
30 Day vs Immediate	1.9-1.1	.8	.05
1 Week vs 1 Day	1.9-1.0	.9	.05
1 Week vs 1 Hour	1.9-1.4	.5	NS
1 Week vs Immediate	1.9-1.1	.8	.05
1 Day vs 1 Hour	1.0-1.4	.4	NS
1 Day vs Immediate	1.0-1.1	.1	NS
1 Hour vs Immediate	1.4-1.1	.3	NS

Analysis of the data in Table VI reveals that both group 4 and 5 retained significantly more than groups 1 and 3, but were not themselves significantly different. Group 2 did not differ significantly from groups 1, 3, 4, and 5; while groups 1 and 3 were not significantly different.

Similarly, for conditions of acquisition under low arousal, as presented in Table VII, the following results were obtained: group 5 retained significantly less than all other low arousal retention groups, 4, 3, 2, and 1. Group 4 did not differ significantly from groups 2 and 1, but did differ from group 3, while groups 1 and 2 were significantly different.

TABLE VII

Summary of Duncan's Range Test

Applied to Retention Scores of Low Arousal Group

Source	Means	Difference	P
30 Day vs 1 Week	.9-1.8	.9	.05
30 Day vs 1 Day	.9-2.0	1.1	.05
30 Day vs 1 Hour	.9-2.1	1.2	.05
30 Day vs Immediate	.9-2.9	2.0	.05
1 Week vs 1 Day	1.8-2.0	.2	NS
1 Week vs 1 Hour	1.8-2.1	.3	NS
1 Week vs Immediate	1.8-2.9	1.1	.05
1 Day vs 1 Hour	2.0-2.1	.1	NS
1 Day vs Immediate	2.0-2.9	.9	.05
1 Hour vs Immediate	2.1-2.9	.8	.05

Examination of the data presented in the foregoing tables suggests that there are significant differences in retention of factual information as a function of arousal. High arousal subjects tested at one month and one week, while not significantly differing from one another, retained more than subjects tested immediately and at one day. Conversely, for the low arousal group after one month, subjects in that retention group remember significantly less than members of all other groups. Figure 3 shows this relationship.

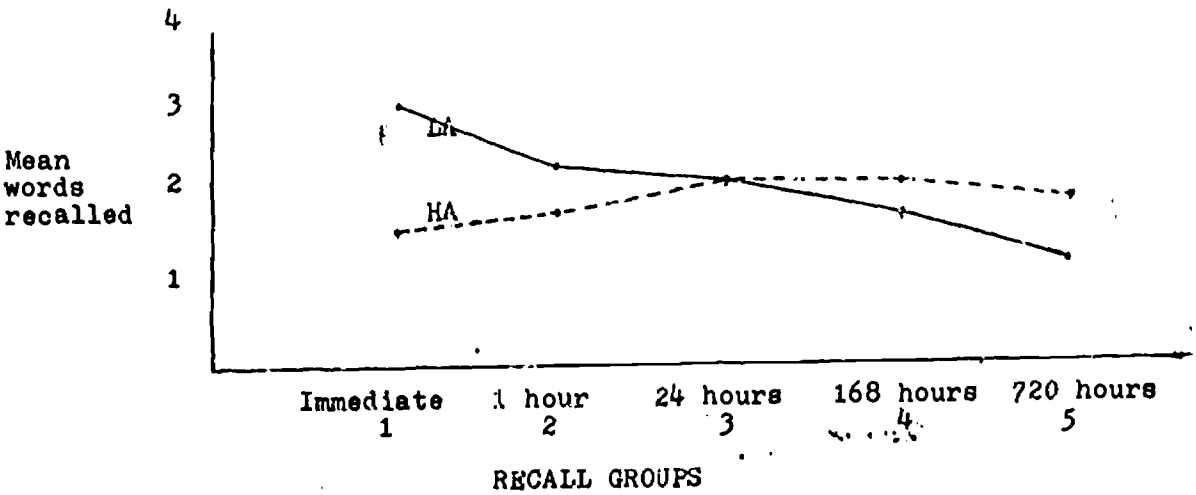


FIG. 3

Mean number of correct responses for high arousal (HA) and low arousal (LA) subjects in five retention groups

D. Conclusions and Recommendations

The results of this investigation are interpreted as supporting the hypothesis that for continuously presented information, forgetting occurs under low arousal conditions while a strong reminiscent effect is observed if acquisition is accomplished under high arousal conditions. Although substantiating the predictions of the arousal hypothesis, the data alone do nothing to further clarify the origin of the arousal retention phenomenon. That is, the data may still be interpreted along a reinforcement frame of reference, Hebb's cell assemblies, consolidation hypothesis, or the orienting reflex. Even though the possible emergence of the arousal retention phenomenon under classroom conditions is not explained, some empirical conclusions seem warrented.

For example, it is apparent from the research described herein, which corroborates the findings of arousal retention hypothesis and discretely presented information, that educators must re-examine their priorities in any given acquisition session. If long term memory or recall ability is more important than short term, then care must be exercised to either induce an arousal state in the learner prior to the presentation of information, or present such information only when the learner is in such an arousal state regardless of its cause. Conversely, if short term recall is more important, as it may be in some circumstances, then high arousal may interfere with effective short term performance.

