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Modification of affective state - Dependent learning

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MODIFICATION OF AFFECTIVE STATE - DEPENDENT LEARNING

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ABSTRACT

Two experiments using male and female college students tested the hypotheses that state-dependent learning (SDL) would be demonstrated by manipulating affective states and that presentation of a discriminative stimulus (S^D) would modify SDL so as to significantly increase the amount of transfer between affective states. Subjects were instructed to imagine feeling "angry" and "relaxed". Anger was defined as an increase in heart rate of 10 beats per minute above baseline and relaxation was defined as a decrease in heart rate of 10 beats per minute below baseline. Subjects learned word lists in both anger and relaxation conditions and were tested for recall in both conditions. A 1kHz tone was presented in either one or both conditions as an S^D. State-dependent learning was demonstrated using affect as the "state". SDL modification was observed after the presentation of an S^D-tone.

AFFECTIVE STATE-DEPENDENT LEARNING

The current experimental design was developed from earlier drug state-dependent learning research and studies which suggested that state-dependent learning could be produced using non-pharmacological variables. This study examined the effect of affective or emotional state changes on the free recall of word lists. Heart rate was monitored as an objective physiological correlate of affective states. Further, this study examined the effect of an external cue (S^D) on affective state-dependent learning.

State-dependent learning (SDL) has been studied in some detail over the past twenty years. SDL studies have investigated the effects of changing drug states on a variety of learning tasks as well as investigating such effects in animals and humans under a number of different conditions. Several of the investigations of state-dependent learning have suggested that non-pharmacological variables influence the outcome of the research (Goodwin, 1969; Connelly & Connelly, 1975, 1978). Specifically, in human subjects, there is reason to suspect that: 1) the emotional or affective state is influential in terms of performance on learning tasks, (Goodwin, 1969; Bartlett & Santrock, 1979; Weingartner, 1978) and 2) there are non-pharmacological factors which disrupt the state-dependent effect (Goodwin, 1969; Connelly & Connelly, 1975; Weingartner, 1978).

The appropriateness of several different physiological

measures of emotional arousal has been investigated and a number of autonomic nervous system functions have been identified as being effected by affective state changes (Ax, 1953; Eich, 1975; Surwit, 1976). Any autonomic response to affective stimuli tends to be general in nature involving the entire autonomic nervous system rather than a discrete structure as is found in pharmacological studies.

State-Dependent Learning. The phenomenon of state-dependent learning, that is to say, the acquisition of knowledge in a specific state of consciousness which does not transfer to other states of consciousness, is well documented. Overton (1964) demonstrated that rats trained, after being injected with pentobarbital (20mg/kg), to turn right or left in a T-maze were unable to repeat the performance in a non-drugged state. When the drug was reintroduced, the rats trained in the drug state matched their original performance. In the same series of experiments, Overton demonstrated through the manipulation of drug dosage that there were levels or degrees of dissociated or state-dependent learning correlated with drug dosage level.

Others have replicated these typical animal results in human subjects. Goodwin and his associates (1969) administered alcohol (200 and 300 ml) to male medical students and tested their ability to perform on four tasks: an avoidance task to measure interference and response latency, a verbal rote learning task to measure recall, a word association task to measure recall or "self-generated" learning, and a picture

task to measure recognition. Each of the subjects was randomly assigned to one of four groups. One group was not given alcohol on either of the two testing days. A second group received alcohol both days. The third group was given alcohol on the first day but not on the second day. The fourth group was sober on the first day and intoxicated on the second. All subjects completed all four of the tasks.

The results of the Goodwin study showed significant differences in the performance of subjects whose drug state had changed except on the picture recognition task. Goodwin also reported asymmetry, that is, the training transferred less completely in the direction of drug to non-drug states than in the reverse direction with the exception of the picture recognition task. In that task each subject was shown 20 pictures on Day I. On the second day, in the opposite drug state, each was asked to pick the 20 seen previously from a group of 40 pictures. Half of the pictures were of models in catalogues and judged neutral while the other half were from nudist magazines and designated as emotional. All of the groups had fewer mean errors for the recognition of the "emotional" pictures. Goodwin concluded that the influence of the state change was not significant in this case. Instead, the data provided evidence that the affective stimuli used in this task disrupted the state-dependent effect.

Early research provided evidence that SDL can be demonstrated under the influence of central nervous system depressants. Overton (1968) reported that such drugs as curare, phenothiazines,

and anticholinergenics are associated with moderate SDL while anesthetic drugs are associated with strong dissociative effects. In more recent research, Overton (1972) compiled a list of drugs and the degree of SDL associated with each. Anesthetic drugs and two minor tranquilizers (Meprobamate and Librium) were associated with the highest degree of dissociated learning. Antimuscarinic drugs, nicotinic drugs, narcotics, stimulants, convulsants, antinicotinics, and hallucinogens were associated with moderate state-dependent effects. Phenothiazines (changed from the earlier report), dibenzozepines, and several inert drugs reportedly were corelated with only mild SDL.

Non-Pharmacological Variables. There is evidence which suggests that the phenomenon of dissociated learning is influenced by nonpharmacological factors. Bustamante, et al, (1969) tested 70 subjects assigned to seven groups. (See Table 1)

On the first day all subjects received the appropriate drug and dosage and thirty minutes later a slide with eight geometric shapes were projected on a screen. Subjects were given three minutes to study the designs. The slide was removed and subjects were given two minutes to draw as many of the eight figures as they could recall. All subjects received five more trials with 48 hours between each trial. Although the results indicated the presence of SDL they did not indicate the asymmetry reported in other studies (Overton, 1964; Goodwin, 1969). This led the authors to conclude that state-dependent

learning may have occurred because of a change in conditions rather than simply because of the presence or absence of a particular drug. They proposed that the reintroduction of the original learning condition constituted a reward because the subject was able to recall more of the figures.

Eich, et al, (1975) provided evidence that SDL may be influenced by both pharmacological and non-pharmacological factors. In their study, thirty subjects were administered a cigarette containing either 10mg endogenous delta-9-tetrahydrocannabinol or a placebo. Each subject was read a list of 48 words and then were asked to write as many as he recalled. Subjects were tested under drug and non-drug conditions, cued and free recall conditions, and with different categories of word lists. In addition to the number of words recalled, subjects' radial pulse was monitored and they were asked to rate their perception of the drug influence on a Likert-type scale. The authors found that recall was facilitated by reproducing the original drug state, i.e., SDL. They also found that subjects recalled more words under cued recall conditions even when in the drug state other than the one in which the original learning occurred. It appeared that the presentation of the cue word modified the state-dependent effect. This result led the authors to conclude that there may be cue-dependence in dissociated learning. They proposed that the memory for an event may be influenced by the person's perception of the situation.

Connelly and Connelly (1978) summarized a series of experiments that demonstrated that state-dependent learning can be modified by emotionally important external stimuli. In the second of a series of four experiments, Connelly, et al, (1975) modified state-dependent learning by associating a specific S^D, paired with foot shock, with the same behavior the drug state was associated with. Eight groups of hooded rats were used. The groups included two dissociation or state-dependent groups, two transfer groups that heard a 1kHz tone during training and testing, and four control groups.

The rats were trained to escape a 0.65 mA footshock in a forced-choice, T-maze situation. During the training procedure, rats were placed in an already electrified start box and allowed to move to the correct goal box only (the incorrect goal box was always blocked in training). The goal box floor was never electrified. After entering the correct goal box, the rats were detained for 15 seconds, returned to their cages for 10 seconds, and then again placed in the electrified start box. Each rat was given five trials a day until the criterion of 18/20 correct responses was reached over a four day period. Testing began 24 hours after criterion was reached. Footshock was never on in testing. The rats were placed in the non-electrified start box and both goal boxes were opened.

The two experimental groups (SDL) were trained to escape foot shock after being administered injections of either Chlordiazepoxide HCL (45mg/kg) or the equal volume of sterile

water. 24 hours after reaching training criterion the experimental groups were tested in the opposite drug state.

The two transfer groups were treated identically to the experimental groups except that during training as the rats were placed in the electrified start box, they heard a 1kHz tone which sounded until the correct goal box was reached. The tone also was sounded during the no-shock testing.

The authors found that the state-dependent effect was present with the two experimental groups. Unlike earlier research however, (Overton, 1964; Goodwin, 1969) Connelly and Connelly found that the dissociation was symmetrical, that is, it was present regardless of the original training condition. The transfer groups, despite drug state changes identical to the two experimental groups, continued to go to the goal box they had originally been trained to enter. The authors concluded that the tone became an emotionally "important" S^D which superceded the "importance" of the drug state S^D and modified the state-dependent effect.

The tone in the Connelly research, the pictures in the Goodwin study, and the cue words in the Bustamante study have provided evidence that non-pharmacological factors may influence state-dependent learning in terms of acting as memory prompters which mediate transfer across drug states. More recently, research has been conducted which focused specifically on how non-pharmacological variables might influence learning and how those variables could be manipulated so as to produce SDL without the

use of pharmacological variables. Further evidence of non-pharmacological effects are found in the work of Weingartner, et al, (1978) and Bartlett and Santrock (1979). These studies used non-pharmacological variables to demonstrate SDL, while these variables disrupted SDL in the Connelly, Goodwin, and Bustamante research.

Weingartner, et al, (1978) behaviorally produced affective state changes by manipulating feedback given to subjects regarding their performances on a pretested anagram and a concept learning task prior to learning groups of words. Nine "depressed" hospitalized and nine "normal" control subjects were used in the study. After the words had been learned, the subjects were asked to recall them after again being given success or failure feedback on the anagram and concept learning task. Each subject was studied under four conditions. (See Table II)

Prior to presentation of the anagram and concept learning tasks subjects were asked to rate their mood and again after receiving the success or failure feedback in the pretesting situation. Subjects were then presented a list of 24 common nouns and asked to generate either a rhyming word or a semantically associated word for each word on the list. The following day subjects were asked to freely recall the self-generated words after being given success or failure feedback and mood measurement. They were read their self-generated rhyming and associated words as cues and were again asked to recall the original list of words.

The authors found significant changes in subjective ratings of mood after differential feedback. Both "depressed" and "normal" subjects showed differences though these results were quantitatively and qualitatively different. "Normals" reportedly showed significant but small changes in mood following either type of feedback. "Depressed" subjects were particularly sensitive to failure feedback.

Further, the results indicated that state-dependent learning was produced by the manipulation of mood in both "depressed" and "normal" subjects. The authors found that free recall was significantly influenced in the success-failure and failure-success conditions. The state-dependent effect was eliminated with cued recall. Weingartner concluded that mood appeared to provide a unique context (state) for processing and remembering events.

Bartlett and Santrock (1979) proposed that affective state changes would influence learning. They hypothesized that children in a "happy" mood would find it easier to recall events associated with that state and would have a relatively difficult time recalling events associated with a "sad" mood. Subjects were tested for free recall, cued recall, and recognition on each of three stories they were told. The affective nature of the stories was manipulated by changing the endings in such a way as to elicit either happy or sad subjective reports from the children. They found that memory for details of stories was influenced by the affective state change. Further, the

results pointed to asymmetric dissociation in that less complete transfer occurred when affect at input (time of story telling) was "happy" than when "sad".

Eich, et al, (1975), Weingartner, et al, (1978), and Bartlett and Santrock (1979) used or defined affect as a state somehow comparable to a drug state. Connelly, et al, (1975, 1977, 1978, 1979) used affect or emotion to modify state-dependent learning. The difference lies in the emphasis and approach used when defining affect as a state and using affect as a memory retrieval facilitator. Further research is needed to clarify the latter.

Emotional Arousal. One of the main problems in determining the effects of emotional arousal or affective arousal on learning and memory has been the absence of an operational definition of arousal. Eysenck (1976) defined arousal as some specific elevated bodily function which represents a nonspecific increment in physiological activity. An added complication has been the discovery of different levels or degrees of affective arousal. Lindsley (1952) developed a continuum model which includes eight levels of arousal each of which is characterized by different levels of awareness and behavioral efficiency as well as cortical activity. The author's research focused on changes in electroencephalogram readings associated with various levels of affective arousal. (See Table III)

Lindsley admitted the probable inadequacies of his model because of the inability of researchers at the time to measure

all possible levels of affective arousal. The same problem is encountered today and continues to empirically describe affective changes and correlate them with physiological changes.

Measurement of Affective Arousal. Closely related to the problem of definition has been the choice of measurement indices. In an early article, Rappaport (1949) surveyed the literature available and concluded that there was no universally accepted measure of affective arousal at the time. The recent literature has not contradicted Rappaport's conclusions. A variety of measures have been employed to monitor the autonomic nervous system and cortical activity associated with affective arousal. The most widely used indices include heart rate, blood pressure, respiration, skin temperature, skin conductance, salivation, gastric changes, electromyograph, and electroencephalograph.

Ax (1953), in an attempt to determine physiological differences between fear and anger, used eight measures: electrocardiogram (ECG), ballistocardiogram, respiration, face and finger temperature, skin conductance (GSR), muscle potential, and blood pressure. The fear stimulus consisted of gradually increasing the intensity of finger shock to subjects. When the subject reported the shock, the experimenter responded with surprise and then created an atmosphere of alarm and confusion. The polygraph operator was the instigator and the target of the anger situation. Prior to his entrance, the experimenter informed the subject of the operator's incompetence. He entered the room under the pretense of making mechanical

adjustments. The experimenter left the room and the operator proceeded to insult the subject as well as the nurse who monitored blood pressure. The operator moved the subject roughly about and stayed in the room for five minutes and then left. The experimenter returned and apologized for his colleague's behavior.

Subjective reports of fear and anger as well as the physiological measures were used as indices of arousal. Ax found that four of the physiological variables showed significant differences during anger. Diastolic blood pressure increased, heart rate was maintained at a higher level, GSR increased in intensity and muscle potential increased in the anger condition. Three variables showed significant changes in the fear situation including increases in the intensity of GSR, number of muscle tension peaks, and respiration rate. Essentially every measure employed, with the exception of stroke volume (ballistogram), showed significant differences between the two affective states.

Deane (1966) provided evidence that the anticipation or thought of noxious stimuli effects physiological processes in a study designed to determine the effects of experimentally induced anxiety on heart rate. Unlike the previously described study, heart rate was the only index monitored. An electrocardiogram (ECG) was used and the standard procedure for placement was used.

All subjects were given a five minute baseline period during

which they were instructed to view a memory drum which signalled when they should inhale. After ten baseline trials, subjects were instructed to continue watching the drum but were told they would receive an electrical shock during one of the trials. All subjects received a 3mV shock of one second duration on the tenth inhalation of each of ten trials. The mean heart rate for all subjects was recorded for the last three baseline trials and during each of the shock anticipation trials in which shock was not administered. Deane found that the instructions alone produced an acceleration in heart rate across subjects. Further increases were observed during the shock anticipation trials. Prior to each of the anticipated shock trials, subjects' heart rate increased significantly and decelerated after the trial whether or not shock occurred.

Epstein and Clarke (1970) used heart rate and skin conductance changes as measures of effects of anticipated intensity of noxious stimuli and experience. Instructions were manipulated for each of three groups so as to produce low, medium, or high anticipation about the intensity of a tone to be sounded during the experiment. The subjects were told that they would hear a series of tones and were instructed to count the tones. The low-threat group was told that one of thetones would be louder than the rest and that this was true only for that specific group. The medium-threat group received the identical instructions with the exception of the description of the tone which they were told would be "quite loud" and that their group was one for

which the tone was among the loudest. The high-threat group again received the same instruction except that they were told the tone would be "extremely loud" and the loudness had been cleared with authorities to insure it could not cause physical damage. The mean heart rate over all trials was highest for the high-threat group and next highest for the medium-threat group. The low-threat group's mean heart rate was only slightly lower than the medium-threat group's. After a number of trials, however, the high-threat group's mean heart rate decreased. This group did not continue to show the anticipatory heart rate increases prior to the onset of the noxious stimuli. The other two groups, after a number of trials, exhibited an anticipatory decrease in heart rate. GSR's increased for all three groups with the presentation of the initial tone. All of the groups showed gradual decreases, after several trials, during the anticipatory interval but then showed increases as the time drew nearer for the noxious stimuli. The researchers concluded that there was a significant relationship between the expected magnitude of threat and physiological arousal during the anticipatory phase. The high-threat group consistently showed the greatest reaction to the presentation of the noxious stimuli in terms of both heart rate and skin conductance.

As noted earlier, emotional arousal can be thought of in terms of a continuum with each point having its own charcateristic behavioral and cortical activity correlates (Lindsley, 1952).

Emotions such as anger and fear can be placed at the high arousal end of the continuum while relaxation is more toward the low arousal end. Each of the levels of arousal is also characterized by physiological changes which can be monitored. The previously cited research has focused on high arousal states but there is evidence that low arousal states such as relaxation can be measured using similar indices.

Surwit, et al, (1976) found that heart rate changes were among the physiological processes involved in biofeedback training, which presumably involves relaxation and thus low arousal. They designed two experiments which explored the extent to which subjects could learn to control digital skin temperature and how such learning might be correlated with changes in cardiovascular activities. The physiological measures used were finger temperature, total pulse amplitude, superficial pulse amplitude, heart rate, and respiration.

The first experiment involved two groups of eight subjects each. Four males and four females were assigned to each group. Group 1 was instructed to decrease finger temperature while Group 2 was told to increase finger temperature. Both groups were told to relax and concentrate on either increasing or decreasing finger temperature. No specific instructions on relaxation techniques were given. Half of the subjects were given seven trials while the other half received 11 trials. The first two sessions were 45 minutes baseline

periods during which subjects were instructed only to remain awake and relaxed. The third trial was the beginning of training. Each subject was given a 10 to 30 minute baseline period for each training session during which no feedback was given, followed by a 75 second trial using the non-dominant hand. Subjects were unaware of which hand was being monitored. Subjects were given 20 75 second trials with 10 second intervals between the trials. At the end of each 75 second trial a tone was sounded and a digital read-out of skin temperature was displayed.

Finger temperature was measured in units of Centigrade degrees and each 0.1 C^{o} degree change was displayed to subjects. Subjects' temperatures were measured for the last 10 seconds of each 75 second trial. Subjects in the decrease group showed more significant changes (average of 2.0 C^{o}) than did the increase group (average of 0.25 C^{o}) within each session. Across sessions, subjects trained to decrease skin temperature showed an average drop of 1.0 C^{o} while those trained to increase skin temperature also showed an initial decrease of 1.0 C^{o}. Learning was not restricted to one hand but finger temperature in the dominant hand was always higher than in the non-dominant hand.

Total pulse amplitude and superficial pulse amplitude were both measured in mVs and were recorded and averaged either five or 10 seconds prior to the end of each 75 second trial. Subjects in the increase group showed larger total

pulse amplitudes but differences were not found to be significant. Similar results for superficial pulse amplitudes were found.

Respiration was measured as the number of breaths per 75 second trial. No significant differences were found between the two groups for this variable.

Surwit, et al, also used heart rate measured in beats per trial. No significant differences between increase and decrease groups were noted on this measure. The authors did find that males and females on the decrease group tended to show decreases in heart rate over the testing days. Females in the increase group tended to show an increase in heart rate while males showed a decrease over days. Heart rate was not shown to correlate significantly with temperature change or any of the other measures analyzed.

In another experiment, Surwit, et al, held all conditions the same as in the initial experiment except that the room temperature was lowered 3.0 C^{o}. This change was made in order to determine if the decrease group of the first experiment had an advantage over the increase group. Lowering of the room temperature did not aid the subjects in increasing finger temperature and in fact, the authors concluded that the change in room temperature hindered performance for all subjects.

A significant finding for the present study was that males and females appeared to have differential ability in vasomotor control. In both experiments, Surwit, et al, noted that males

tended to slow heart rate while increasing skin temperature while females tended to increase heart rate. The authors concluded that males and females in their study may have learned to use different physiological mechanisms to increase peripheral skin temperature. They did suggest, however, that measuring cardiovascular variables such as heart rate is appropriate when exploring the physiology of peripheral circulation.

Various methods have been demonstrated to be effective in the manipulation of affective arousal including the presentation of auditory and tactile noxious stimuli (Ax, 1953; Epstein & Clarke, 1970) and electric shock (Ax, 1953; Dean, 1966). More recent studies have demonstrated that affective state changes may be produced without physical discomfort (Weingartner, 1978; Bartlett & Santrock, 1979). All of the above cited studies relied on experimenter-controlled manipulation of affective state changes, that is, subjects were passive recipients of some externally generated manipulation. Other researchers have investigated the influence of subject control of or internally generated manipulation of affective state changes.

