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DETECTION THRESHOLD FOR
HEART RATE CHANGE IN PSYCHOPATHS,
RECIDIVISTS AND NORMALS

A Thesis

Presented to

the Faculty of the Department of Psychology

The University of the Pacific

In Partial Fulfillment

of the Requirements for the Degree

of the Master of Arts

by

William K. Volner, Jr.

This thesis, written and submitted by

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INTRODUCTION

The number and variety of conceptions of the psychopathic personality have been limited only by the number of investigators of the problem. Hare and Hare (1967) in their bibliography cite 604 articles dealing with psychopathic behavior, and they hasten to state that their list is limited to books and journals printed in English and further limited to those contemporary articles of direct relevance which are relatively accessible to most investigators.

Early studies floundered in attempting to come to a universally acceptable definition of the psychopath's disorder, which resulted in psychopathy being labeled a "wastebasket" category (e.g., Pennington, 1954; White, 1956). The confusion gradually diminished following Cleckley's (1955) clinical study of the psychopath which indicated the basic characteristics of this disorder to be chronic misbehavior and emotional flatness or lack of affectivity. Currently most studies seem to agree with McCord and McCord (1964) that, "The psychopath is an asocial, aggressive, highly impulsive person, who feels little or no guilt and is unable to form lasting bonds of affection with other human beings (p.14)."

With the problem of definition relatively settled, contemporary research has attempted to explain through studies of emotion and learning the behavior patterns and lack of affectivity of the psychopath.

Following a series of studies exploring the interaction of cognitive and physiological determinants of emotional states, Schachter (1964) proposed that emotion be considered a function of a state of physiological arousal and of cognitions appropriate to this state of arousal, physiological arousal being a necessary but not sufficient condition for emotion. As Schachter and Singer (1962) demonstrated, it is possible to have subjects in a high state of sympathetic arousal who give no indication of emotion in either behavior or introspective self-report. Apparently cognitions, or individual interpretations of a given situation in terms of one's own educational and experiential background determine whether or not a state of physiological arousal is labeled as an emotion.

Several studies have been made of psychopathy and autonomic reactivity. There have been at least seven independent studies concerned with some aspect of the relationship of the "characteristic" of emotionality with autonomic reactivity (Landis, 1932; Learmonth, Ackerly, and Kaplan, 1949; Jones, 1950; Lykken, 1957; Dykman, Ackerman, Galbrecht, and Reese, 1963; Valins, 1963; Schachter and Latane', 1964). The evidence is consistent and strong, for both heart rate

and GSR, that "non-emotional" subjects such as psychopaths are more reactive autonomically than are emotional or normal subjects.

The major results of these studies indicate that psychopaths are individuals characterized by marked autonomic reactivity, but who over the course of their development have not come to attach emotional labels or cognitive states to their states of arousal.

There has been increasing reliance placed upon learning theory as a basis of discussion of the psychopath. Studies of positively reinforced behavior have shown psychopaths and normals to be equally capable of learning (Lykken, 1957; Schachter and Latane', 1964). However, avoidance learning tasks indicate psychopaths to be defective learners (Lykken, 1957; Schachter and Latane', 1964). Schachter and Latane', (1964) demonstrated marked improvement in avoidance learning by psychopaths injected with adrenalin, which indicated a relationship between autonomic reactivity and avoidance learning in psychopaths. The psychopath injected with adrenalin is in a state of autonomic reactivity similar to that of a normal subject. Thus prepared, psychopaths learn to avoid punishment with the same ease as do normals.

A theory of learning which appears to explain the type of learning problem faced by psychopaths is that of Mowrer (1960). Mowrer theorized learning to be a matter of conditioning plus a feedback principle as diagrammed below.

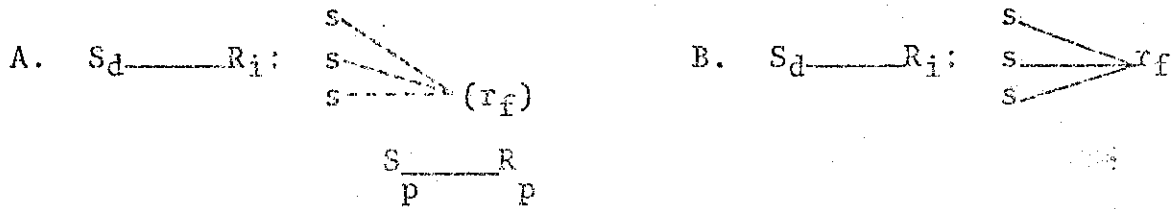


Fig. 1. Schematic representation of Mowrer's current learning theory showing the changes produced in behavior by punishment as derived from conditioning plus the feedback principle.

Mowrer's description of behavior followed by punishment would be as follows: A problem situation or drive, S_d (hunger), produces an overt instrumental response, R_i (theft) as diagrammed in Figure 1-A. R_i is followed by punishment, which is here represented as S_p . The punishment elicits a response R_p of which r_f , or fear is a component. But when R_i occurs, it not only produces the extrinsic punishment, S_p , it also produces a number of other stimuli, s, s, s , which are inherently related to the occurrence of R_i . These other stimuli would be proprioceptive and kinesthetic stimuli, or any other factor associated with the act of theft. The result: a part of the reaction produced by S_p , namely fear, gets conditioned to these response-produced stimuli, s, s, s . Consequently, when S_d recurs as diagrammed in Figure 1-B and the organism starts to perform R_i , the resulting stimuli "remind" the organism of the antecedent punishment, i.e., cue of r_f , which tends to inhibit R_i .