Another conclusion of this research is that educators must

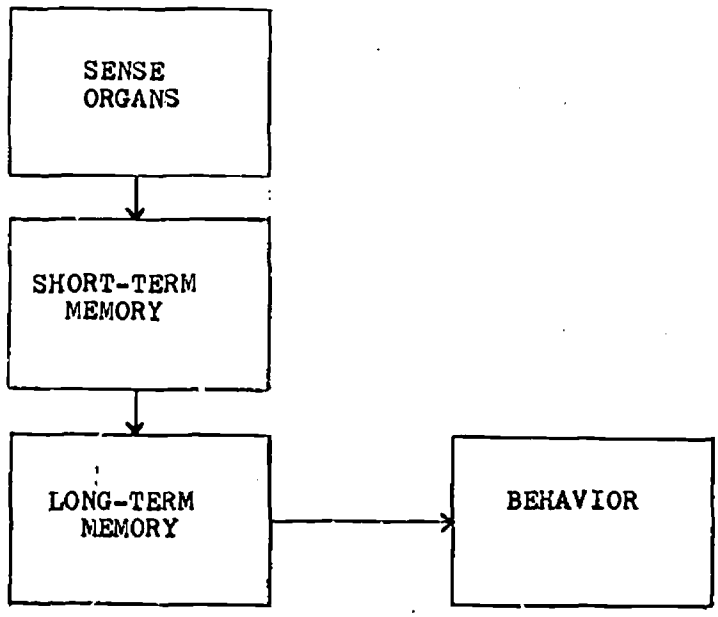
recognize the necessity of considering measures of delayed performance in their studies of learning. The significant recall ability of high arousal subjects in this study testifies to the importance of such methods which, although are effectively employed for immediate recall, may not be as effective for delayed recall.

Finally, for many learning situations educators are interested in long term retention, but their measures are usually of short term variety. Here the implication is if Student A outperforms Student B on a short term test, it is possible that an opposite effect could be observed over a longer period of time if the arousal retention hypothesis holds.

As indicated earlier, the data do not clarify the philosophical differences which exist between theorists espousing reinforcement theory versus some other approach. It appears to this investigator that a combination of variables affect the arousal retention phenomenon. First, the orienting or "what is it" reflex as described by Pavlov is elicited. This assumes a number of physiological reactions which facilitate the flow of information to the individual and prepares him for responding. With increased attention or vigilance, the subject focuses his attention more acutely to the external environment. Perhaps the consolidation hypothesis could then be postulated to account for differences in short term versus long term retention. Information entering through the sense modalities begin a short term memory process which is instrumental in initiating the second phase of long term retention. If consolidation

could be enhanced, then long term retention would be facilitated as per Figure 4 in what has been termed the two stage successive memory model. It may be that with the increased vigilance brought about by the orienting reflex, more information entering the nervous system due to neurological facilitation, permits this consolidation. Such consolidation from short term to long term memory, however, takes time because of the hypothesized electrochemical nature of short term memory and the biochemical nature of long term memory.

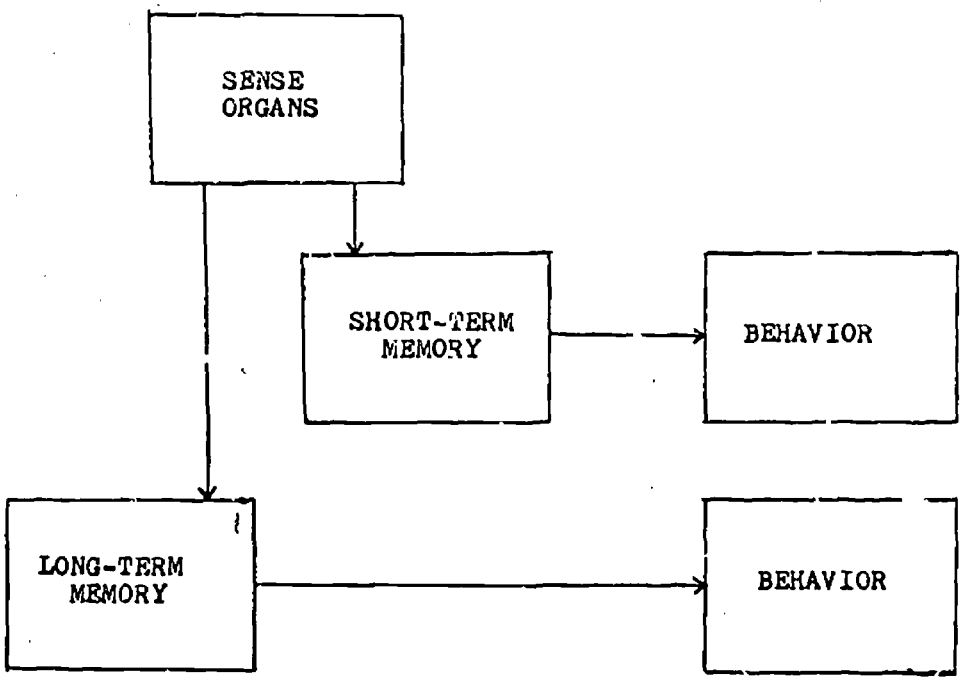
Even if the two stage independent memory model shown in Figure 5 or the three stage system in Figure 6 is accepted, the same basic explanation shown in Figure 7 holds.