Subject control of an experimental condition has been a concern of researchers for some time. Rywick and Gaffney (1972) studied 48 subjects who were asked to imagine that they were going to judge the work of another person and that person would judge their work. The judgements were in the form of

electric shocks; zero shocks for excellent work to 10 shocks for poor work. Subjects were asked to draw a floor plan for a house. They were told to imagine their judge gave their floor plan a judgement of eight shocks. One group received eight 0.7 ma shocks of one second duration each: the second group received no shocks but was asked to imagine receiving eight uncomfortable but not painful shocks, and a third group received one shock and was asked to imagine receiving eight shocks. Subjects were given a floor plan and asked to imagine it to be the floor plan of their judge. They then wrote down the number of shocks they would administer as judgement.

Subjects who actually received the eight shocks gave more severe judgements than other subjects. The authors concluded that the imagined shock did not produce the same behavior as real shocks in that situation. There was no significant difference in judgements made by the one shock and no shock groups. Rywick and Gaffney reported that because of the similarity between those groups' results, they hesitated to generalize the results of the eight shock group to other situations and suggested further study in the area of imagined stimulation.

Further investigations comparing situations producing noxious stimulation was reported by Malcuit (1973). This study was designed to evaluate changes in heart rate in subjects faced with an aversive situation. Sixty male

subjects were assigned to one of six groups. (See Table IV) Upon arrival, the experimenter attached standard ECG electrodes and calibrated all machines. Subjects were given instructions to sit quietly and await further instructions. Each subject was given a 10 minute baseline period after which an ECG reading was taken and shock intensity adjusted.

All subjects were told that they would hear a series of tones which would precede electric shocks. Subjects in the three passivity groups were told they had nothing to do but passively endure the shocks. Subjects in two of the avoidance groups were told they could avoid receiving the shocks by pressing telegraph keys during some predetermined period of time during the trial. Only one of the two groups receiving these instructions could actually avoid the shock, since the keys were disconnected for the other group. The third avoidance group received the same instructions except they were told a light would flash if they had successfully avoided the shock. Each subject was given 30 trials in Phase 1.

Phase 2 consisted of 20 trials in which each subject was tested in an opposite condition. (See Table IV)

Baseline heart rates across subjects were comparable. During testing heart rate was monitored every third trial. Malcuit found that subjects who had no control over receiving shock (Passivity and Avoidance + Shock) showed a significant deceleration in heart rate immediately prior to shock onset.

Subjects who tried to avoid shock, successfully or not, did not show a significant deceleration in heart rate prior to shock onset. Those subjects also displayed an acceleration in heart rate at tone onset. In Phase 2, subjects whose heart rate in Phase 1 was high remained stable even though conditions changed.

Malcuit concluded that results from both phases of the experiment consistently indicated different patterns of cardiac response according to the type of interaction subjects had with the situation. Subjects who tried to control the administration of shock showed accelerated heart rates. When in the passive condition, the same subjects showed the characteristic deceleration in heart rate associated with loss of control.

It appears that Malcuit's research possibly indicated that giving subjects some control, whether perceived or real, significantly affected heart rate. Active involvement in controlling outcome seems to produce increases in heart rate. Further, the study combined the threat of discomfort, the actual administration of shock, and success-failure feedback. Malcuit commented that the subject's perception of a situation can be correlated with cardiovascular activity and provides further evidence that not only the situation but the perception of the situation affect subjects' physiological and behavioral responses.

It is clear from the results of previously cited research that it is critical that an adequate task be employed in

combination with appropriate physiological measures and effective methods for the manipulation of affective states. It is important that a task be chosen which will neither facilitate nor disrupt SDL. Any task that could aid or eliminate SDL would contaminate research which was designed to determine the influence of another variable such as affective state changes.

Task Selection. The previously cited studies demonstrated that the state-dependent effect, either pharmacologically or non-pharmacologically produced, could be observed using a variety of tasks. Learning to turn one direction or another in a maze, for example, was a task used with rats (Overton, 1964; Connelly, et al, 1975, 1977, 1978). Studies with human subjects have employed free recall, cued recall, story content recognition, picture recognition, and avoidance responses (Goodwin, 1969; Bustamante, 1969; Malcuit, 1973; Eich, et al, 1975; Weingartner, et al, 1978; Bartlett & Santrock, 1979). It appears that some tasks are more vulnerable to state-dependent changes than others. Goodwin (1969), for example, found that performance on free recall and avoidance tasks was significantly influenced by state changes particularly when original learning occurred in a drug state. Eich, et al, (1975) reported that subjects gave more correct responses under cued recall conditions than under free recall conditions. Weingartner, et al, (1978) reported that state-dependent learning was present under free recall conditions but that cued recall eliminated SDL.

Eysenck (1976) suggested that affective arousal influences performance on both free recall and paired-associate learning. Kaplan and Kaplan (1968), commenting on their previous research, concluded that because free recall involves selection of certain material which is familiar and well established in memory while paired-associate learning presumably involves forming new bonds or representations, the former is superior under high arousal conditions. It appears that free recall of material is one of the most appropriate tasks available for demonstrating SDL.

Several cited studies have used free recall of word lists as one of the response measures (Goodwin, 1969; Eich, et al, 1975; Weingartner, et al, 1978). Only the Weingartner research reported the types of words used but it appears that word selection is as important as task selection and method of manipulating affective states.

Word Selection. The type of words used as stimuli in state-dependent research appears to influence results. Weingartner, et al, (1978) reported using common nouns as cognitive stimuli and found that "depressed" subjects recalled more meaningful words. Paivio, et al, (1969) presented two lists of 500 words each to subjects and instructed them to rate each word based on its ability to produce a mental picture or sensory experience. The mental picture score was translated into an imagery rating. A second group of subjects rated the same word lists for concreteness

and abstractness. Meaningfulness of the words was determined by having a third group of subjects write down as many words as came to mind after seeing the stimulus word. The research resulted in a 925 word list with meaningfulness, imagery, and concreteness scores. It appeared that the words which could be considered the most common nouns and verbs received the highest meaningfulness ratings, thus making Weingartner's choice of common nouns an appropriate one. The current study used words selected from the Paivio word list.

It is apparent that subject ability to imagine situations and make meaningful connections between stimulus words and situations or states is desirable in a research design which seeks to determine the effect of affective state changes on recall. Determining this ability in subjects in the present study and related abilities in previously cited studies was achieved by pretesting subjects on the same or a closely related task.

Subject Suggestibility. Two of the cited studies (Weingartner, et al, 1978; Bartlett & Santrock, 1979) measured the ability of subjects to perform on a closely related task prior to the actual presentation of experimental variables. Weingartner, et al, (1978) required subjects to work out several anagrams in a pretest situation. Bartlett and Santrock (1979) pretested subjects for their ability to remember story content. The current research required that subjects imagine emotional situations after being given verbal instructions.

Imagining such situations on command with sufficient intensity to change physiological processes (HR) required that subjects be able to control and manipulate their imagination. In the present study, subjects' ability to imagine situations was measured by performance on the Barber Suggestibility Scale (Barber, 1966).

The original Barber Suggestibility Scale (BSS) involved subjects imagining a series of eight test situations while an observer objectively measured their performance. More recently, a subjective rating scale has been developed (Barber, 1969) (See Appendix B). Subjects were asked to select the statement which most closely described this condition while imagining the test situation. A Likert-type scale is scored 0, 1, 2, 3, with 0 corresponding to the least intense feeling and 3 with the most intense. Subjects' scores on the BSS were not used to determine eligibility for participation but did serve as an indicator of ability to use imagination.

Hypotheses. The present experiment was designed to examine the influence of affective state changes on free recall of common words (SDL) and the effect of an external cue (S^D-tone) on the state-dependent effect. It was hypothesized that: 1) the state-dependent effect would be observed by manipulating affective states; and 2) presentation of a discriminative stimulus would modify the SDL so as to increase the amount of transfer between affective states.

Experiment 1

The procedure was approved by the Rights of Human Subjects Committee at both the departmental and university levels. The risks to subjects were minimal and were outlined in the consent form which each subject voluntarily signed. The benefits outweighed any risks. The procedure was described to subjects prior to their signing of the consent form, questions were encouraged and answered, and subjects were informed of their right to withdraw from the research at any time. The experimenter was supervised by her faculty advisor throughout the course of the research and he was available to assist should any emergency arise. Data were stored in a locked office away from the testing room. No names of subjects have been used in the report of the research.

Method.

Subjects. Ten volunteer subjects were recruited from the student population of Pittsburg State University. The heart rate monitor was demonstrated and volunteers were asked to increase their heart rate while imagining an anger producing situation of their own definition and to decrease heart rate while imagining a relaxing situation of their own definition. Volunteers were selected to participate after demonstrating the ability to manipulate heart rate, that is, to increase and decrease heart rate at least ten beats per minute from baseline. Three males and seven females between the ages of 18 and 44 participated.

Apparatus. Subjects' level of suggestibility was determined by using the Barber Suggestibility Scale (Appendix B).

Heart rate was measured with a "Heart Rate Monitor", Model #77066, manufactured by Lafayette Instrument Company, Lafayette, Indiana. This instrument provided a digital display of mean beats per minute through the mechanism of a finger-clip transducer placed on the index finger of the subject's dominant hand. The heart rate monitor drove a strip-chart recorder, Model # R1 5P, manufactured by General Scanning, Inc., which provided a printed linear analog of heart rate.

Word lists were developed from Paivio, et al, (1968) and Thorndike and Lorge (1944). Words were chosen based on similarity of number of syllables, meaningfulness, concreteness, imagery, and frequency ratings (Appendix C).

An overhead projector was used to present the words which were projected on a wall approximately five feet from the subject.

A 1kHz (1000 cps) tone was produced using a tone generator which was amplified with a Magnavox speaker positioned approximately two feet away from the subjects.

Procedure. Pretest. One to five days before the experiment began, volunteers were pretested to determine their ability to manipulate their heart rate and imagine emotional situations. During the last 10 seconds of a one minute heart rate monitoring period, baseline heart rate was recorded. The subject was then asked to imagine an anger situation and was given three minutes to increase heart rate. After a five minute rest period, the

subject was asked to imagine a relaxing situation and was given three minutes to decrease heart rate. Subjects were selected for participation if they successfully increased and decreased heart rate by ten beats per minute from baseline within the allotted three minute recording session. Subjects were asked to participate and scheduled for three one-hour experimental sessions. Each of the three experimental sessions was divided into an acquisition phase and a recall phase.

Prior to the start of the experimental treatment on Day I, subjects were given, asked to read and sign a consent form. (Appendix A) Next, the experimental apparatus was described and demonstrated and the Barber Suggestibility Scale was administered. Subjects were allowed to ask questions regarding the amount of time involved in participation and heart rate measurement, for example. Questions regarding the nature and purpose of the research asked at this time were responded to by asking the subject to defer the questions until after completion of the experiment. All subjects signed the consent form and were informed of their right to withdraw from participation in the study at any time.

Day I: Phase I: (Acquisition). The actual experimental treatment began with the acquisition phase immediately after the subject signed the consent form. The subject was seated in a reclining chair and was requested to direct their attention toward the wall in front of them. Each word of Word List 1 (Appendix C) was projected for five seconds with a 10 second

interval between each presentation. Immediately after the last word was shown, the subject was asked to recall as many words as possible. The number of words recalled after one presentation was designated as word recall baseline. Word List 1 was presented until the acquisition criterion of two perfect recitations or five presentations was reached. Next Word List 2 (Appendix C) was projected with each word being shown for five seconds and 10 seconds between each presentation. Immediately after the presentation of the last word of Word List 2, the subject was asked to recall as many words as possible from that list. The number of words recalled after one presentation was designated as word recall baseline for Word List 2. Word List 2 was presented until the acquisition criterion of two perfect recitations or five presentations was reached.

The order of presentation of word lists was determined using the ABBA method of counterbalancing between subjects. (See Table V) The acquisition phase ended when criterion was reached.

Day I: Phase II: (Recall). The recall phase began five minutes after completion of the acquisition phase. The finger transducer for the heart rate monitor was again demonstrated and explained to the subject and placed on the index finger of the subject's dominant hand. The subject was asked to sit quietly for one minute during which a heart rate baseline was obtained. A strip-chart recording was taken during the last 10 seconds of the one-minute baseline period.

The subject was then instructed to imagine an "angry" situation and increase the monitored heart rate (daily baseline) by ten beats per minute by the following instructions:

> I want you to imagine a situation in which you were very angry. Try to get your body to feel like it did when you were in the situation. I want you to be very specific. Remember who you were with, where you were, what was said, and when the situation occurred. When we are finished, I will ask you to give me the details I have mentioned. As you imagine this situation, I want you to try to change the reading on this machine. I want you to increase the number on the machine by 10 beats and we will not continue with the procedure until you have done so.

When the 10 beat per minute increase in heart rate occurred, the subject was asked to "recall as many words as possible from the training phase."

After recall in the anger condition and a five minute rest interval, the subject was asked to imagine a relaxing situation and decrease heart rate 10 beats per minute from the daily baseline by the following instructions:

> I want you to imagine a situation in which you were very relaxed. Try to get your body to feel like it did when you were in the situation. I want you to be very specific. Remember who

> you were with, where you were, what was said, and when the situation occurred. When we are finished, I will ask you to give me the details I have mentioned. As you imagine this situation I want you to try to decrease the number on this machine by 10 beats per minute. We will not continue with the procedure until you have done so.

The subject was allowed enough time to decrease heart rate by 10 beats per minute and was asked to "recall as many words as possible from the training phase."

The order of presentation of conditions (anger/relaxation) was determined by counterbalancing using the ABBA method between subjects. (See Table VI)

Day II: Phase I: (Acquisition). The second experimental day began with the establishment of heart rate baseline. After heart rate baseline was determined, the acquisition phase began with the instructions for anger being read orally to the subject. When heart rate was increased 10 beats per minute above the daily baseline, (the procedure was identical if the subject received the R condition first except that a decrease of 10 bpm was required prior to the presentation of the first word of Word List 4) the first word of Word List 3 was shown. Subsequent words were presented every 10 seconds only if there was no decrease in heart rate. When a decrease in heart rate did occur the subject was given enough time to return to the 10 beat per minute above baseline (daily) before another word was presented. Word List 3 (Appendix C) was

presented until the criterion of two perfect recitations or five presentations was reached. Heart rate was monitored and recorded by the experimenter for 10 second periods (at each word presentation) throughout each acquisition trial. After a five minute rest interval, the subject was read the instructions for the relaxation condition. When heart rate was decreased by 10 beats per minute below daily baseline, the first word of Word List 4 was presented. Again, the next word was presented every 10 seconds only if there was no increase in heart rate. When an increase in heart rate did occur, the subject was allowed enough time to return to the relaxation level. Word List 4 presentation continued until the criterion of two perfect recitations or five presentations was reached. Heart rate was monitored for 10 second periods (with word presentation) throughout each acquisition trial by the experimenter. The acquisition phase lasted approximately 45 minutes for each subject.

Day II: Phase II: (Recall). After a five minute rest period, the recall phase began with the subject being read the instructions for the anger condition. When the heart rate monitor indicated an increase of 10 beats per minute above baseline (daily), the subject was orally given the following instructions: "Tell me as many words as you recall from the training trials." The subject was allowed two minutes for recall. After the two minute recall period and a five minute rest interval, the subject was read the instructions for the

relaxation condition. When the heart rate monitor indicated a decrease of 10 beats per minute below baseline, the subject was orally given the following instructions: "Tell me as many words as you recall from the training trials." The subject was given two minutes for recall, rescheduled for the next day, and dismissed.

Day III: Phase I: (Acquisition). The third experimental day began with establishing a heart rate baseline and the procedure was identical to Day II: Phase I (Acquisition) except that a tone was introduced with word presentation. The subject was read the instructions for the anger condition and given time to increase heart rate 10 beats per minute above the daily baseline. When the desired heart rate was achieved, a 1kHz (1000cps) tone was sounded for one second as each word of Word List 5 was presented. Again, the next word of Word List 5 was shown every 10 seconds only if heart rate was maintained at the increased rate. If a decrease occurred, the subject was given time to return to the 10 beats per minute above baseline level before the tone and next word were presented. Word List 5 presentation continued until the criterion of two perfect recitations or five presentations was reached. Five minutes after the final acquisition trial for the anger condition the subject was read the relaxation instructions. Again, the procedure was identical to Day II: Phase I: (Acquisition) except that after the subject's heart rate decreased 10 beats per minute below daily baseline,

a 1kHz (1000 cps) tone was sounded for one second as each word of Word List 6 was presented. The words of Word List 6 were presented every 10 seconds only if the subject maintained the decreased heart rate. If an increase in heart rate occurred, the subject was given time to return to the relaxation level. Word List 6 presentation continued until the acquisition criterion of two perfect recitations or five presentations was reached. The acquisition period lasted approximately 45 minutes for each subject.

Day III: Phase II: (Recall). Five minutes after the final acquisition trial for the relaxation condition, the recall phase began with the anger instructions being read to the subject. When an increase of 10 beats per minute above the daily baseline was indicated by the heart rate monitor, the tone was sounded for one second and the subject was orally given the following instructions: "Tell me as many of the words as you can recall from the training trials." The subject was allowed two minutes for recall. After the two minute recall period and a five minute rest period, the instructions for the relaxation condition were read. The subject was given time to decrease heart rate to the appropriate level, the tone was sounded for one second and the subject was given the following directions: "Tell me as many of the words as you can recall from the training trials." The subject was allowed two minutes for recall.

After the final recall, the subject was asked to comment on participation in the study, particularly on the ease of

imagining anger and relaxing situations and maintaining the feelings. (See Appendix D) The nature and purpose of the research were explained and the subject was dismissed.

Experiment 2. The subject requirements, apparatus, and procedure were identical to Experiment 1 except that on Day III, the 10 subjects (4 males and 6 females) heard the 1kHz (1000 cps) tone only in the condition in which performance from Day II: Phase II: (Recall) was poorest. If, for example, the subject recalled fewer words from the anger condition on Day II: Phase II than from the relaxation condition, the tone was sounded only in the anger condition on Day III in Experiment 2. The prediction was that the tone would improve recall in that condition by acting as an S^D.

Day III: Phase II: (Acquisition). The subject was read the instructions for the anger condition and given time to increase heart rate 10 beats per minute above the daily baseline level. When the desired heart rate was achieved, a 1kHz (1000 cps) tone was sounded for one second as each word of Word List 5 was presented. Subsequent words from Word List 5 were presented every 10 seconds only if the increased heart rate was maintained. If a decrease occurred, the subject was given time to return to the higher heart rate before the tone and the next word were presented. Word List 5 presentation continued until the criterion of two perfect recitations or five presentations was reached. Five minutes after the final acquisition trial for the anger condition, the subject was read the instructions for the relaxation condition.

The procedure was identical to Day II: Phase I: (Acquisition) of Experiment 1 except that after the desired decrease in heart rate occurred, the words of Word List 6 were presented without the tone. Words of Word List 6 were presented every 10 seconds only if the subject maintained the decreased heart rate. If an increase did occur, the subject was given time to return to the decreased level. Again, Word List 6 was presented until the acquisition criterion of two perfect recitations or five presentations was reached.

Day III: Phase II: (Recall). Five minutes after the final acquisition trial for the relaxation condition, the recall phase began with the anger instructions being read to the subject. When an increase in heart rate of 10 beats per minute above baseline (daily) was indicated by the heart rate monitor, the tone was sounded for one second and the subject was orally given the following directions: "Tell me as many of the words as you can recall from the training trials." The subject was allowed two minutes for recall. After the two minute recall period and a five minute rest interval, the instructions for the relaxation condition were read. The subject was given time to decrease heart rate to the desired level and was orally given the following directions: (No tone was sounded) "Tell me as many of the words as you can recall from the training trials."

The debriefing procedure following the final recall was identical to that of Experiment 1.

The method was designed to test the hypothesis that SDL would be observed after the manipulation of affective states, that manipulation of affective states would occur by having subjects imagine specified emotional situations, that heart rate would serve as an accurate index of affective arousal, and that the presentation of a tone would disrupt the SDL.

Results. As discussed in the introduction, SDL is the acquisition of knowledge in a specific state of consciousness which does not transfer to other states of consciousness. The current research proposed to demonstrate SDL by manipulating affective states. One of the measures used to determine the presence of SDL was recall performance. The criterion employed was a performance decrement or loss of two or more words in the recall phase as compared to the acquisition phase.