Two-Stage Successive Memory

FIG. 4

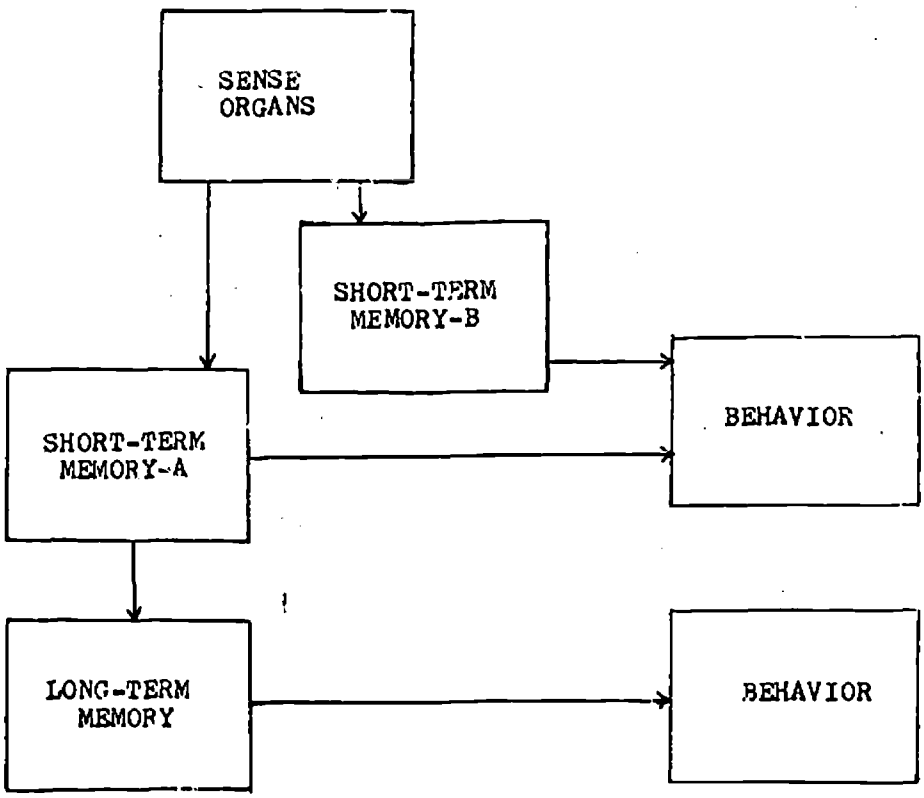
Schematic representation of theoretical organization of memory (after Krech, 1969)



Two-Stage Independent Memory

FIG. 5

Schematic representation of theoretical organization of memory (after Kreeh, 1969)



Three-Stage Memory System

FIG. 6

Schematic representation of theoretical organization of memory (after Krech, 1969)