The following section examines differences in performance each day, for both experiments; trends across days for each subject; physiological correlates of SDL; the presence of SDL between days, and group data.

Recall: Experiment 1.

Day I. The factor which distinguished subjects in Experiment 1 was the presentation of the tone in both conditions on Day III.

Table 7 presents the acquisition and recall performance for each subject on Day I. The reader will recall that acquisition occurred with no manipulation of affective states on this day. In the recall phase, subjects were required to change affective

states prior to actually recalling the word lists. In other words, acquisition occurred in the state in which the subject entered the experiment and recall occurred after affective state manipulation. This follows the SDL model proposed by earlier research.

Each subject achieved the level of performance which met the acquisition criterion of two perfect recitations or five trials. It was predicted that the state-dependent effect would be observed after manipulation of affective states.

Subject 1 demonstrated the performance expected in the earlier mentioned SDL model. When in the anger condition in recall, two anger list words and one relaxation list word were recalled. Similarly, when in the relaxation condition in recall, four anger list words and one relaxation list word were recalled. Subject 4 exhibited SDL in only the anger state in the recall phase, though the performance decrement was not as remarkable as those seen in the subject who demonstrated SDL in both conditions.

Seven subjects (2,3,5,6,7,8,9) showed no performance decrements or did not meet the criterion established to determine the presence of SDL. Three (6,7,8) of these subjects demonstrated no decrements as compared to acquisition, that is, recall remained at seven in both anger and relaxation states. Another of the seven (3) showed a decrement of one relaxation list word in the relaxation condition but remained at acquisition level in the anger condition and recalled seven anger words in the R condition.

The three remaining subjects (2,5,9) also showed a decrement in recall in one word list but remained at acquisition level on the other. Data from one subject was eliminated because it was not interpretable across days.

The subject who demonstrated SDL in both conditions (1) showed only a small amount of transfer or recall of opposite state associated words in each condition. The subject who showed SDL in the anger condition (4) had a large amount of transfer, seven words in each of the conditions. The remaining seven subjects (2,3,5,6,7,8,9) also demonstrated large amounts of transfer in both conditions. The results are not easily interpreted because acquisition did not involve affective state changes.

Day II. Table 8 represents the acquisition and recall performance for each subject on Day II. Subjects experienced affective state changes in the acquisition phase and in the recall phase. As was discussed earlier, subjects learned word lists in the anger condition and the relaxation condition. Recall occurred under the same conditions.

It was predicted that performance decrements (SDL) would occur but would be a function of the manipulation of state changes, that is, subjects would recall same state words while decrements would occur in recall of opposite state words. Transfer was not expected to be a significant factor.

All subjects achieved the level of performance which met the acquisition criterion of two perfect recitations or five

trials. Two subjects (1,3) demonstrated generalized performance decrements in both conditions from acquisition to recall. One of these subjects (1) recalled more anger list words than relaxation list words in both conditions though there was a decrease of at least three words recalled in each condition. Another subject (3) exhibited approximately equal performance deficits in both conditions.

Seven subjects (2,4,5,6,7,8,9) showed a mild state-dependent trend in only one condition. Three of those (2,4,6) had perfect recall of relaxation words in the relaxation condition. Subject 5 recalled only relaxation words in the relaxation condition. Two subjects (7,8) had perfect recall of anger list words in the anger condition. Data for one subject was eliminated because it was not interpretable across days.

Although all the subjects showed a trend toward SDL, transfer was a more predominant factor in the Day II results. Every subject exhibited some transfer between states. Those who demonstrated the state-dependent effect in only one condition also tended to recall the same words in the opposite state. The decrement was associated with one of the affective states regardless of the recall condition.

Day III. Table 9 presents the acquisition and recall performance for each subject on Day III. Subjects experienced affective state changes in both acquisition and recall phases. In addition, a tone was presented in both the acquisition and recall phase. The subjects heard the tone with every word presentation

in the acquisition phase and immediately after hearing the recall instructions. The prediction was that the tone would function as an S^D and would mediate the S^D function of the affective states. Transfer was expected to be observed in high levels.

All subjects achieved the level of performance which met the acquisition criterion of two perfect recitations or five trials. Three subjects (1,3,4) required five trials.

Six subjects (1,3,4,5,6,9) had approximately identical performance across conditions and recalled as many opposite state words as same state words. One subject (3) who required five trials maintained the acquisition level in recall. The other two (1,4) who required five trials showed performance deficits in both conditions though recall level was similar across conditions. Three subjects (2,7,8) exhibited the state-dependent effect in one condition and a significantly lower level of recall in the other condition. Subject 2 recalled all relaxation words in both conditions; the other two (7,8) recalled more anger words in both conditions.

To generalize, the number of subjects who demonstrated SDL was lower than for either of the other two days. The presence of the tone apparently functioned as predicted, that is, it modified SDL and became a stronger S^D than the affective state. Transfer was observed in significant levels in all subjects further validating the idea of the modifying function of the tone.

Experiment 2. Subjects in Experiment 2 received the identical treatment on Day I and Day II as the Experiment 1 subjects. On Day III, however, subjects in Experiment 2 received the tone only in the condition in which Day II performance was poorest.

Day I. Table 10 presents the acquisition and recall performance for each subject on Day I. Subjects learned two lists of words to criterion with no affective state manipulation. In the recall phase, subjects were required to change affective states prior to actually recalling the word lists.

Each subject achieved the level of performance which met the acquisition criterion of two perfect recitations or five trials. It was predicted that SDL would be observed after manipulation of the affective states.

Five subjects (1,2,3,5,6) showed no performance deficits or did not meet the criterion established to determine the presence of SDL. One (1) of these subjects remained at the acquisition level across conditions. The other four (2,3,5,6) showed small performance decrements in one of the conditions but the deficits were not enough to constitute SDL.

Four subjects (4,7,8,9) demonstrated SDL in the anger condition. Each of these subjects showed a performance decrement of at least four anger list words while remaining at acquisition level in the relaxation condition. Data for one subject was eliminated because it was not interpretable across days.

Transfer was observed with all subjects though in varying

degrees. The four subjects (4,7,8,9) whose performance demonstrated SDL showed almost no change in recall of anger words in the relaxation condition. The results cannot be easily interpreted because acquisition did not involve affective state changes and therefore transfer as earlier defined cannot be determined.

Day II. Table 11 presents the acquisition and recall performance for each subject on Day II. Subjects experienced affective state changes in the acquisition and recall phases. The procedures for both the acquisition phase and the recall phase were identical to those described for Experiment 1. The prediction was that performance decrements would occur but would be a function of the affective state manipulation. Transfer was not expected to be a significant factor.

All subjects achieved the acquisition criterion of two perfect recitations or five trials. Two subjects (6,7) required five trials. Two subjects (4,7) showed performance decrements in both conditions. Five subjects (1,2,3,6,9) had larger decrements in the anger list words than in the relaxation list words. Each of these five subjects maintained the low level of recall of anger list words in the relaxation condition. All of these subjects recalled at least six relaxation list words in both conditions. Two subjects (5,8) showed performance decrements in the relaxation condition which exceeded decrements in recall of anger list words. Again, these subjects maintained the low level of recall of relaxation list words in both conditions.

The performance deficits observed in the data for Day II are largely uninterpretable except to say the prediction was not upheld. The decrements represented SDL but they are generalized so the only pattern noted was that of a general decline in the number of words recalled. On the other hand, transfer was amply demonstrated and appears to have been a significant factor.

Day III. Table 12 presents the acquisition and recall performance for each subject on Day III. Subjects in Experiment 2 received the tone in only the condition in which recall performance for Day II was poorest. The tone was sounded with every word presentation in that condition and immediately after the recall instructions were completed. The prediction was that SDL would be observed in the condition with no tone and that the tone would function as an S^D which would mediate the S^D function of the affective state. All the subjects achieved the acquisition criterion of two perfect recitations or five trials. Six subjects (1,2,4,6,7,9) received the tone in the anger condition. Of these, subject 2 maintained acquisition level of recall of anger list words in both conditions as well as of relaxation list words in both conditions. Three (4,6,9) showed significant performance decrements in the recall of anger list words across conditions. Two of these (6,9) had perfect recall of relaxation list words in both conditions. The other one (4) demonstrated a generalized performance decrement in recall of both lists and in both conditions. Three subjects (3,5,8) received the tone in the relaxation condition. SDL was observed in one subject (4)

recalled no anger list words in either condition. This subject recalled more relaxation list words in the anger condition than in the relaxation condition when the tone was sounded. The other two of these three also showed performance decrements in recall of the tone associated word list.

The trend toward SDL was observed in only two subjects (7,8). The transfer phenomenon was more readily seen in this data. The tone appeared to have an opposite effect with six subjects who recalled more opposite state associated words. The prediction of mediation of SDL was observed but the function of the tone is unclear.

Trend Analysis. Trend analysis refers to the pattern of a subject's responses and is recorded as a line of best fit or line of regression which may have a negative or positive slope. In this case a negative slope indicates a trend toward a decrease in number of words recalled across days while a positive slope suggests an increase in number of words recalled across days.

Experiment 1. Two subjects (1,9) showed strong positive trends in both conditions across the three testing days. Two other subjects (2,4) had a positive trend in one condition and a negative trend for the other. Four subjects (3,5,7,8) showed negative trends in both conditions across days. One subject (6) showed no significant variation and the trend was neither negative nor positive. The trend analysis for subjects in this experiment suggested that two subjects improved in overall recall performance across days while four subjects tended toward poorer performance as

variables were introduced across days. The two subjects who showed different direction slopes may have been particularly influenced by the affective states. (See Figures 1-9)

Experiment 2. One subject (2) showed strong positive trends in both conditions across days. Three subjects (5,6,8) showed a negative trend in one condition and a positive trend in the other. Three subjects (1,3,9) showed a negative trend in one condition and no variation across days in the other. Two subjects (4,7) showed negative trends across days in both conditions.

The trend analysis for subjects in this experiment suggested that only one subject's performance improved across days. Three subjects may have been influenced particularly by the affective states. The three others who showed negative trends in one condition and little variation in the other may have again been particularly influenced by the negatively effected state. The two who had negative trends may have been influenced by the introduction of variables across days (See Figures 11-19)

Heart Rate. As was discussed in the introduction, heart rate (HR) has been imployed as a measure of both affective and physiological arousal. In the present research, heart rate was the objective measure of affective states.

Heart rate was recorded for each subject during manipulation of affective states. It was determined from the literature that HR of 10 bpm above baseline correlated with the anger state while HR of 10 bpm below baseline was positively correlated with relaxation.

Experiment 1. Heart rate was recorded only during the recall phase of Day I. Seven subjects increased heart rate at least 10 beats per minute above baseline in the anger condition. Six subjects lowered heart rate by at least 10 beats per minute in the relaxation condition. One subject showed a seven beats per minute decrease in the relaxation condition. Baseline data was not recorded for two subjects due to experimenter error. The two subjects who showed SDL on Day I did not vary significantly in heart rate from those who did not.

Heart rate was recorded during both acquisition and recall on Day II. Six subjects increased heart rate by at least 10 beats per minute in the anger condition and decreased heart rate by at lease 10 beats per minute in the relaxation condition in both acquisition and recall phases. One subject decreased heart rate by 3 to 10 beats per minute in the relaxation condition. Baseline data was not available for two subjects.

Heart rate was recorded during both acquisition and recall on Day III. Eight subjects increased heart rate by at least 10 beats per minute in the anger condition and decreased heart rate by at least 10 beats per minute in the relaxation condition in both acquisition and recall phases. Baseline data was not available for one subject. (See Figures 1-9)

Experiment 2. The procedure for recording heart rate was identical to that in Experiment 1.

Heart rate was recorded only during recall on Day I. Seven

subjects increased heart rate by at least 10 beats per minute in the anger condition and decreased heart rate by at least 10 beats per minute in the relaxation condition. Two subjects decreased heart rate by 6 to 8 beats per minute in the relaxation condition.

Heart rate was recorded during acquisition and recall on Day II. Nine subjects increased heart rate by at least 10 beats per minute in the anger condition and decreased heart rate by at least 10 beats per minute in the relaxation condition.

Heart rate was recorded during both acquisition and recall on Day III. Seven subjects increased heart rate by at least 10 beats per minute and decreased heart rate by at least 10 beats per minute in the appropriate states. Two subjects decreased heart rate by 6 beats per minute in the relaxation condition.

The heart rate data indicates no significant differences between subjects in either experiment. Any correlation between recall and heart rate is unclear at this time.

Group Data.

Experiment 1. In this experiment each subject received a tone in both anger and relaxation conditions on Day III. Data for nine subjects were calculated; one subject's data were not interpretable because there was no change in number of words recalled across days.

Figure 21 shows the mean number of words recalled by

subjects in this group across days. On Day I the mean for words recalled in the anger condition was 12.5 and for relaxation 12.0. On Day II the mean for words recalled in anger was 11.7 and relaxation, 10.5. The mean number of words recalled on Day III in the anger condition was 8.0 and for relaxation was 10.5.

There were no statistically significant differences in the number of words recalled between anger and relaxation ($F=.793$) on Day III. No statistical analysis was calculated on Day I and Day II data because the only difference in treatment occurred on Day III. Day I data was the baseline which indicated the presence of SDL on Day II, that is, Day II performance for each subject was compared to Day I performance to determine if SDL occurred.

Experiment 2. In this experiment, each subject received a tone on Day III in the condition in which performance was poorest on Day II. Data for nine subjects were calculated; one subject's data were uninterpretable because there were no significant changes in the number of words recalled across days.

Figure 22 shows the mean number of words recalled by subjects in this group across days. On Day I the mean number of words recalled in the anger condition was 9.7 and in relaxation, 12.9. On Day II, the mean for words recalled in anger was 7.5 and relaxation, 10.2. The mean number of words recalled on Day III in the anger condition was 8.0 and in relaxation was 10.9.

This group was statistically equal between conditions (F=1.72), that is, there were statistically significant differences in number of words recalled between anger and relaxation on Day III.

Discussion. This study employed a within subjects design, that is, each subject in Experiment 1 received all the treatments and each subject in Experiment 2 received all the treatments. More specifically, each subject of each experiment was given the identical instructions and treatment on each of the testing days. As was mentioned earlier, the only difference between the two experiments was the presentation of the tone on Day III. The nature of a within subjects design requires that each subject acts as the control within days as well as across days. Because of that, individual data is considered initially and generalizations are made about trends from categorizing the individual data.

The data considered for each subject in this study included changes in number of words recalled between acquisition and recall each day, changes in heart rate with the introduction of affective state changes, and trends in recall across days.

All subjects received identical instructions which initiated affective state changes and must be considered when analyzing the data. The instructions for imagining the different emotional situations were very specific and left little room for variation or ambiguity. Subjects were told what the criteria were and no treatment began until they met the criteria.

Even with the specificity of the instructions, each subject responded with differing degrees or levels of heart rate change. Several maintained a level which minimally met criteria while many exceeded the level of criteria significantly.

Subjects also showed variability in heart rate response with each presentation of the instructions. Such a finding indicates that subjects responded to the very specific instructions differently with each presentation and that while the overall trend was toward meeting criteria, there were many individual extremes. It appears that individual perception of the instructions changed in some way.

The instructions for recall differed considerably from those given to initiate affective state changes. Recall instructions were ambiguous in that no specific guidelines were mentioned for which words were in question. Individual responses varied greatly. All subjects responded with words from both lists with the exception of one subject on Day II who recalled no anger list words in either condition and two subjects on Day III, one who recalled no anger list words in either condition and one who recalled no relaxation list words in the relaxation condition. Subjects demonstrated different levels of transfer in recall and the generalization about the effect of the instructions mentioned above appears to hold for recall at that level. Predictions could not be readily made about the number or type of words that would be recalled, that is, it was not possible to predict that a subject would recall only anger list words in the anger condition,

for example, due to the ambiguity of the instructions.

The ambiguity of the recall instructions may have operated as an S^D which to some degree superceded the S^D effect of the affective states. As was stated above, only three subjects had no recall of words from one of the lists. It seems likely that the instructions were sufficiently vague so as to cause the subjects to try to remember as many words as possible rather than from the list associated with the state they were experiencing.

Similarly, the instructions may have competed with the S^D effect of the tone on Day III. Transfer was observed in every subject with the exception of two, one who recalled no relaxation list words in the relaxation condition but did recall relaxation list words in the angry condition, and one who recalled no angry list words in either condition. It is unclear, based on the data, which of the two S^D's exerted the most influence over recall. It does seem very probable that the instructions continued to act as an S^D on Day III as it did on Day I and Day II.

Keeping in mind the possible action of the instructions on recall it is interesting to note that SDL did occur on all three days. Every subject demonstrated some degree of SDL on one or more days. Had the instructions been more specific the state-dependent effect might have been more pronounced. It must be noted that even with the vagueness of the instructions some subjects continued to show mild SDL across days which

suggests that the instructions were not as influential for those subjects.

The group data indicates that there was a mechanism operating which mediated the degree of SDL thus negating the individual differences observed. It was originally hypothesized that the tone would be that mechanism and modification would occur most noticeably on Day III. Further it was predicted that there would be significant differences between Day III performance in subjects in Experiment 1 and Experiment 2. That did not occur and suggests again that something other than the tone acted as an S^D on Day III, at least for some subjects.

The results of this study provide conclusive data that affective state dependent learning can be demonstrated though in this case not as strongly as was demonstrated in the drug studies of Connelly, et al (1973, 1975, 1977, & 1978): Overton, (1964); & Goodwin, et al, (1969). The method used to manipulate affective states was effective to a degree. This tends to affirm the results of Rywick & Gaffney (1972) in that imagining an emotional situation does not have the same impact on performance as actually experiencing that affective state.

The heart rate results indicate that it is an appropriate index of physiological activity, that is, it provides observable evidence of affective arousal. It may be beneficial in the future to derive a less general index such as blood chemistry, which may give an even clearer picture of physiological processes which operate in affective arousal.

Summary. State-dependent learning was demonstrated with most of the subjects in both experiments. In both experiments, affect was effective in terms of defining the state in which learning occurred, that is, affective states operated much in the same way drug states did in earlier SDL studies. Affective states of anger and relaxation were defined as changes in heart rate from each subject's baseline. Heart rate varied from subject to subject and each subject showed some degree of variation within days and between days. SDL was modified by the introduction of an S^D-tone which was evidenced by an increase in transfer.

Conclusions. The results clearly indicate that state-dependent learning can be demonstrated using affect as the state in which learning occurs. The use of a within-subjects design facilitated the observation of significant individual differences which, as evidenced by the results of the group data analyses, would have been lost in a between-subjects design. Finally, the introduction of another discriminative stimulus modified the state-dependent effect in such a way as to increase the degree of transfer.

The discriminative stimuli, i.e., affective states, employed to demonstrate SDL in this research were chosen because most people have experienced the conditions in everyday life. The results raise questions about the impact of emotion on learning in other situations. Future research should focus on isolating other variables which also may influence acquisition and recall performance on cognitive tasks.

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TABLE I

Bustamante Drug Groups*

Group	Day I	Day II	Day III	Day IV	Day V	Day VI
1	Placebo	Placebo	Placebo	Placebo	Placebo	Placebo
2	Amphetamine	Amphetamine	Amphetamine	Amphetamine	Amphetamine	Amphetamine
3	Amobarbital	Amobarbital	Amobarbital	Amobarbital	Amobarbital	Amobarbital
4	Amphetamine	Placebo	Amphetamine	Placebo	Amphetamine	Placebo
5	Placebo	Amphetamine	Placebo	Amphetamine	Placebo	Amphetamine
6	Amobarbital	Placebo	Amobarbital	Placebo	Amobarbital	Placebo
7	Placebo	Amobarbital	Placebo	Amobarbital	Placebo	Amobarbital

*Taken from: Bustamante, J.A.; Jordan, A.: Vila, M.; Gonzalez, A.; Insua, A.; "State-Dependent Learning in Humans", Physiology and Behavior, 5, 1969, 793-796.

TABLE II

Weingartner Feedback Consitions*

	Pretest Condition	Post-Training Condition
1.	Success Feedback	Success Feedback
2.	Failure Feedback	Failure Feedback
3.	Success Feedback	Failure Feedback
4.	Failure Feedback	Success Feedback

*Taken from: Weingartner, H.; Murphy, D.L.; Stillman, R.C.; "Mood State-Dependent Learning," in Stimulus Properties of Drugs: Ten Years of Progress; Colpaert, F.C. & Rosecrans, J.A. (Eds.); Elsevier North-Holland Biomedical Press, Amsterdam, 1978, 445-453.