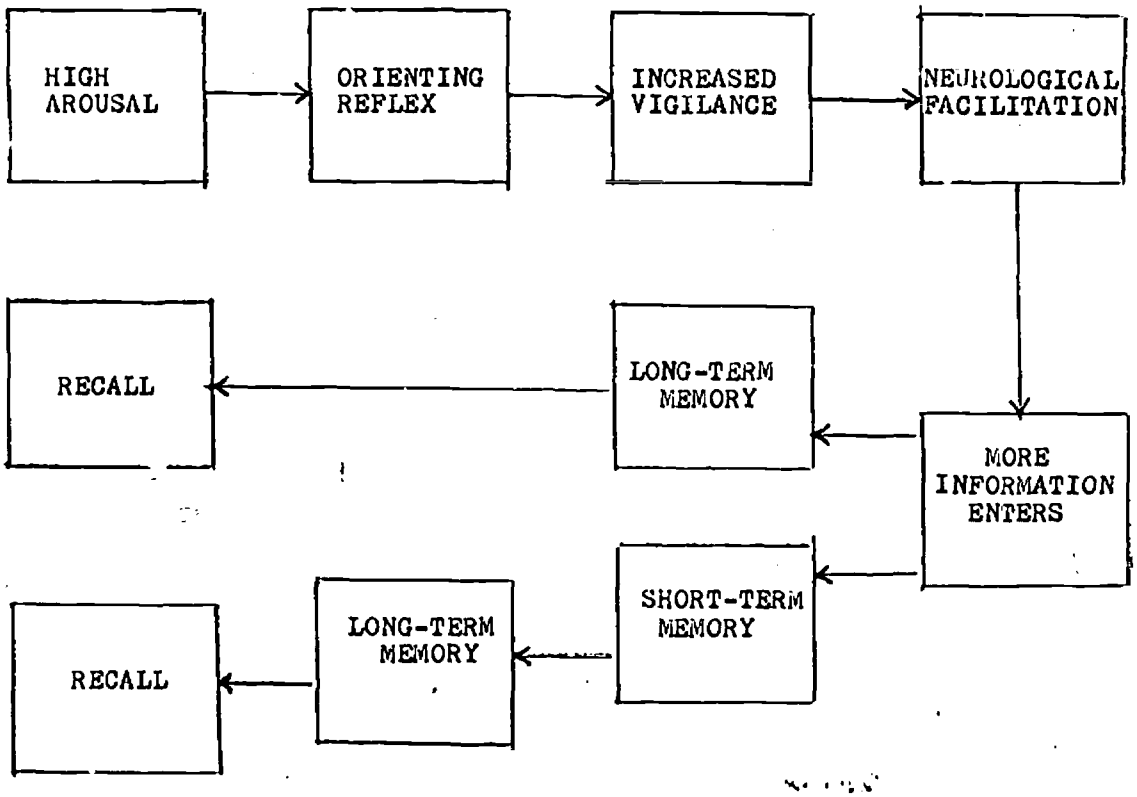


FIG. 7

Proposed model for interaction of orienting reflex and consolidation hypothesis

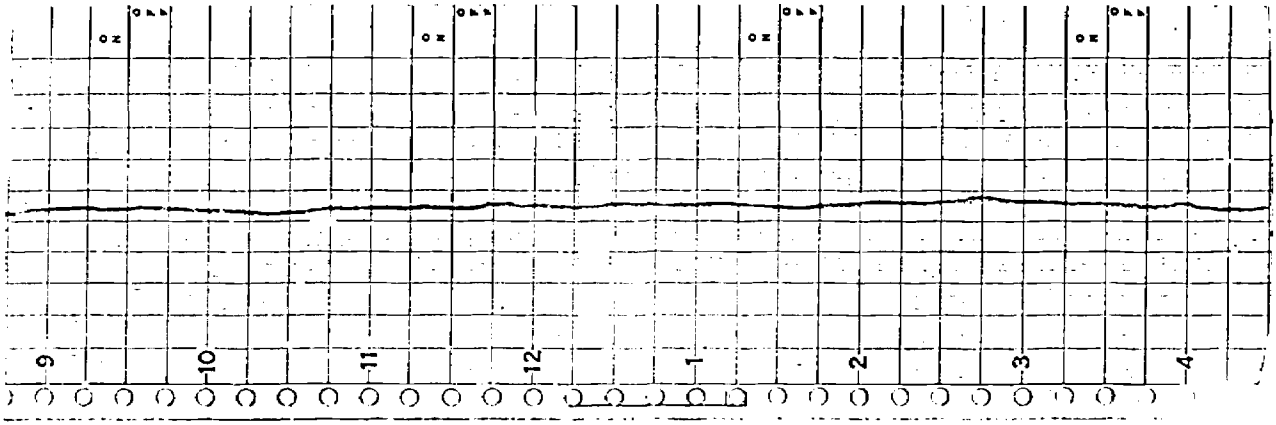
In summary, this investigation supports the arousal retention hypothesis for continuously presented information and several recommendations have been made concerning relevance to education. At this point, the experimentor suggests some avenues of research which may help to further understand this phenomenon and aid in its implementation.

(1) If a stimulus serves to arouse one subject and not another, then it would appear that the application of the arousal retention hypothesis should be studied with individualized instruction techniques.

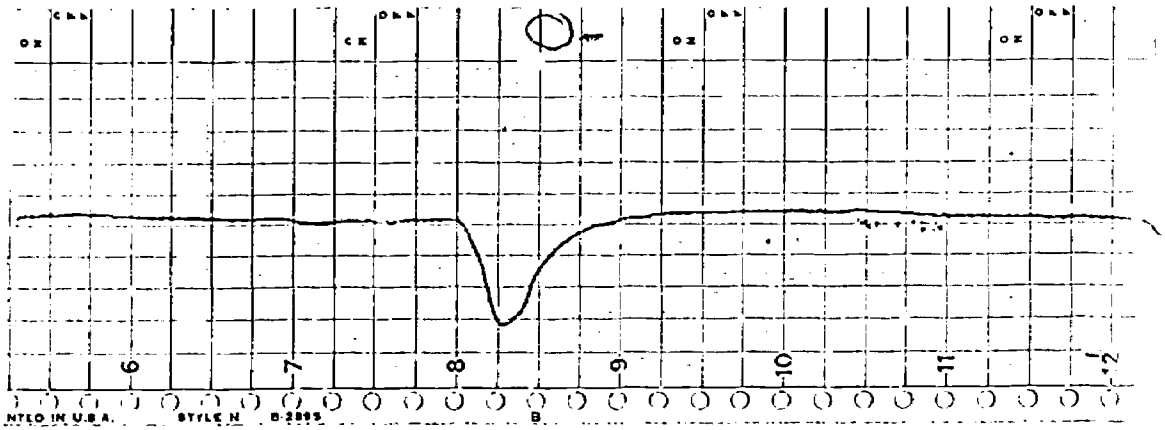
(2) If an arousing stimulus is independent of emotion qualitatively, then various types of stimuli, such as clicks, sounds, colors, etc., should be studied in an attempt to further understand the role of the orienting reflex.