TABLE III
PSYCHOLOGICAL STATES AND THEIR EEG, CONSCIOUS AND BEHAVIORAL CORRELATES*

Behavioral Continuum	Electro-Encephalogram	State of Awareness	Behavioral Efficiency
Strong, Excited Emotions (Fear) (Rage) (Anxiety)	Desynchronized; Low to moderate amplitude; fast mixed frequencies.	Restricted awareness; divided attention; diffuse, hazy; "Confusion"	Poor: (lack of control, freezing up, disorganized)
Alert Attentiveness	Partially synchronized; Mainly fast, low amplitude waves.	Selective attention, but may vary or shift. "Concentration" anticipation, "set"	Good; (efficient, selective quick reaction) Organized for serial response
Relaxed Wakefulness	Synchronized; Optimal alpha rhythm.	Attention wanders-not forced, Favors free association	Good; (routine reactions and creative thought.)
Drowsiness	Reduced alpha and occasional low amplitude slow waves.	Borderline; partial awareness. Imagry and reverie. "Dream-like" states.	Poor; (uncordinated, sporadic, lacking sequential timing).
Light Sleep	Spindle bursts and slow waves (larger) Loss of alpha	Markedly reduced consciousnedd, loss of consciousness. Dream state.	Absent
Deep Sleep	Large and very slow waves (synchrony but on slow time base) Random, irregular pattern.	Complete loss of awareness (no memory for stimulation or for dreams.)	Absent
Coma	Isolectric to irregular large slow waves.	Complete loss of consciousnedd, little or no response to stimulation; amnesia	Absent
Death	Isolectric; Gradual and permanent disappearance of all electrical activity	Complete loss of awareness as death ensues.	Absent

*Taken from: Lindsley, D.; "Physiological Phenomena and the Electroencephalogram," Electroencephalography and Clinical Neurophysiology, 4, 1952, 443-456.

TABLE IV

Malcuit Instruction Conditions*

Groups	Instructions Phase I	Instructions Phase II
1	Avoidance	Passive
2	Avoidance + Shock	Passive
3	Avoidance + Feedback	Passive
4	Passive	Avoidance
5	Passive	Avoidance + Shock
6	Passive	Avoidance + Feedback

*Taken from: Malcuit, G.; "Cardiac responses in aversive situations with and without avoidance possibility," Psychophysiology, 1973 (May), 10 (3), 295-306.

TABLE V

ABBA COUNTERBALANCING FOR WORD LISTS			
Subject	Day I	Day II	Day III
1	Word List 1	Word List 3	Word List 5
2	Word List 2	Word List 4	Word List 6
3	Word List 2	Word List 4	Word List 6
4	Word List 1	Word List 3	Word List 5
5	Word List 1	Word List 3	Word List 5
6	Word List 2	Word List 4	Word List 6
7	Word List 2	Word List 4	Word List 6
8	Word List 1	Word List 3	Word List 5
9	Word List 1	Word List 3	Word List 5
10	Word List 2	Word List 4	Word List 6

TABLE VI

ABBA COUNTERBALANCING FOR CONDITIONS			
Subject	Day I	Day II	Day III
1	Anger	Anger	Anger
2	Relaxation	Relaxation	Relaxation
3	Relaxation	Relaxation	Relaxation
4	Anger	Anger	Anger
5	Anger	Anger	Anger
6	Relaxation	Relaxation	Relaxation
7	Relaxation	Relaxation	Relaxation
8	Anger	Anger	Anger
9	Anger	Anger	Anger
10	Relaxation	Relaxation	Relaxation

TABLE 7

EXPERIMENT I

DAY I

Subject	Training Trials						Anger Recall		Relaxation Recall	
		1	2	3	4	5	A Words	R Words	A Words	R Words
1	A	3	6	7	7		2	1	4	1
	R	5	5	7	7					
2	A	6	7	7			7	7	7	6
	R	7	7	7						
3	A	6	7	7	6	7	6	7	7	7
	R	7	7	6	6	7				
4	A	6	7	7			5	7	4	7
	R	7	6	7	7					
5	A	7	7	7			7	7	6	7
	R	7	7	7						
6	A	6	7	7			7	7	7	7
	R	6	7	7						
7	A	7	7				7	7	7	7
	R	7	7							
8	A	7	7	7			7	7	7	7
	R	6	7	7						
9	A	7	7				7	7	7	4
	R	7	7							
10	A	7	7				7	7	7	7
	R	7	7							

TABLE 8

EXPERIMENT I

DAY II

Subject	Training Trials						Anger Recall		Relaxation Recall	
		1	2	3	4	5	A Words	R Words	A Words	R Words
1	A	7	7				4	3	4	2
	R	7	7							
2	A	6	7	7			3	5	2	7
	R	6	7	7						
3	A	6	5	7	7		4	5	5	4
	R	6	5	7	7					
4	A	6	7	7			3	7	4	7
	R	6	7	7						
5	A	6	7	7			0	7	0	6
	R	4	7	7						
6	A	6	7	7			1	7	1	7
	R	6	7	7						
7	A	7	7	7	7		7	4	7	5
	R	5	6	7	7					
8	A	7	7				7	3	7	3
	R	7	7							
9	A	4	7	7			6	5	7	6
	R	3	7	7						
10	A	7	7				7	7	7	7
	R	7	7							

TABLE 9

EXPERIMENT I

DAY III

Subject	Training Trials						Anger Recall		Relaxation Recall	
		1	2	3	4	5	A Words	R Words	A Words	R Words
1	A	4	5	6	7	7	3	2	3	2
	R	7	7							
2	A	7	7	7			4	7	5	7
	R	7	6	7						
3	A	7	7				6	6	6	6
	R	6	6	5	6	6				
4	A	7	7	7			5	6	5	5
	R	6	6	7	6	7				
5	A	6	7	7			5	6	6	6
	R	5	7	7						
6	A	5	7	7			7	7	7	7
	R	7	7							
7	A	7	7	7			7	4	6	4
	R	6	7	7						
8	A	7	7				6	5	6	3
	R	7	7							
9	A	5	7	7			7	6	7	6
	R	7	7							
10	A	7	7				7	7	7	7
	R	7	7							

TABLE 10

EXPERIMENT II

DAY I

Subject	Training Trials						Anger Recall		Relaxation Recall	
		1	2	3	4	5	A Words	R Words	A Words	R Words
1	A	5	7	7			7	7	7	7
	R	7	7	7						
2	A	7	7				5	6	7	7
	R	7	7							
3	A	7	7	7	7		7	7	7	6
	R	4	6	7						
4	A	6	7	7			2	6	3	6
	R	5	7	7						
5	A	7	7				7	5	7	6
	R	7	7							
6	A	7	7	7			7	6	7	6
	R	5	7	7						
7	A	6	7	7			2	7	3	6
	R	7	7	7						
8	A	7	7				1	7	1	7
	R	7	7							
9	A	6	7	7			3	7	4	7
	R	5	6	7	7					
10	A	7	7				7	7	7	7
	R	7	7							

TABLE 11

EXPERIMENT II

DAY II

Subject	Training Trials						Anger Recall		Relaxation Recall	
		1	2	3	4	5	A Words	R Words	A Words	R Words
1	A	7	7				2	7	2	7
	R	4	7	7						
2	A	6	6	7	7		3	7	6	7
	R	6	7	7						
3	A	3	5	6	6		0	7	3	7
	R	5	7	7	7					
4	A	7	4	6	7		3	2	4	1
	R	6	7	7						
5	A	4	7	7	7		4	3	7	3
	R	3	6	7	7					
6	A	5	6	6	7	7	3	6	4	7
	R	5	7	7	7	7				
7	A	4	4	7	7		1	3	3	4
	R	4	4	4	4	5				
8	A	5	7	7			7	3	7	3
	R	6	7	7						
9	A	6	7	7			2	7	3	7
	R	6	7	7						
10	A	6	7	7			6	7	5	7
	R	7	7	7						

TABLE 12

EXPERIMENT II

DAY III

Subject	Training Trials						Anger Recall		Relaxation Recall	
		1	2	3	4	5	A Words	R Words	A Words	R Words
1	A	7	7				5	7	5	7
	R	7	7							
2	A	4	7	7			7	7	7	7
	R	4	7	7						
3	A	3	5	7	7		6	6	7	6
	R	4	5	7	7					
4	A	7	7				0	7	0	5
	R	6	7	7						
5	A	6	7				6	4	6	0
	R	7	7							
6	A	3	6	7	7		3	7	3	7
	R	5	7	7	7					
7	A	7	7				2	4	2	5
	R	3	6	6	7	4				
8	A	5	7	7			5	2	4	3
	R	6	7	7						
9	A	4	7	7			1	7	1	7
	R	7	7	7						
10	A	7	7				5	7	6	7
	R	7	7							

Figures 1 - 10

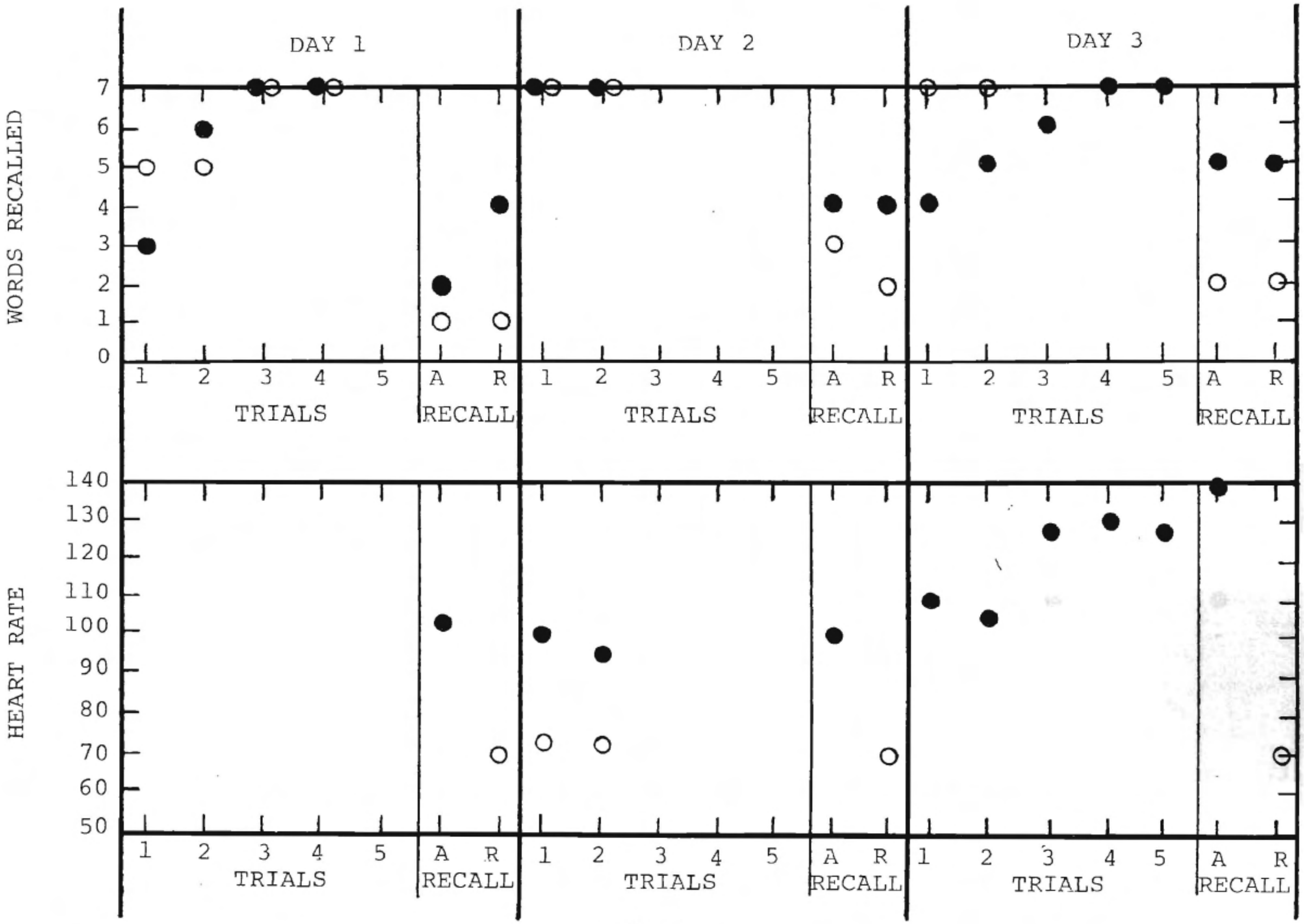
Recall and Heart Rate

Data for

Experiment 1

• Anger Condition

o Relaxation Condition



DAY 1
DAY 2
DAY 3
WORDS RECALLED
7
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1 2 3 4 5
A R
TRIALS
RECALL
HEART RATE
140
130
120
110
100
90
80
70
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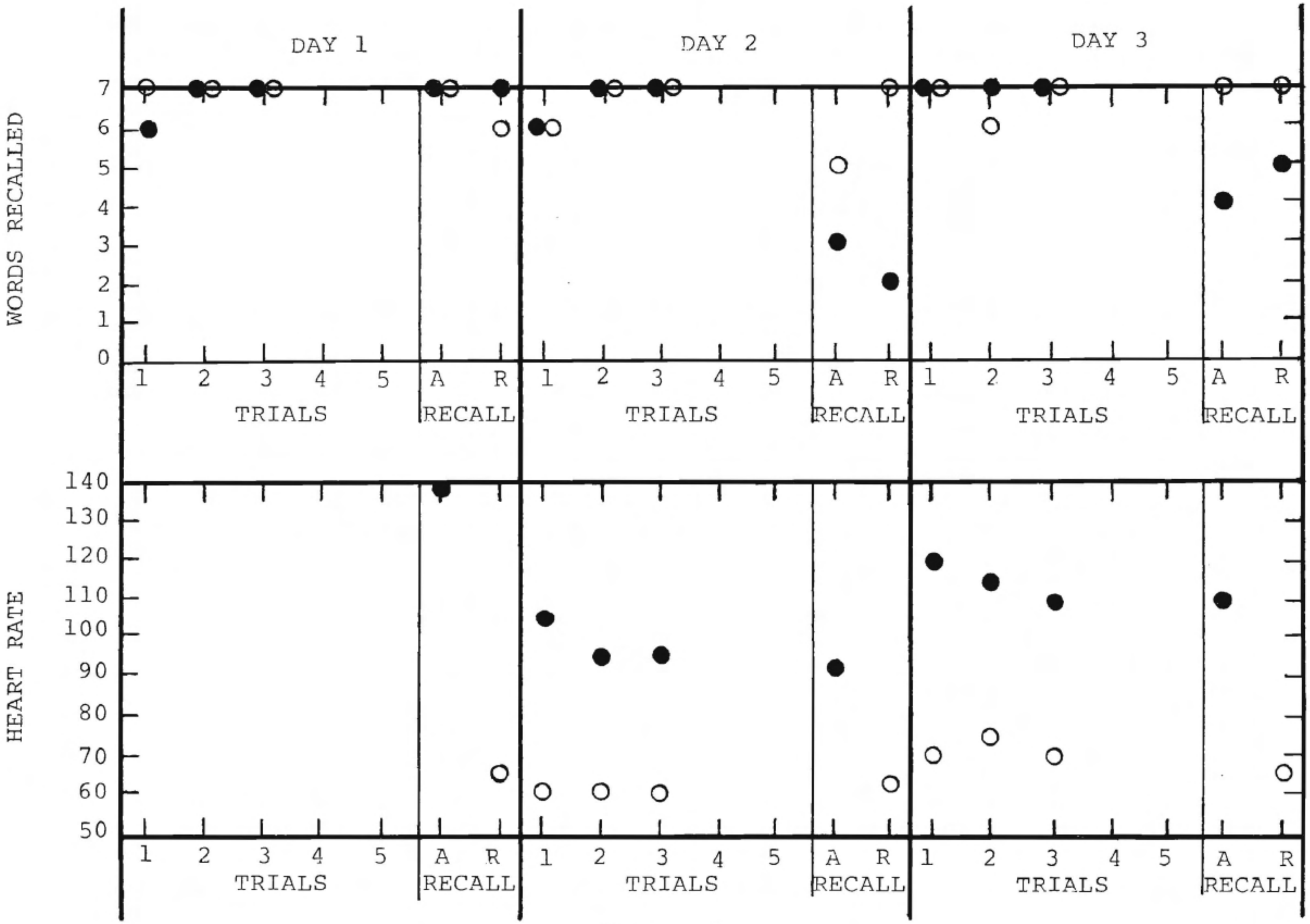
FIGURE 1


DAY 1
DAY 2
DAY 3
WORDS RECALLED
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1 2 3 4 5 A R 1 2 3 4 5 A R 1 2 3 4 5 A R
TRIALS
RECALL
HEART RATE
140
130
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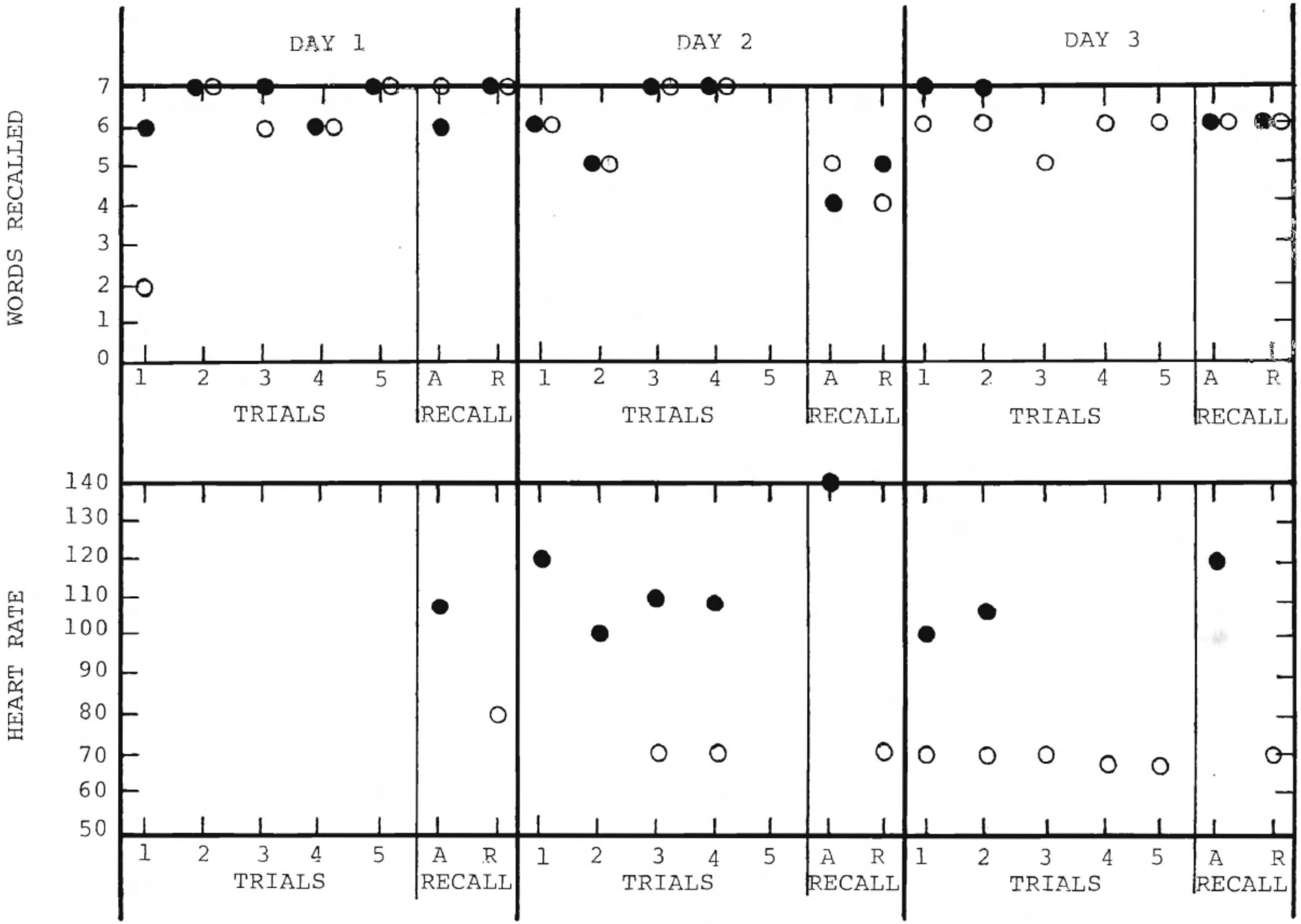
FIGURE 2