Appendix A

Sample GSR Recording
Showing Subjects Response to
Each of Eight Stimulus Words *

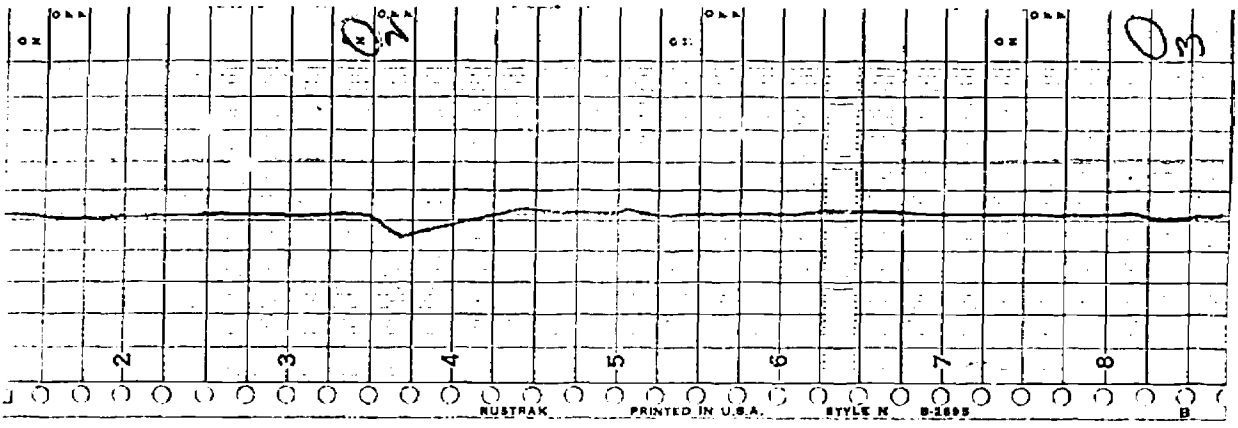


Base Level

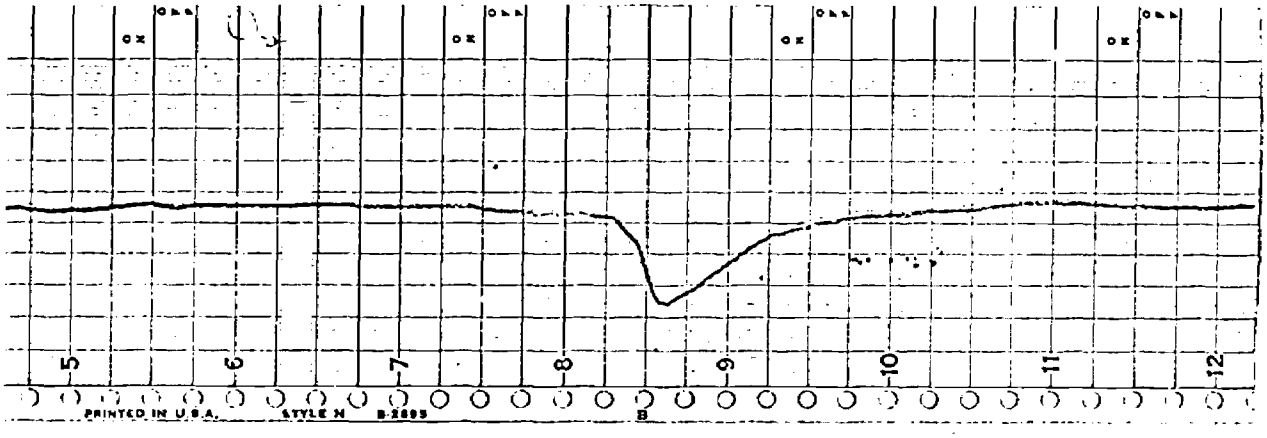


Stimulus 1

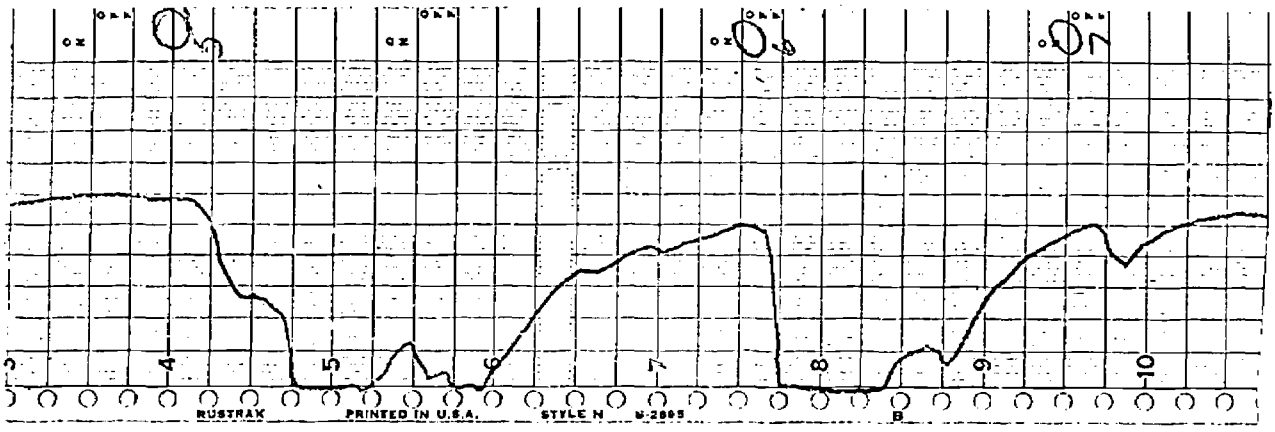
* Recordings made on Marietta Recording GSR Apparatus 69A-12-13R