DAY 1
DAY 2
DAY 3
WORDS RECALLED
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1 2 3 4 5 A R 1 2 3 4 5 A R 1 2 3 4 5 A R
TRIALS
RECALL
TRIALS
RECALL
TRIALS
RECALL
HEART RATE
140
130
120
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1 2 3 4 5 A R 1 2 3 4 5 A R 1 2 3 4 5 A R
TRIALS
RECALL
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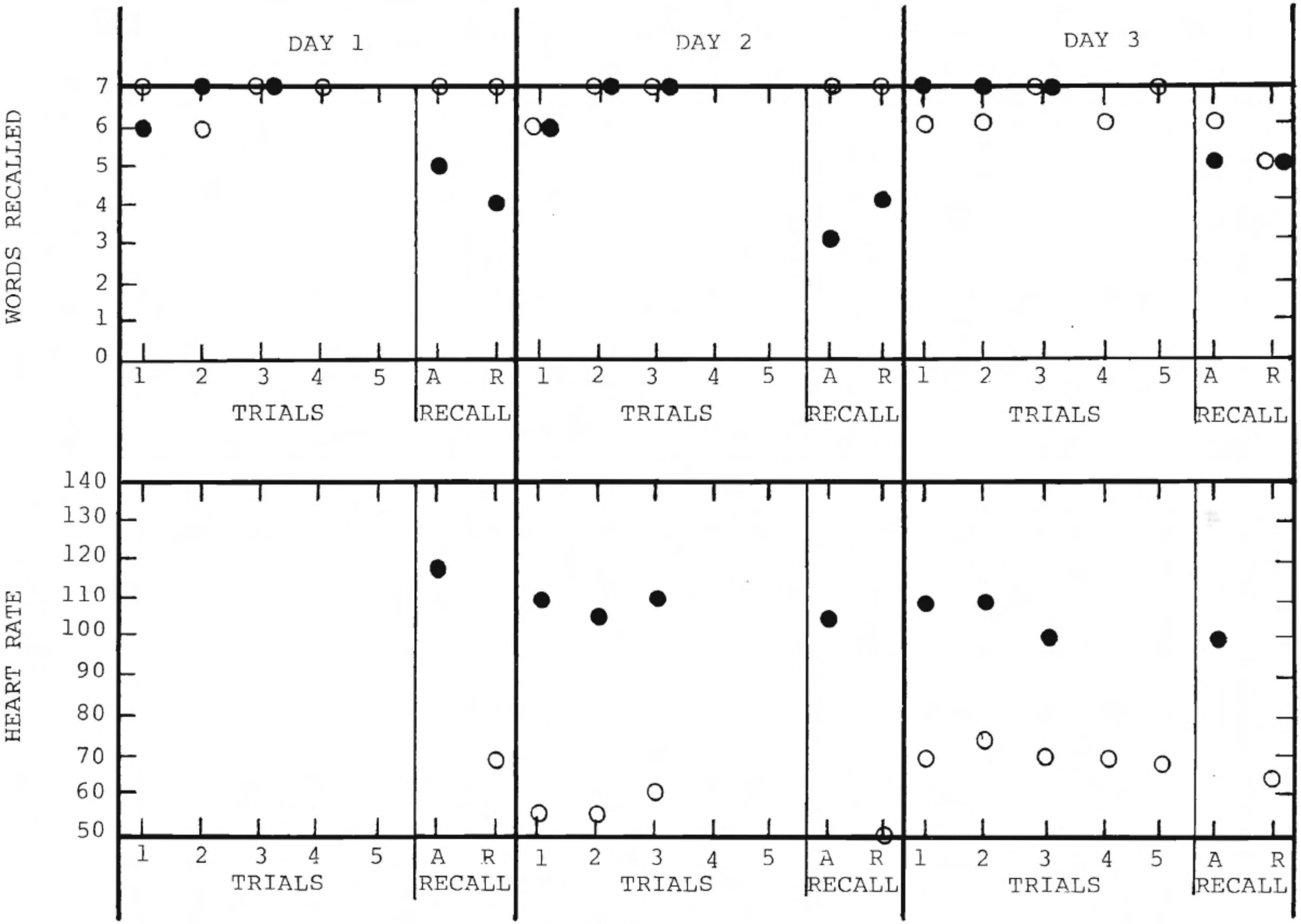
TRIALS
RECALL

FIGURE 3


DAY 1
DAY 2
DAY 3
WORDS RECALLED
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1 2 3 4 5 A R
TRIALS RECALL
HEART RATE
140
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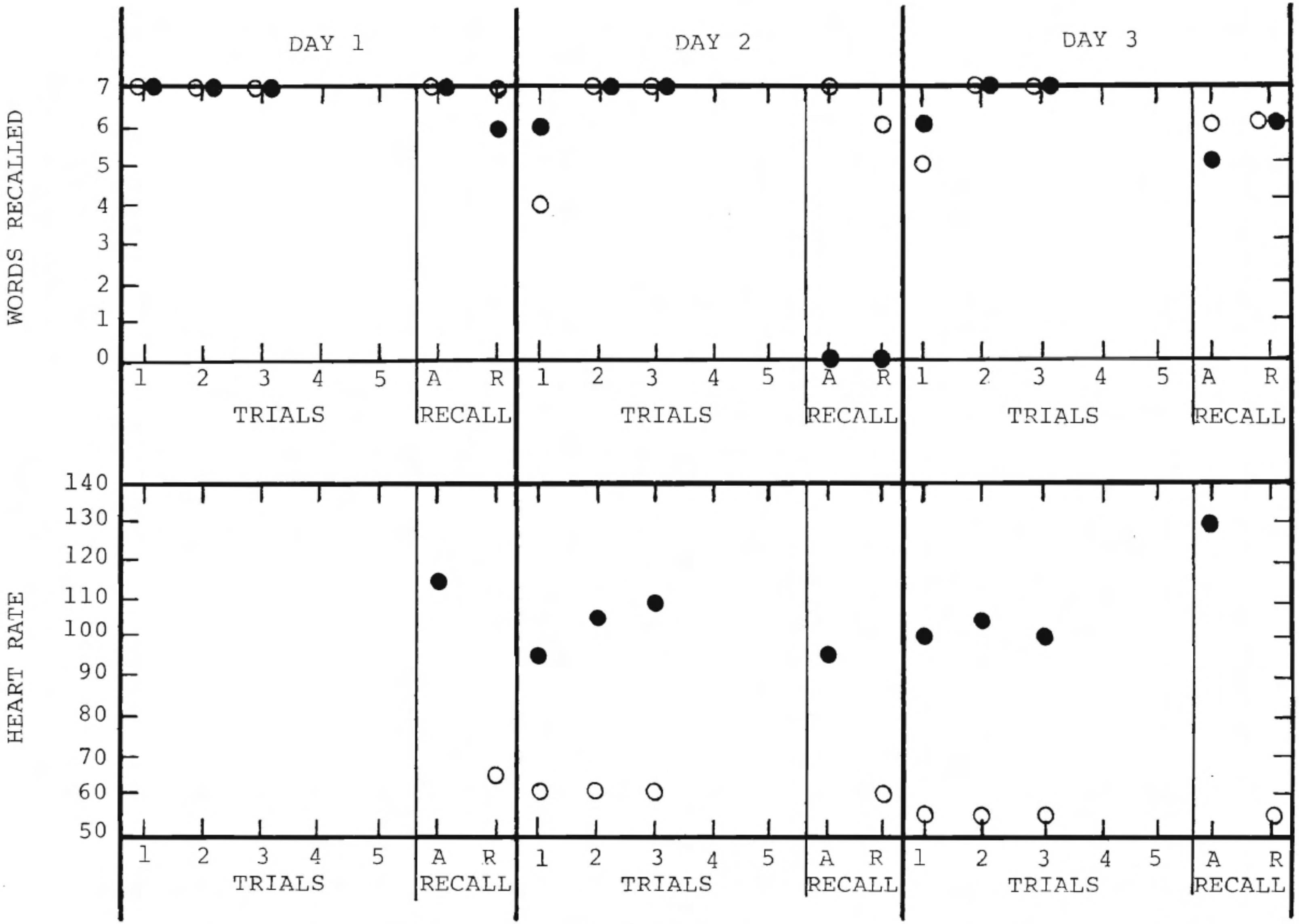
FIGURE 4


DAY 1
DAY 2
DAY 3
WORDS RECALLED
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1 2 3 4 5 A R
TRIALS
RECALL
HEART RATE
140
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FIGURE 5

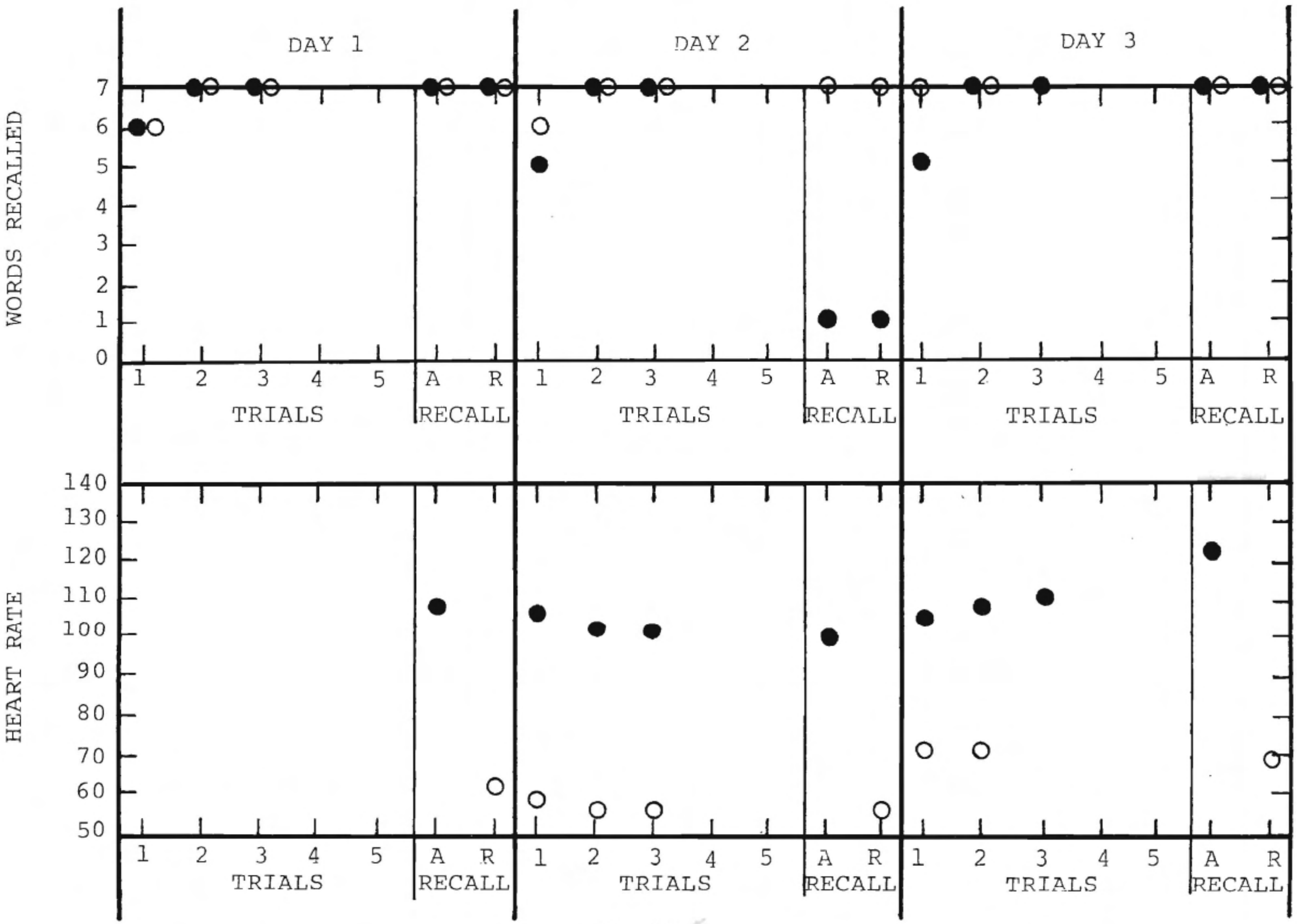
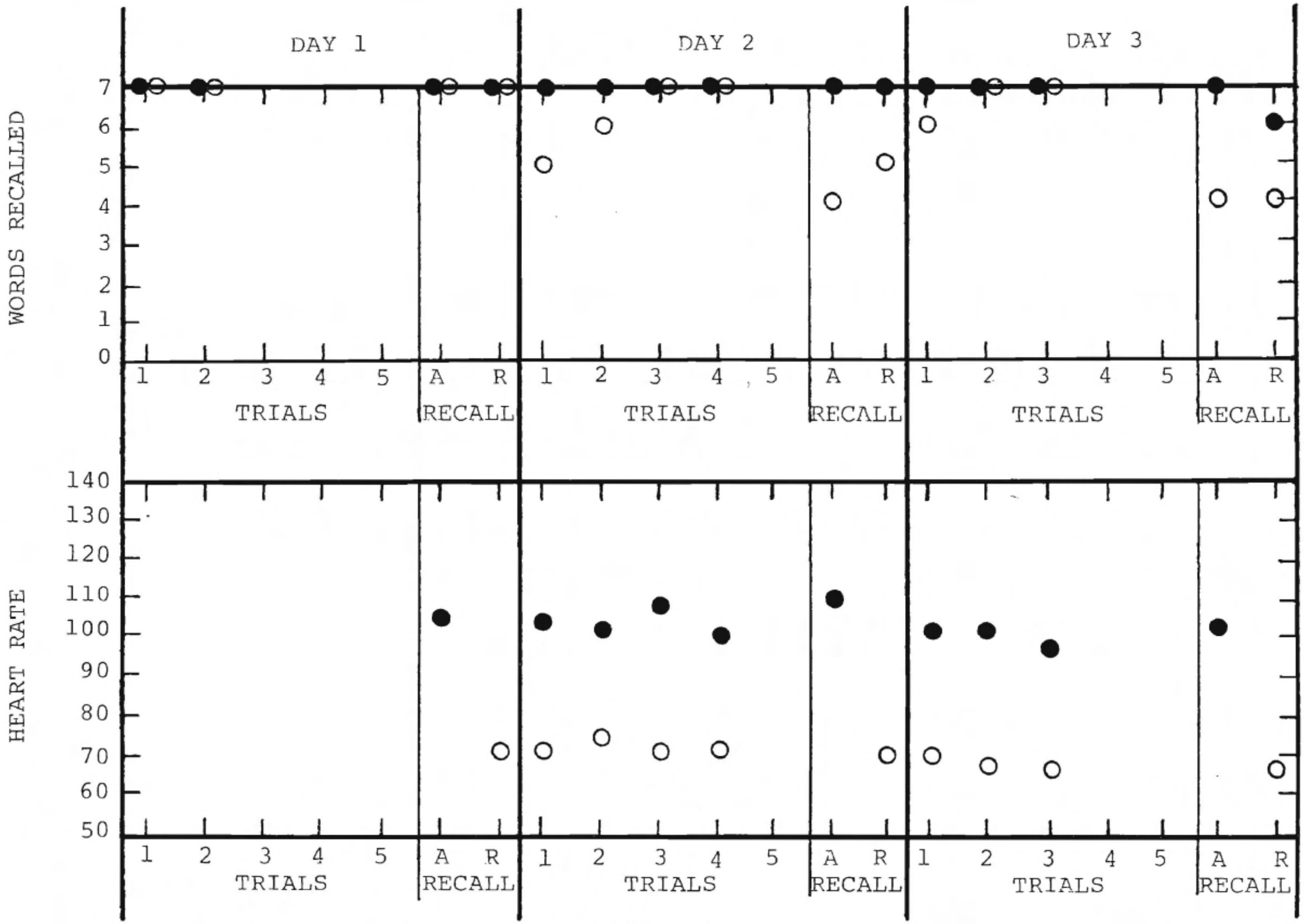


FIGURE 6



DAY 1
DAY 2
DAY 3
WORDS RECALLED
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1 2 3 4 5 A R
TRIALS
RECALL
HEART RATE
140
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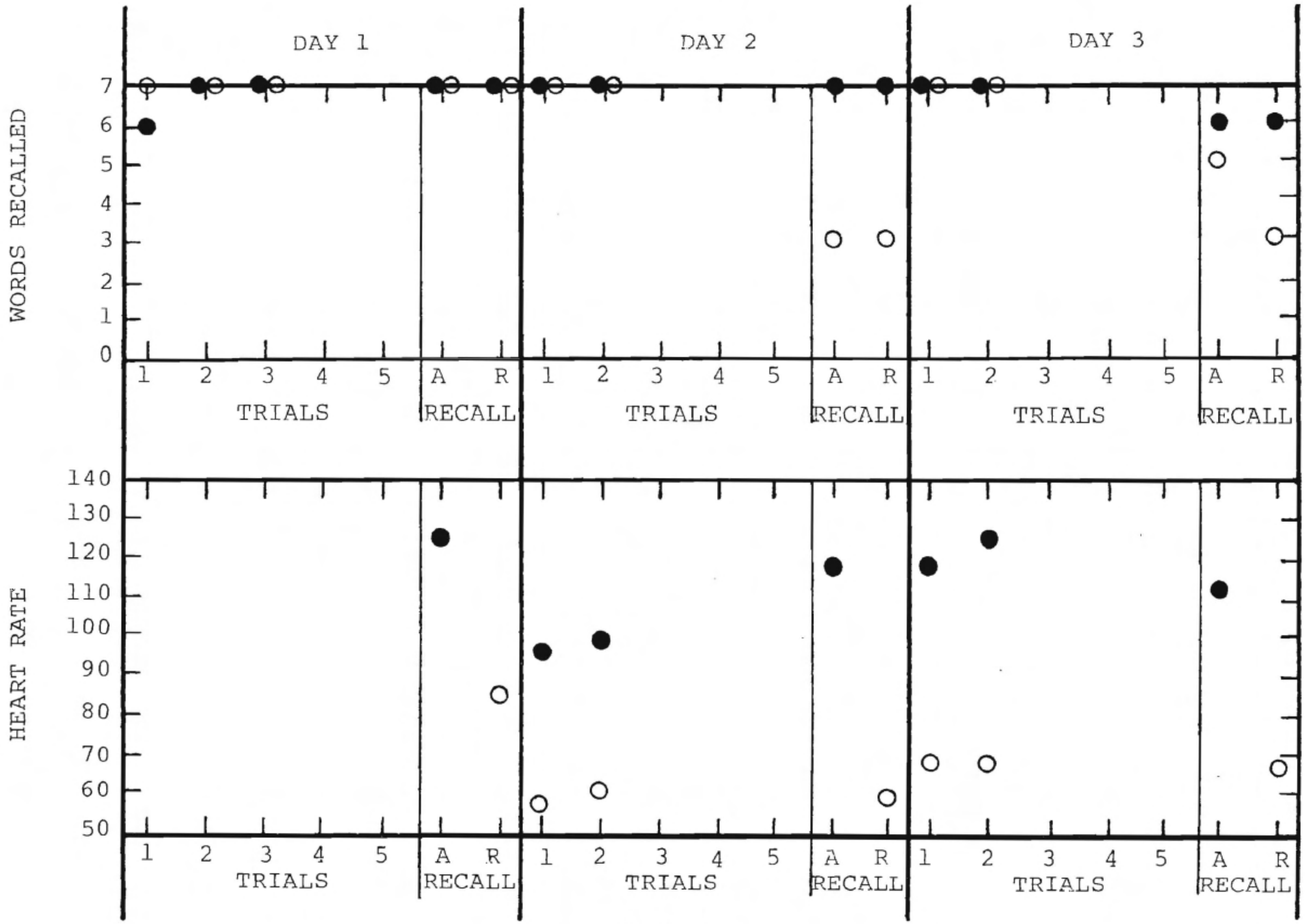
FIGURE 7


DAY 1
DAY 2
DAY 3
WORDS RECALLED
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1 2 3 4 5
TRIALS
A R
RECALL
HEART RATE
140
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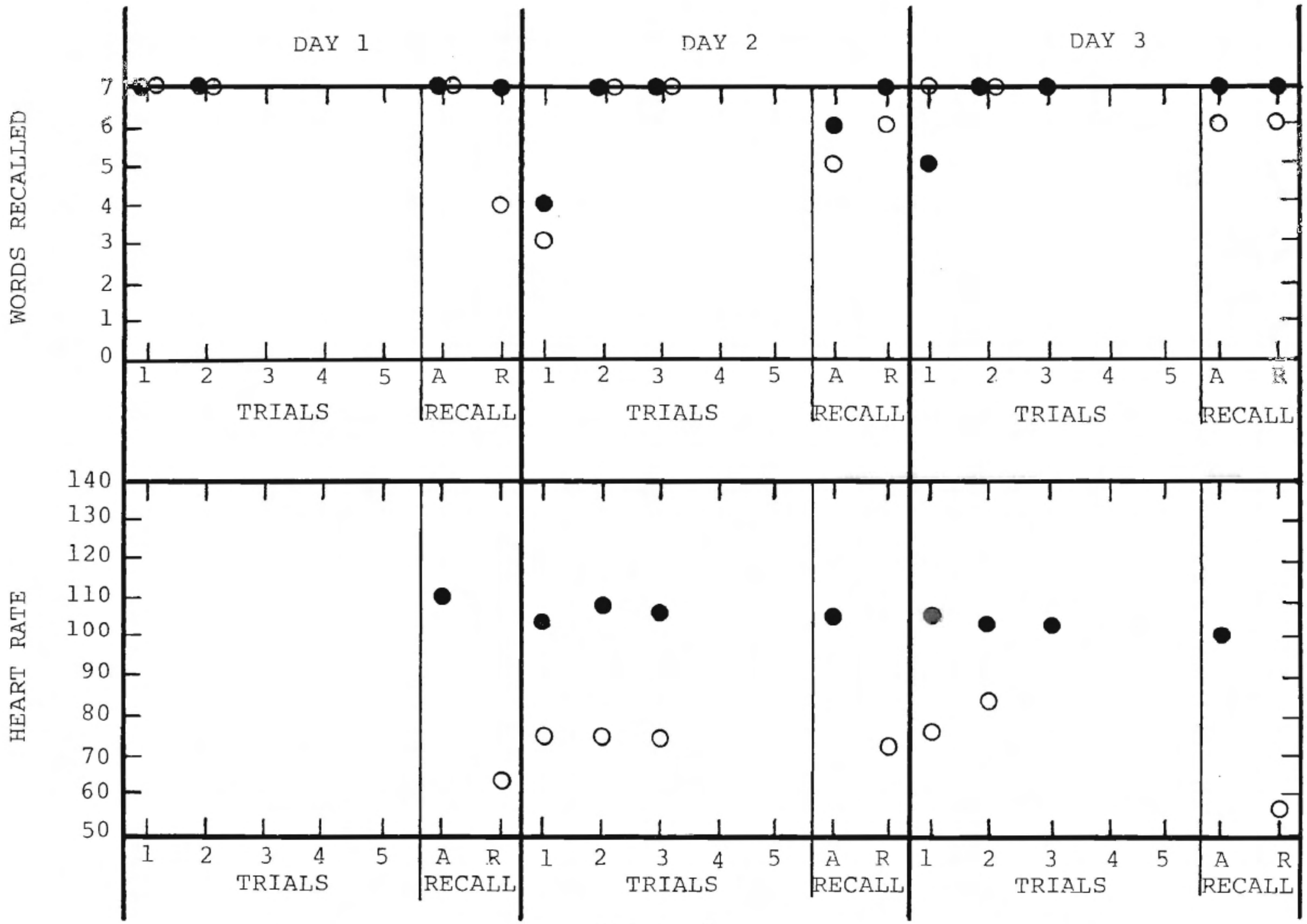
FIGURE 8


DAY 1
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DAY 3
WORDS RECALLED
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1 2 3 4 5 A R 1 2 3 4 5 A R 1 2 3 4 5 A R
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RECALL
TRIALS
RECALL
TRIALS
RECALL
HEART RATE
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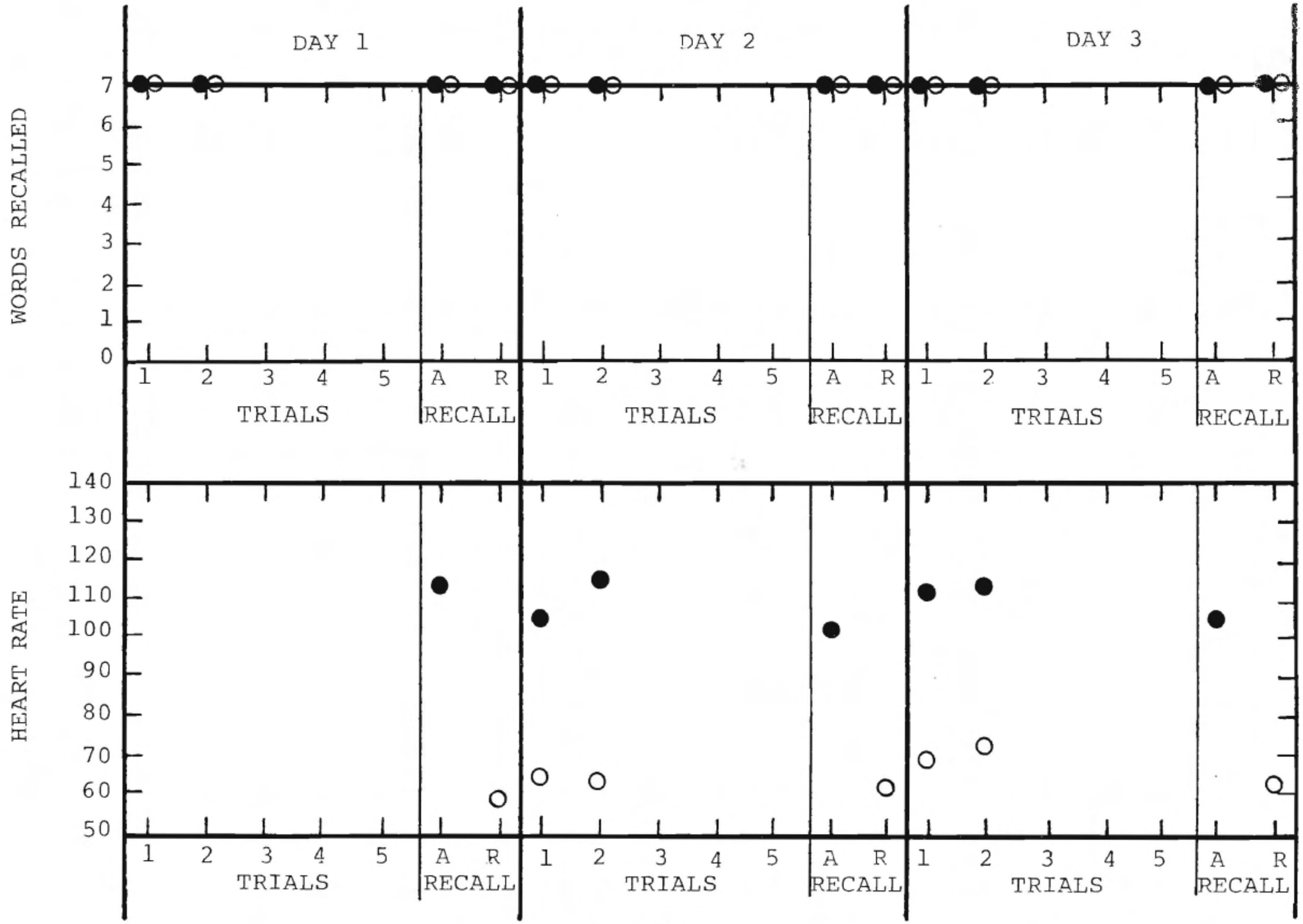
1 2 3 4 5 A R 1 2 3 4 5 A R 1 2 3 4 5 A R
TRIALS
RECALL
TRIALS
RECALL
TRIALS
RECALL

FIGURE 9



DAY 1
DAY 2
DAY 3
WORDS RECALLED
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1 2 3 4 5 A R
TRIALS RECALL
HEART RATE
140
130
120
110
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FIGURE 10

Figures 11 - 20

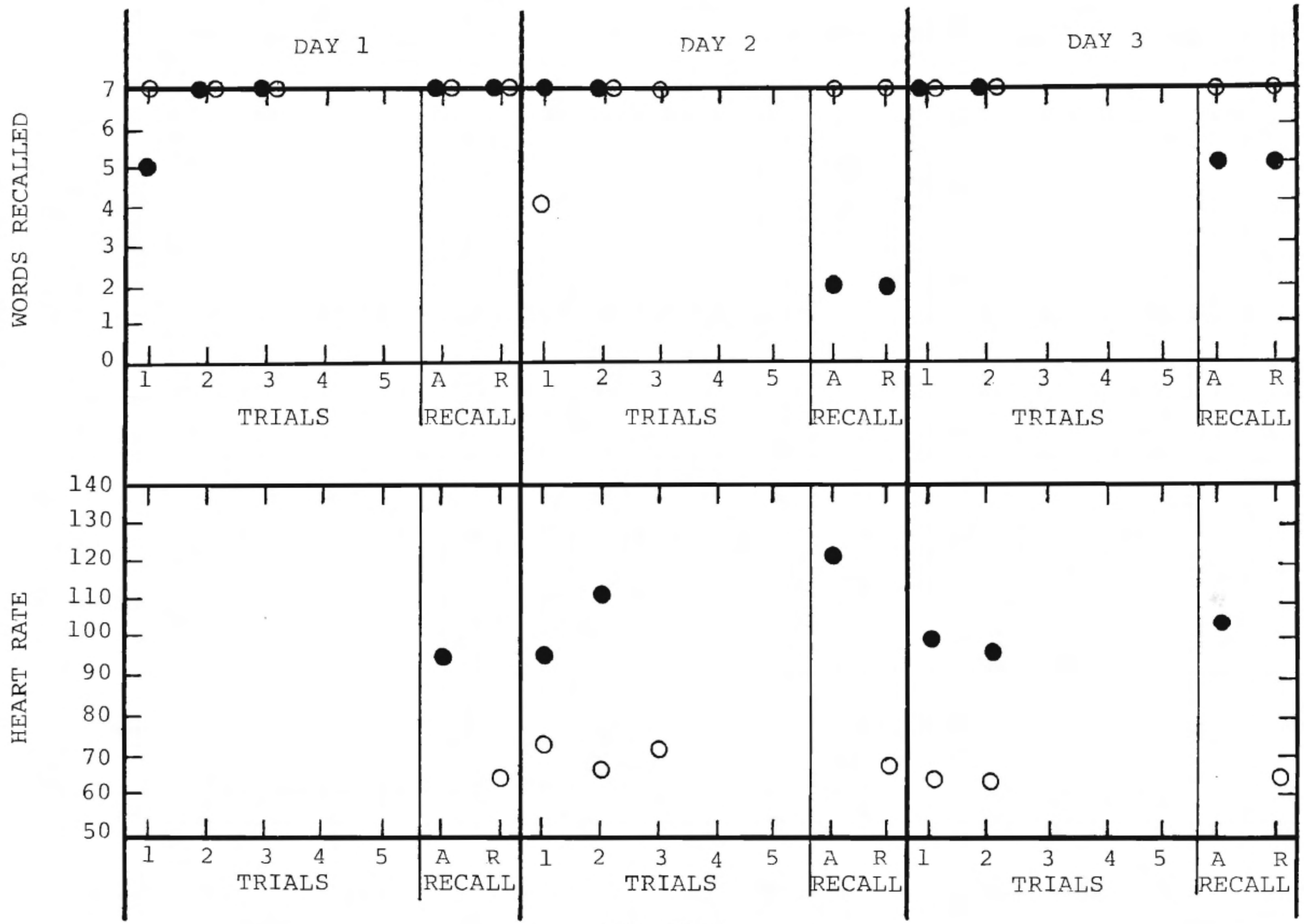
Recall and Heart Rate

Data for

Experiment 2

● Anger Condition

o Relaxation Condition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DAY 2
DAY 3
WORDS RECALLED
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1 2 3 4 5 A R
TRIALS RECALL
HEART RATE
140
130
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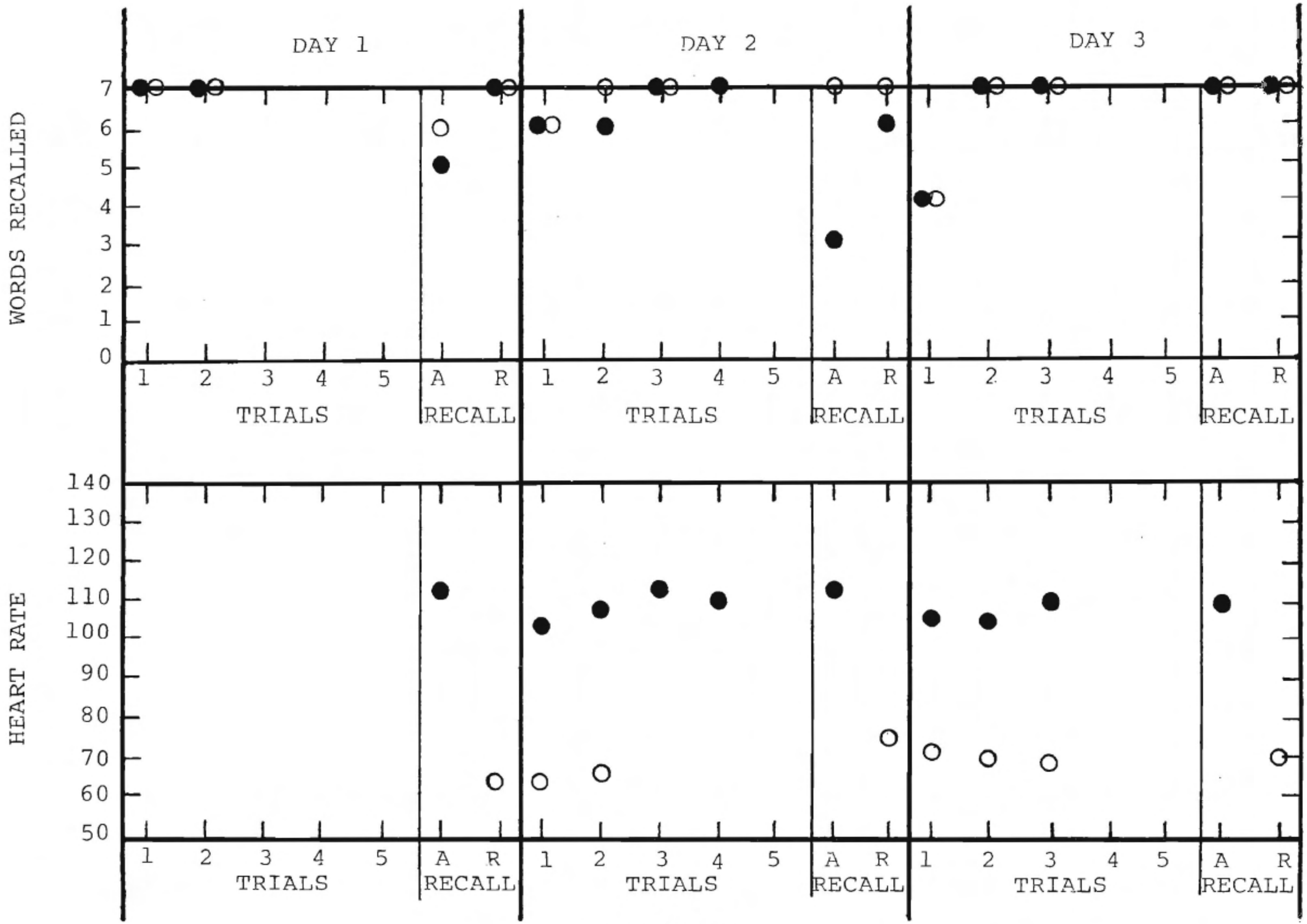
1 2 3 4 5 A R
TRIALS RECALL

FIGURE 11


DAY 1
DAY 2
DAY 3
WORDS RECALLED
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1 2 3 4 5 A R 1 2 3 4 5 A R 1 2 3 4 5 A R
TRIALS
RECALL
HEART RATE
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FIGURE 12

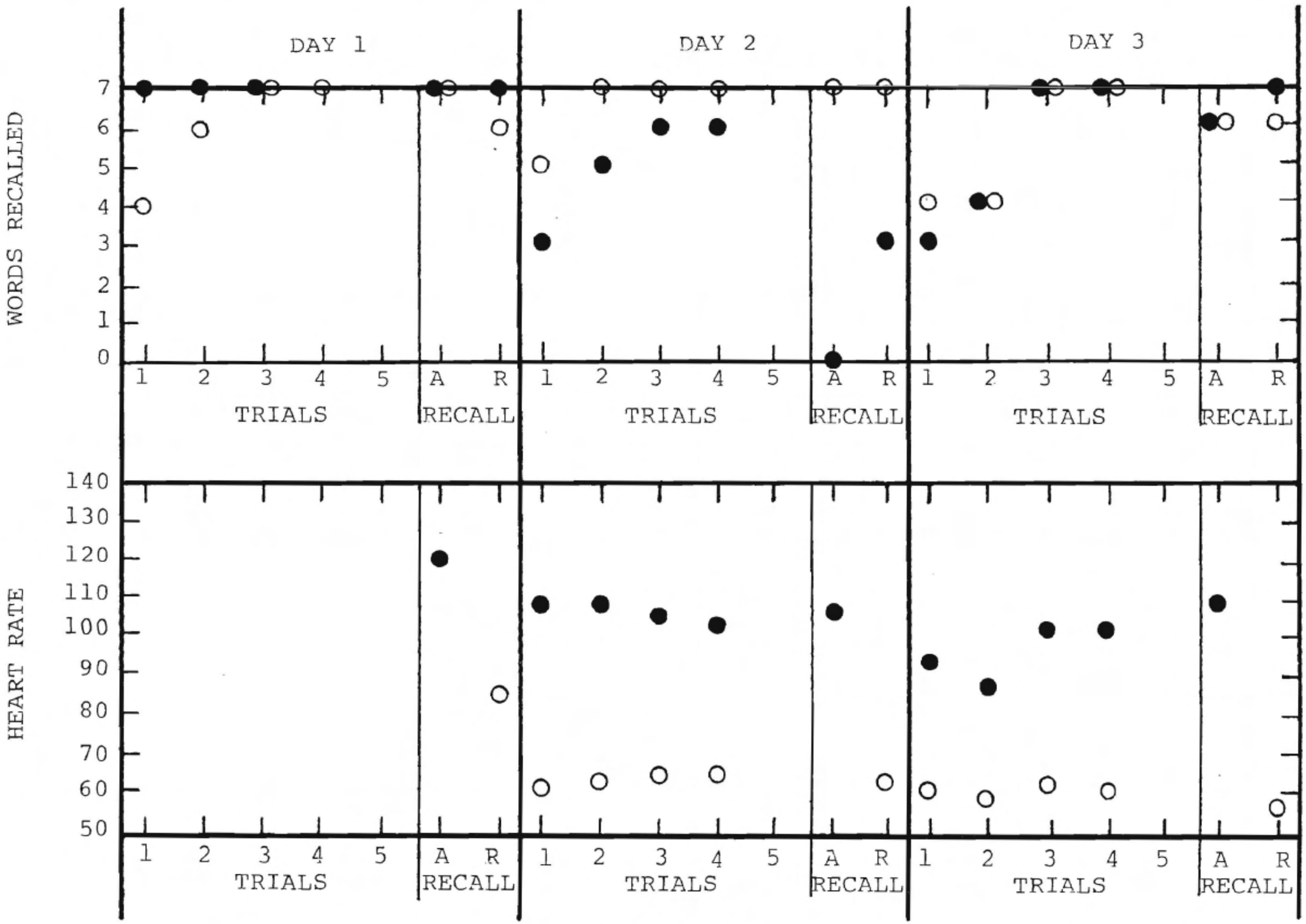
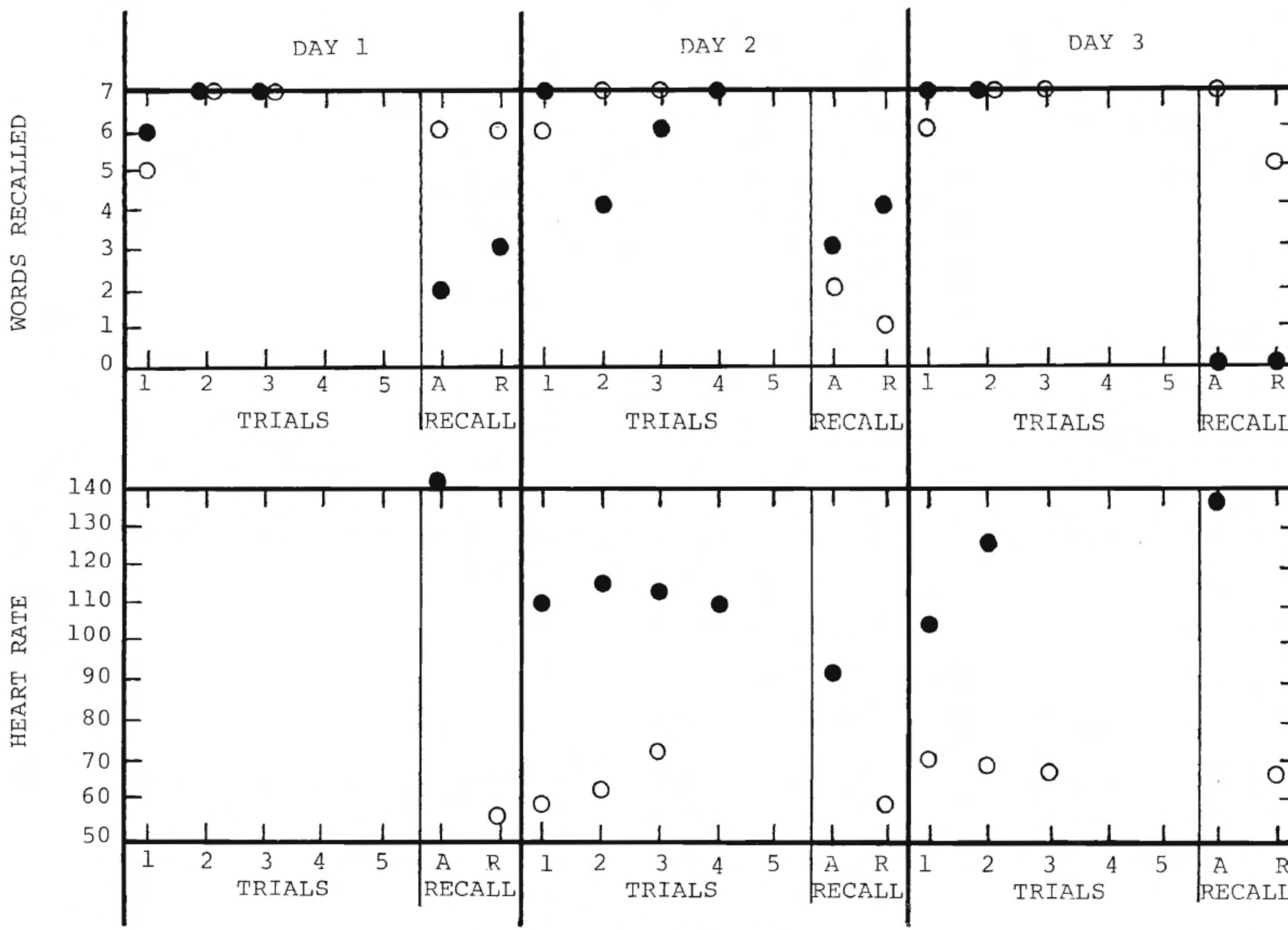