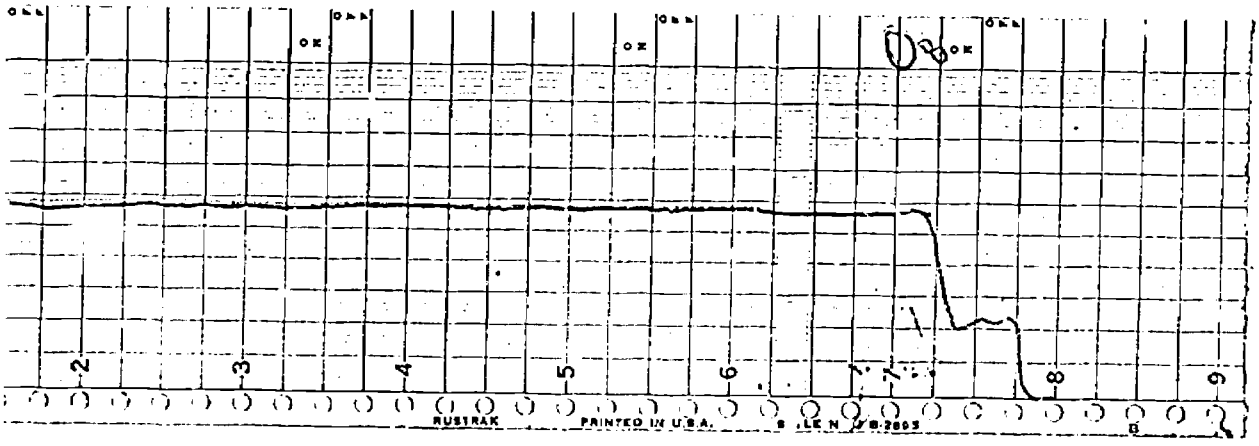
Stimulus 2 and 3



Stimulus 4

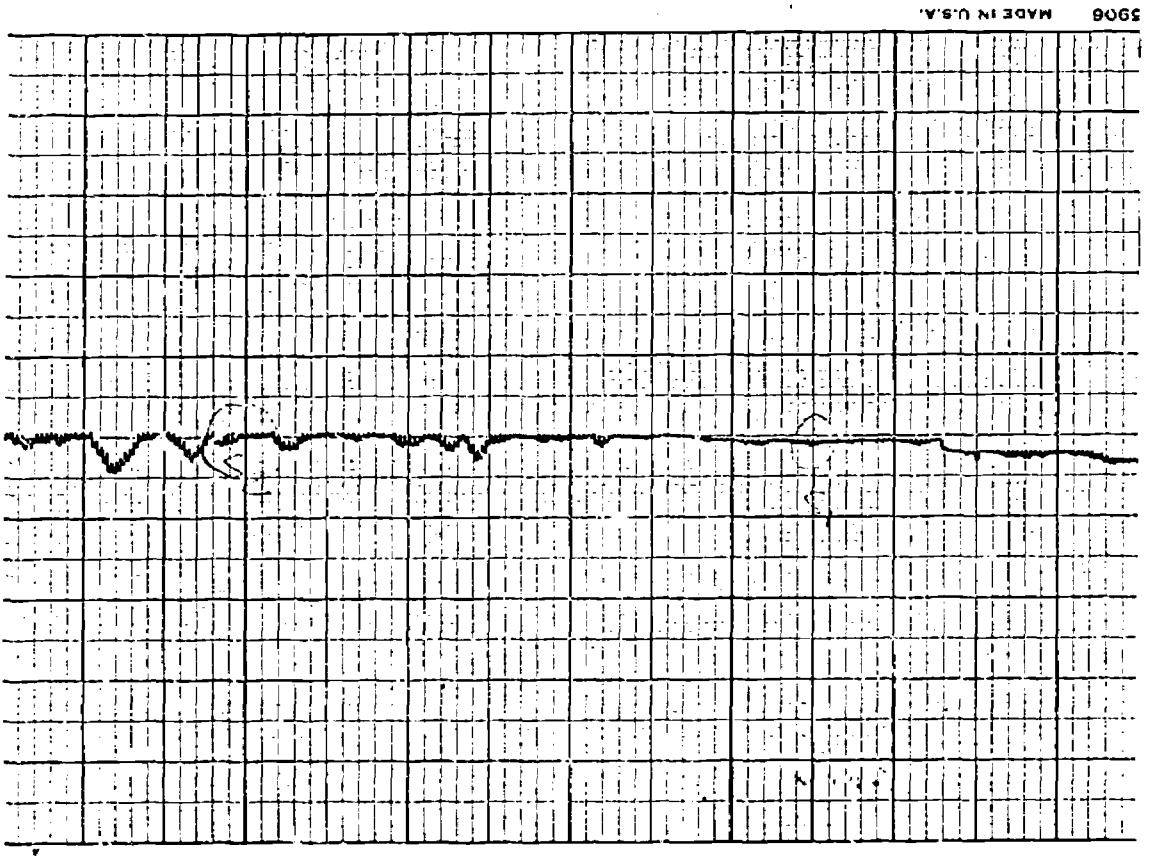


Stimulus 5, 6, and 7