FIGURE 13


DAY 1
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DAY 3
WORDS RECALLED
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TRIALS
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RECALL
HEART RATE
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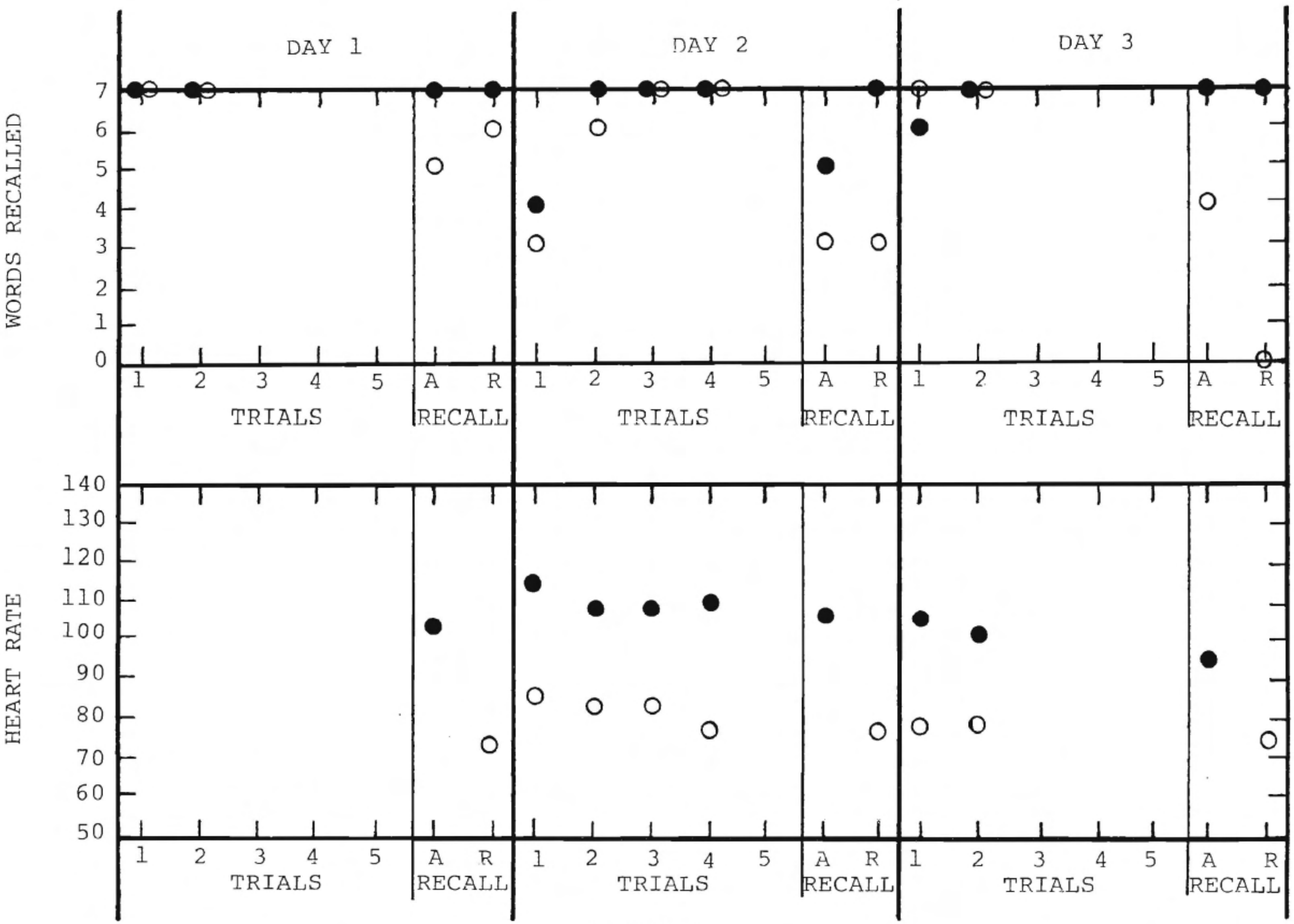
FIGURE 14



DAY 1
DAY 2
DAY 3
WORDS RECALLED
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1 2 3 4 5 A R 1 2 3 4 5 A R 1 2 3 4 5 A R
TRIALS
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HEART RATE
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TRIALS
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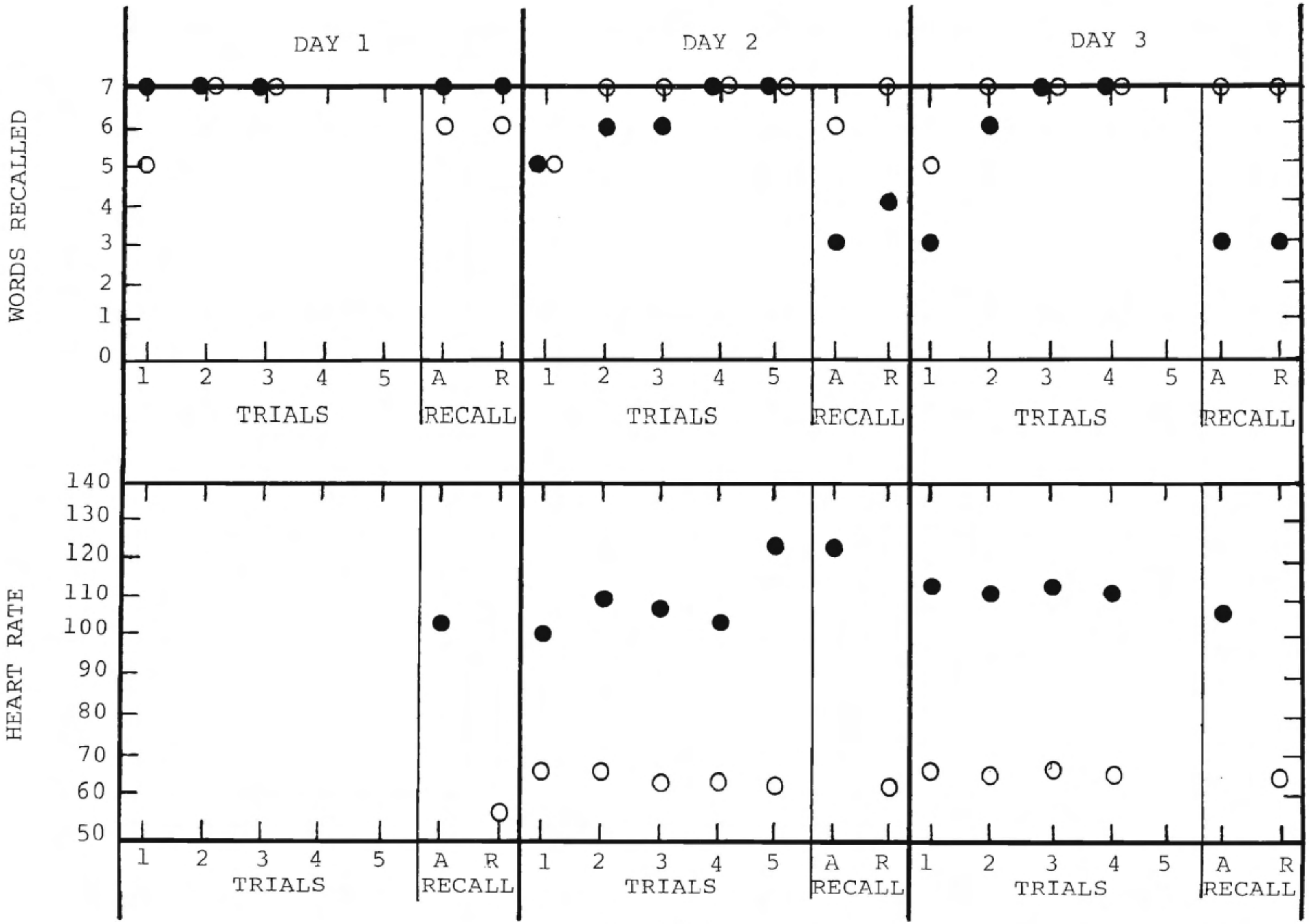
TRIALS
RECALL

FIGURE 15


DAY 1
DAY 2
DAY 3
WORDS RECALLED
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1 2 3 4 5 A R 1 2 3 4 5 A R 1 2 3 4 5 A R
TRIALS
RECALL
TRIALS
RECALL
TRIALS
RECALL

FIGURE 16

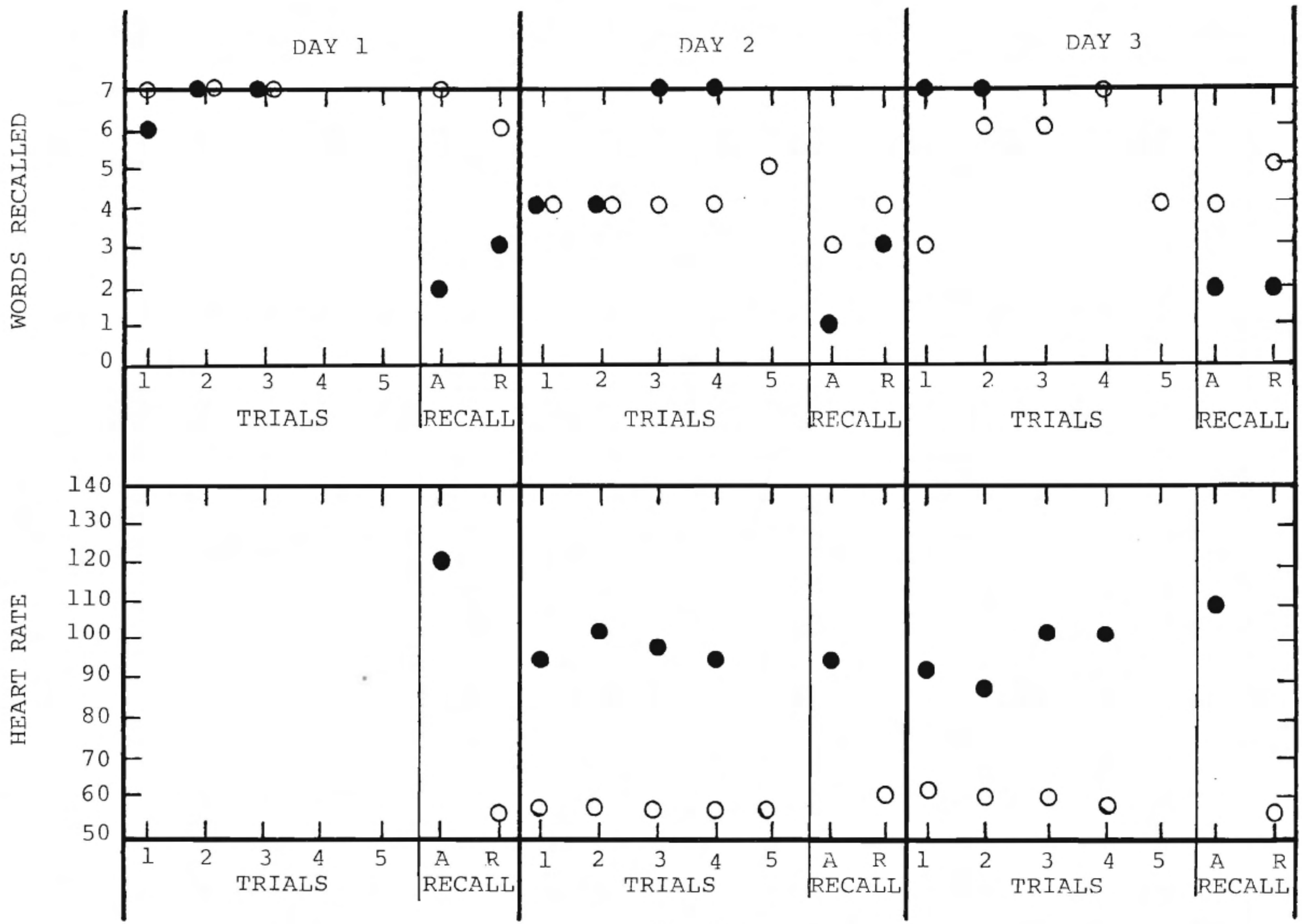

DAY 1
DAY 2
DAY 3
WORDS RECALLED
0
1
2
3
4
5
6
7
1
2
3
4
5
A
R
TRIALS
RECALL
HEART RATE
50
60
70
80
90
100
110
120
130
140

FIGURE 17

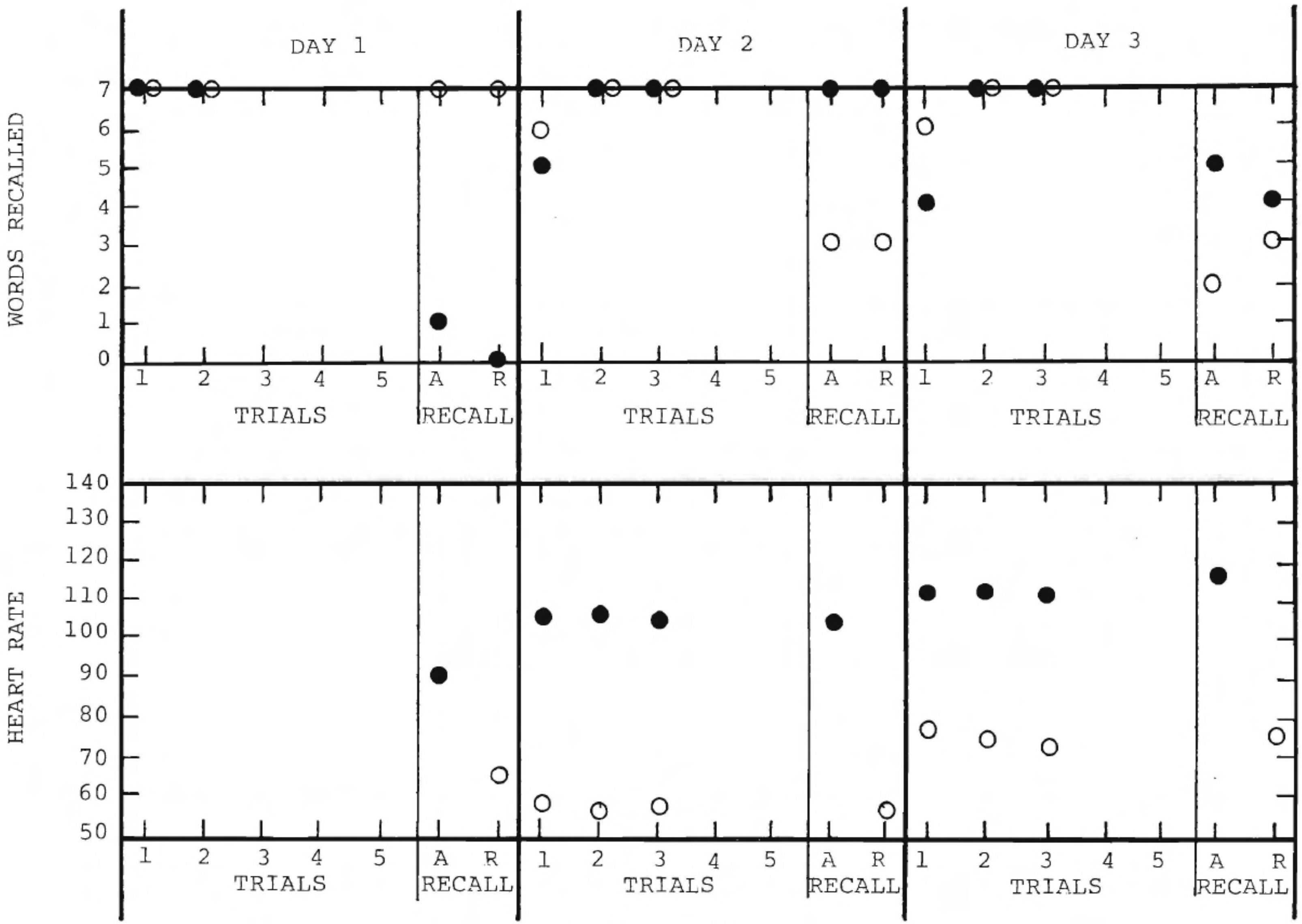

DAY 1
DAY 2
DAY 3
WORDS RECALLED
7
6
5
4
3
2
1
0
1 2 3 4 5 A R
TRIALS
RECALL
HEART RATE
140
130
120
110
100
90
80
70
60
50

FIGURE 18

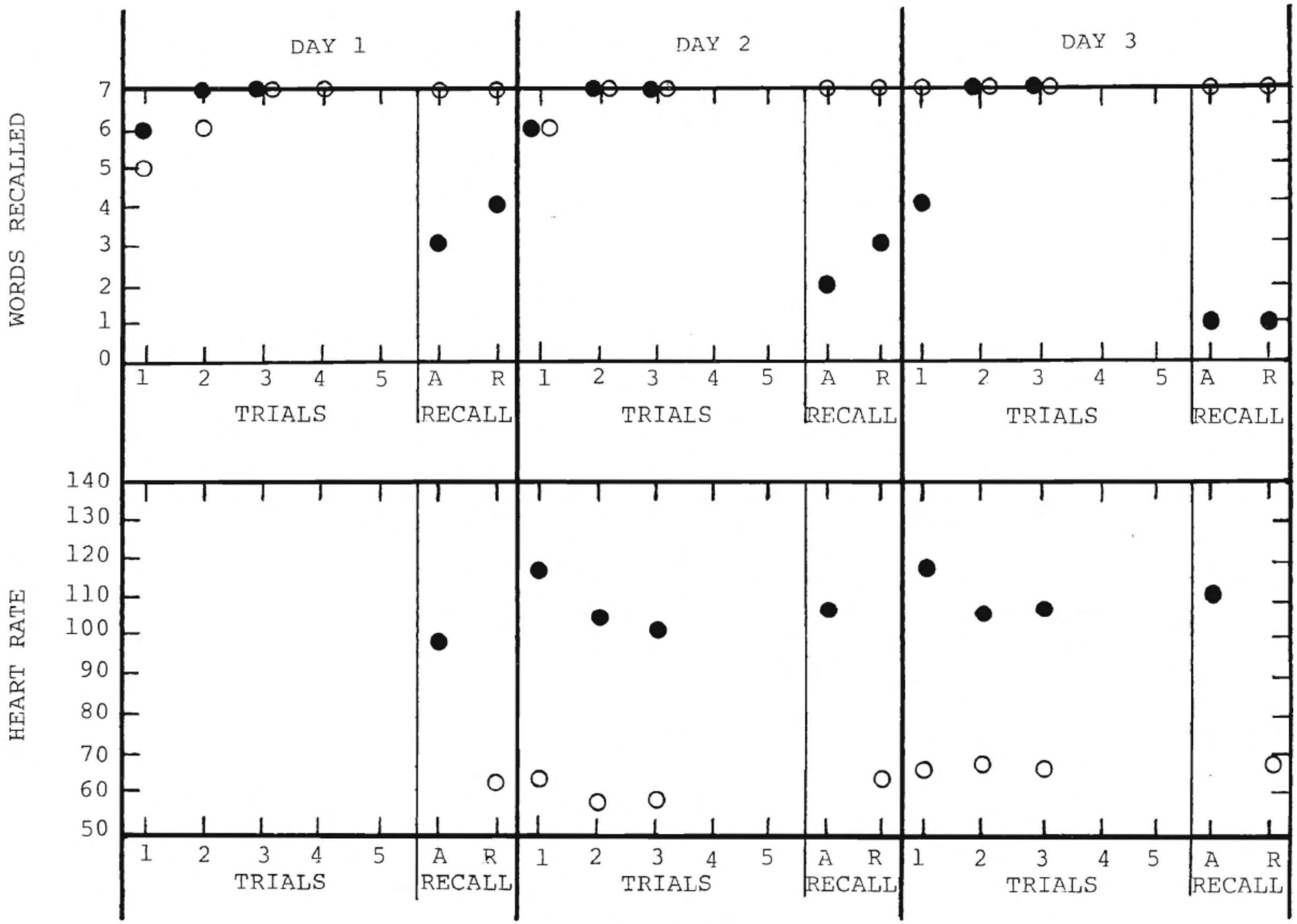

DAY 1
DAY 2
DAY 3
WORDS RECALLED
7
6
5
4
3
2
1
0
1 2 3 4 5 A R
TRIALS
RECALL
HEART RATE
140
130
120
110
100
90
80
70
60
50

FIGURE 19

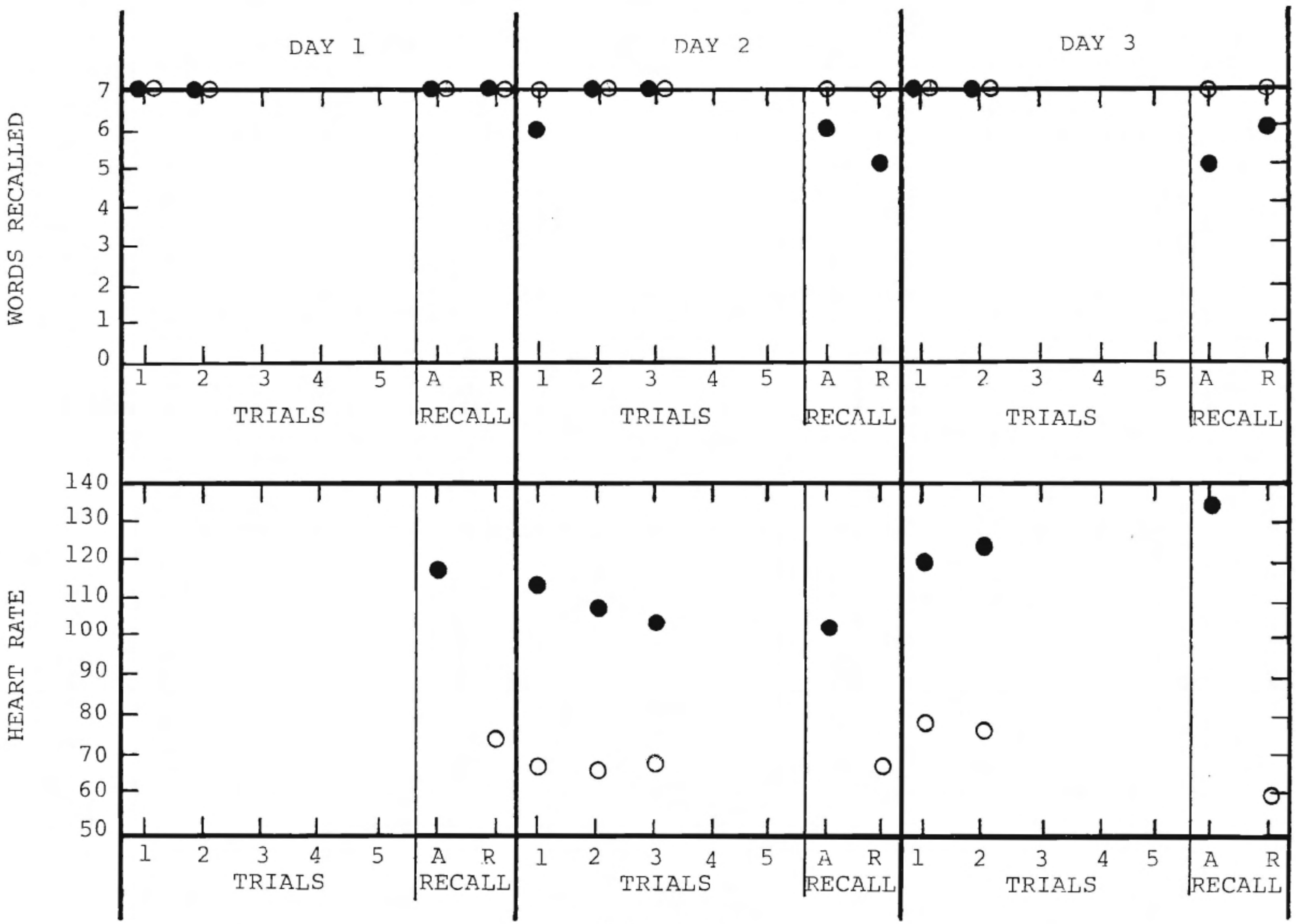
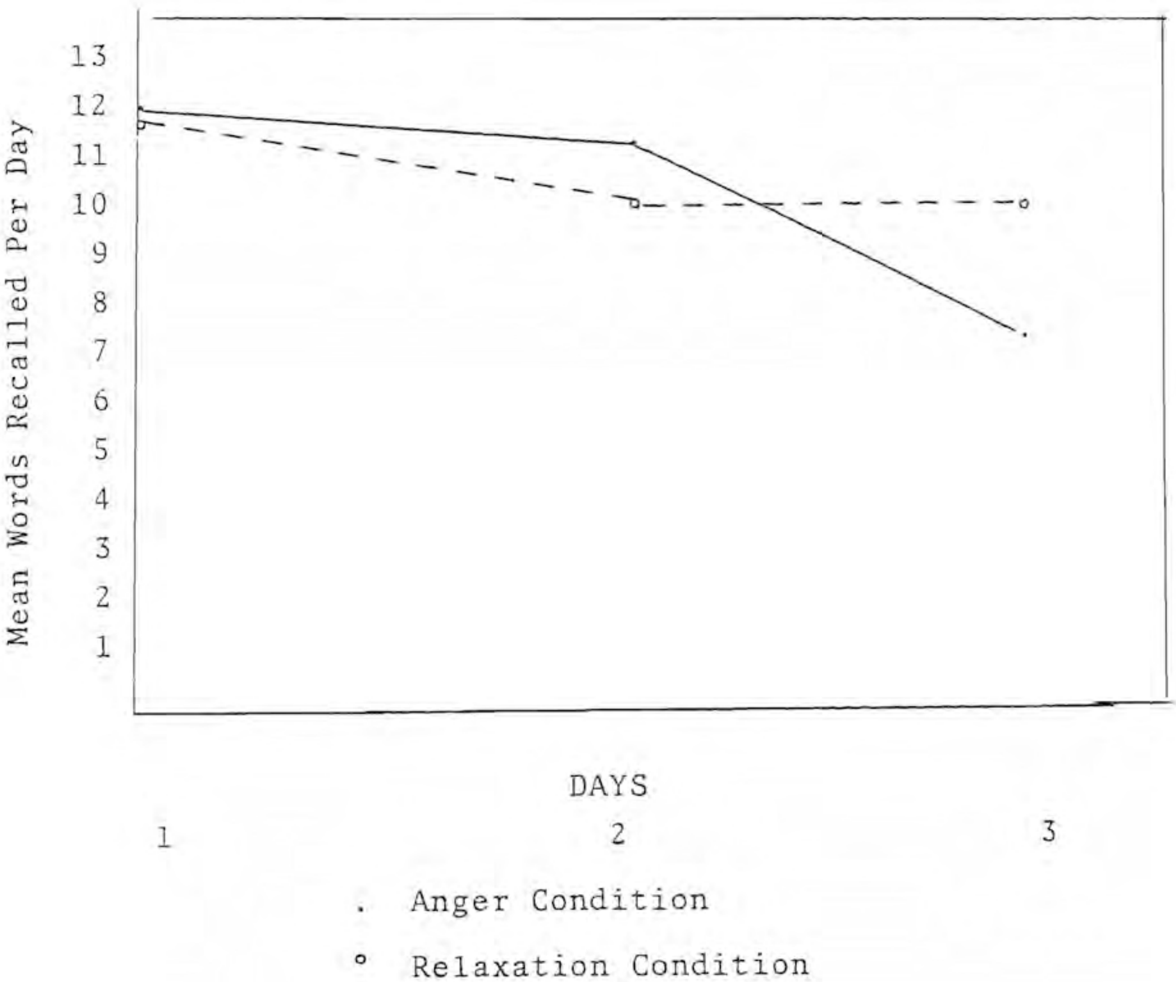

DAY 1
DAY 2
DAY 3
WORDS RECALLED
0
1
2
3
4
5
6
7
1 2 3 4 5 A R
TRIALS
RECALL
HEART RATE
50
60
70
80
90
100
110
120
130
140

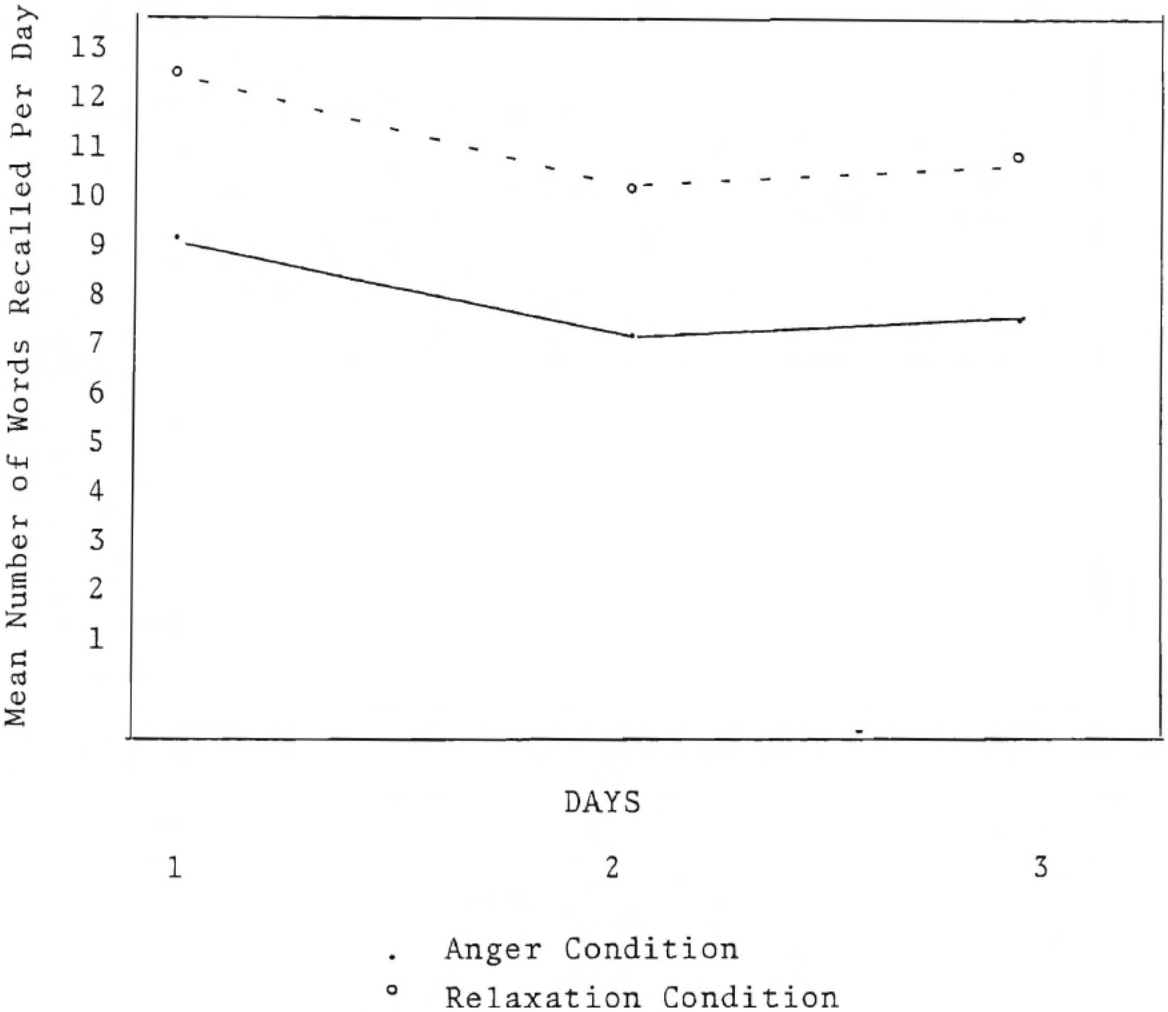
FIGURE 20

FIGURE 21



13
12
11
10
9
8
7
6
5
4
3
2
1
Mean Words Recalled Per Day
DAYS
1
2
3
. Anger Condition
° Relaxation Condition

FIGURE 22


Mean Number of Words Recalled Per Day
13
12
11
10
9
8
7
6
5
4
3
2
1
DAYS
1
2
3
. Anger Condition
° Relaxation Condition

APPENDIX A

RELEASE AGREEMENT

The undersigned of lawful age does hereby release Pittsburg State University, the Department of Psychology and Counseling, Dr. Connelly and/or his research assistant(s) from all claims, demands, damages, actions or causes of action, costs, loss of services and expenses resulting or that may result from the ordinary, usual, and expected reactions from research that will include measurement of the subject's heart rate (including related electronic equipment and its attachment to the subject), that may include the subject imagining various emotional situations, that may include the subject being confronted with a personally-involving emotional situation, that will include the administration of suggestibility scales and emotion scales, as well as pre-testing for heart rate and relaxation, to the undersigned.

Dated this _____day of__________, 19___.

Subject Signature________________________

Witnessed:

____

APPENDIX B

Barber Suggestibility Scale

Student Name: ______________________________

Phone Number: ______________________________

When it was suggested that your right arm was heavy and was moving down, the arm felt:

_____Not Heavy _____Slightly _____Heavy _____Very Heavy

When it was suggested that your left arm was light and moving up, the arm felt:

_____Not Light _____ Slightly _____Light _____Very Light

When it was suggested that your hands were stuck together, and you couldn't take them apart, the hands felt:

_____Not Stuck _____ Slightly _____Stuck _____Very stuck

When it was suggested that you were thirsty, you felt:

_____Not Thirsty _____Slightly _____Thirsty _____Very Thirsty

When it was suggested that your throat was stuck and you couldn't speak, your throat felt:

_____Not Stuck _____Slightly _____Stuck _____Very Stuck

When it was suggested that you were stuck in the chair, you felt:

_____Not Stuck _____Slightly _____Stuck _____Very Stuck

When the experiment was over, and the experimenter clicked, you felt:

_____Not Coughing _____Slightly _____Coughing _____Very Much Like Coughing

When the experiment was over and you were recalling the tests, you felt that you remembered the test about the arm rising:

_____No Difficulty _____Slight _____Difficulty _____Great Difficulty (Or No Memory)

Your Score: __________

APPENDIX C
WORD LISTS

Word List 1	Imagry	Meaningfulness	Concreteness	Frequency	# of Syl-lables
admiral	6.20	6.35	6.11	20	3
captive	5.27	5.80	5.39	21	2
effort	3.33	2.22	5.75	AA	2
interest	3.13	2.20	5.52	AA	3
painter	5.87	6.59	6.40	25	2
settler	5.40	6.07	6.48	20	2
teacher	5.77	6.38	6.00	AA	2
Word List 2					
alcohol	6.47	5.67	6.36	AA	3
cottage	6.50	6.90	7.76	46	2
excuse	2.77	3.05	4.04	A	2
injury	5.70	5.51	7.32	24	3
picture	6.20	6.75	7.16	AA	2
scarlet	6.37	5.96	5.80	27	2
trumpet	6.60	7.00	6.80	17	2
Word List 3					
abdomen	6.00	4.75	6.83	7	3
circuit	4.97	6.38	5.63	21	2
engine	6.33	6.08	6.76	A	2
institute	4.60	4.92	5.84	21	3
pepper	6.27	6.52	6.96	27	2
singer	6.17	6.64	6.35	20	2
ticket	6.20	7.21	7.00	A	2
Word List 4					
athletics	5.70	6.92	4.60	7	3
costume	5.80	6.19	6.12	25	2
exhaust	5.17	6.29	5.00	28	2
industry	5.77	6.00	5.76	AA	3
prison	6.23	7.21	6.62	A	2
salute	5.77	6.52	5.00	22	2
table	6.50	7.60	7.00	AA	2

APPENDIX C
WORD LISTS

Word List 5	Imagry	Meaningfulness	Concreteness	Frequency	# of Syl-lables
appliance	5.73	6.64	6.45	7	3
contract	4.50	6.32	5.24	A	2
errand	4.27	6.48	4.21	20	2
infection	4.87	6.12	5.08	8	3
palace	6.50	7.03	6.73	A	2
sunset	6.83	6.96	6.07	24	2
temple	6.13	6.75	6.69	A	2
Word List 6					
attendant	5.03	4.50	6.07	26	3
creature	4.60	5.50	6.03	A	2
elbow	6.30	5.16	6.94	26	2
interview	5.03	4.88	4.34	26	3
pencil	6.37	6.48	7.70	40	2
salad	6.53	7.20	6.83	28	2
tower	6.53	6.42	6.96	A	2

APPENDIX D

Name____________________

Date____________________

Experimental Day__________

1. How angry were you?

1 2 3 4 5

2. Was the event you imagined something that happended recently or several years ago?

1 2 3 4 5

3. Were there any other people involved?

No 1 2 3 4 5

4. Was it easy to maintain the anger?

1 2 3 4 5

5. Did you feel tight and tense when you were angry?

1 2 3 4 5

6. How relaxed were you?

1 2 3 4 5

7. Was the event one you have actually experienced or an imaginary experience?

1 2 3 4 5

8. Were there any other people involved?

1 2 3 4 5

9. Was it easy to maintain the relaxation?

1 2 3 4 5

10. Did your body feel relaxed?

1 2 3 4 5