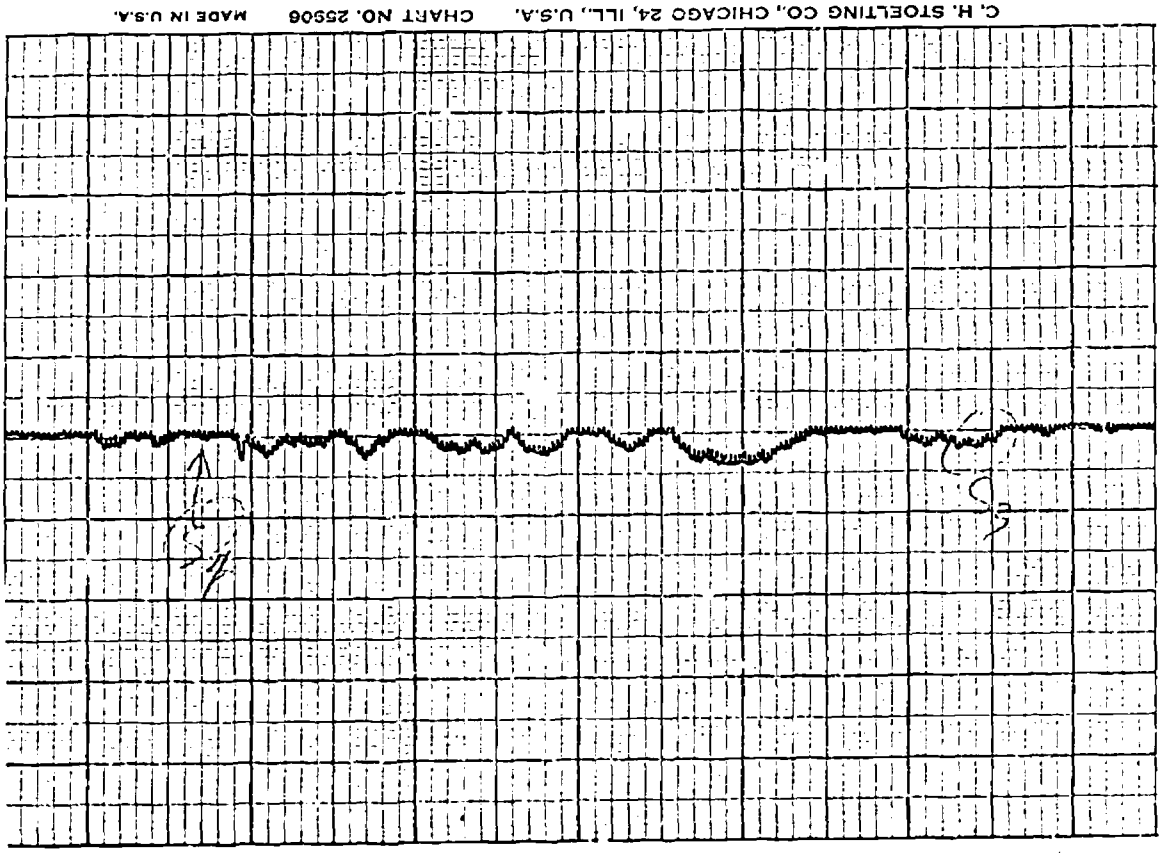
Stimulus 8

Sample Cardiotachometer Recording
Showing Subjects Response to
Each of Eight Stimulus Words *

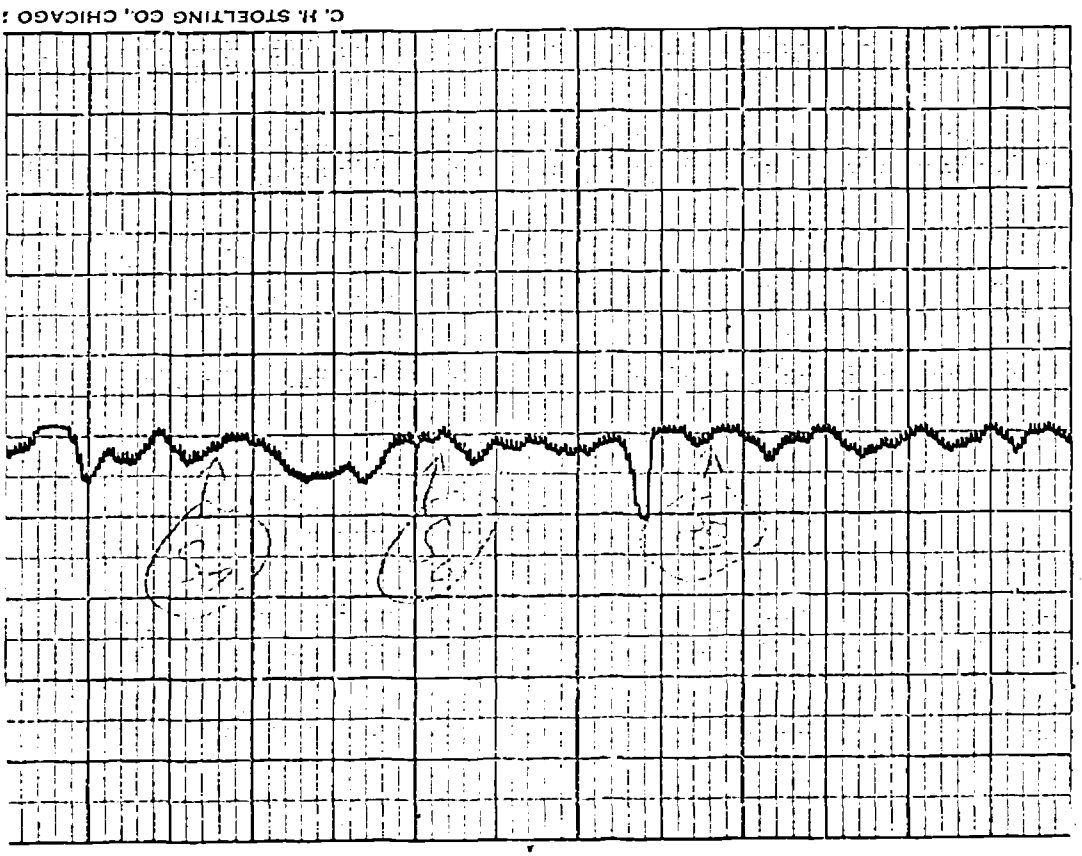


Stimulus 1 and 2

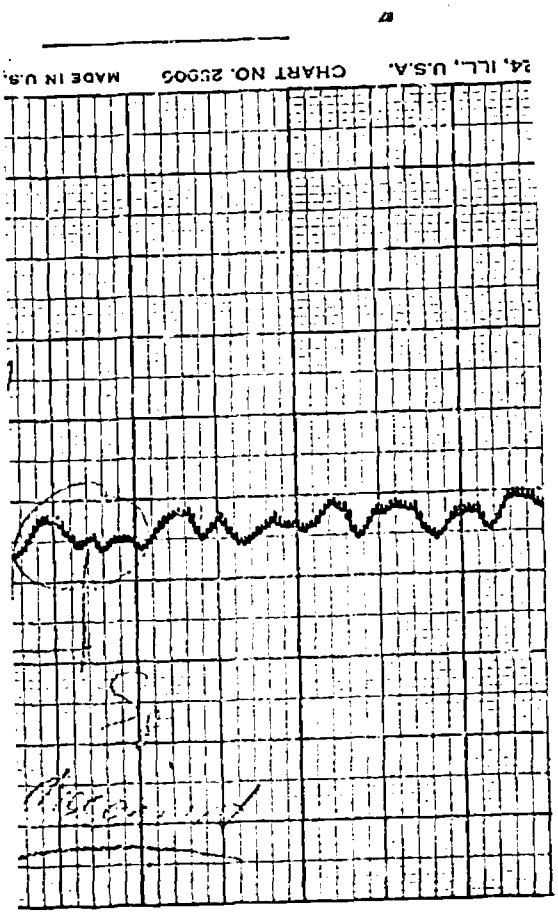
* Although appended, the cardiotachometric reports did not provide an effective measure of arousal and the results were not included in the analysis of data.



Stimulus 3 and 4



Stimulus 5, 6, and 7



Stimulus 8

APPENDIX B

Post Test

The following informational facts were presented during the tape. Please provide the correct answer to each question.

_____1. Of what act were the petitioners accused by the District of Columbia police in the spring of 1958?

_____2. Judge Washington dissented, believing that the petitioner's _____ Amendment rights had been abridged.

_____3. All that was heard through the microphone was what an (a) _____, hidden in the hall, bedroom, or the closet might have heard.

_____4. Once the spike touched the ____, it, in effect became a giant microphone.

_____5. Relying upon these circumstances, the Court reasoned that the intervening wires are _____ part of the defendant's house or office.

_____6. At the very core stands the right of a man to retreat into his own home and there be free from unreasonable _____ intrusion.

_____7. A distinction between the detectaphone employed in Goldman and the spike mike utilized here seemed to the Court of Appeals _____.

_____8. I agree with the Court that the judgement of a conviction must be _____.

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