Schachter and Latane's (1964) theory of emotion could be conceptualized as a modification and refinement of Mowrer's model at the $S_p \text{---} R_p$ level in Figure 1-A. This modification is schematically illustrated in Figure 2. The punishment, S_p , which follows the instrumental response of theft, R_i , in

$S_p \text{---} R_{ar}$: $S_{ar} \text{---} R_{an}$ (cognition of anxiety)

Fig. 2. Schematic representation of Schachter and Latane's theory of emotion as applied to Mowrer's theory of learning.

Figure 1 leads to a response of increased autonomic reactivity, R_{ar} , as illustrated in Figure 2. This R_{ar} response produces a response on the cognitive level, R_{an} , which is the conscious experience of anxiety.

In order for the learning described by Mowrer to take place the punishment, S_p , must be intense enough to elicit an emotional response, R_{ar} . In the case of psychopaths, it may be that the stimuli, S_{ar} , associated with R_{ar} are present but not effective. Lack of attention to the stimulus accompaniments of autonomic reactivity could be the factor in the lack of a normal emotional response.

To test this a three part study would be required. First, it should be determined if there is a difference between the threshold for perception of increased heart rate in psychopaths and normals in order to see if the problem is an attentional one. If such a difference were not found the next step would be to compare psychopaths and normals on the strength of the

cognitive fear reaction to S_{ar} , the source of which in this case is increased heart rate. Finally, if results show no cognitive fear attached to the awareness of their increased heart rate, an attempt would be made to condition fear to the physiological stimulus of increased heart rate.

The following study was concerned with completion of the initial phase of this three part study.

Method

Design. The ability to detect heart rate change was compared for four subject types: psychopathic inmates, recidivist inmates, normal inmates, and freemen. The threshold for perception of heart rate change was measured on four trials, during alternating exercise and rest periods. The result was a split plot factorial design with subject type as the first factor and repeated measures as the second factor.

Subjects. The source of subjects for this study was the Deuel Vocational Institution (DVI). DVI is a medium security prison of the State of California, housing largely chronic male criminals committed to both the California Youth and Adult Authorities. For the most part the inmates committed here have long records, being difficult cases promoted from lesser security jails. Also housed here are first term offenders guilty of particularly serious offenses such as murder.

From this general population an attempt was made to select subjects representative of three of the major inmate subgroups: psychopaths, recidivists, and other prisoners (excluding murderers). The selection process was designed to select representative subjects, not subjects from the population extremes. The process involved three indices: emotional flatness, assessed using the Lykken scale (1957), the number of felony offenses for which an individual was

arrested and the charge not dismissed, and time in prison. Imprisonment time was evaluated by computing the proportion of a prisoner's life spent in confinement since the age of eight (the minimum age of imprisonment of the groups of subjects).

A sample of 100 inmates was drawn randomly from the general population of 1,300 inmates at DVI by applying a series of random numbers to the unit roster boards, the roster boards listing inmates according to room number only. The individual case histories of each of the selected inmates was screened to determine imprisonment time and number of felony arrests. Since DVI regulations required that all subjects be volunteers, each of the 100 inmates was then individually interviewed. In the interview each inmate was told that he would be asked to take a test containing a number of written questions, introduced to the first page of instructions for the Lykken scale, and then told he would also be asked to ride an exercycle and report on his heart rate. He was instructed that there would be a maximum payment of \$2.00 for his cooperation, the money to be credited to his personal prison account. Only three of the 100 dropped out following the interview.

The 97 remaining inmates were then given the Lykken scale in one group administration. Inmates having five or more felony convictions were identified, and from that group those who fell above the sample group's median time in prison

were selected. Ten men in that subgroup had Lykken scale scores above the sample group's median and these were classified as the psychopathic subjects. Twelve of the men had five or more felony convictions but were below the sample group's median imprisonment time or Lykken scale score or both. Ten were randomly selected and placed in the recidivist group. Ten of the remaining inmates, those having fewer than five felony convictions and falling below the imprisonment time or Lykken scale medians or both, were randomly selected as the normal prisoner subjects.

Table 1
Mean for Subject Groups on Age and
Three Pretest Selection Measures

Group	Age	Felony Arrests	% Life in Prison	Lykken
Psychopath	23.4	5.2	43.1	49.3
Recidivist	21.6	5.2	28.0	42.3
Normal Prisoner	23.4	2.3	24.8	37.4
Freeman	19.3	0.0	0.0	34.1

The freeman group consisted of 10 subjects drawn from freshman volunteers in an introductory psychology course at the University of the Pacific. They were given the Lykken scale in one group administration. The resultant

mean values on each index for each subject group are presented in Table 1 along with the mean ages of each.

An analysis of the scores on each index by means of a simple analysis of variance indicated significant differences for all indexes except age (age $F = 2.72$, $df = 3/36$, $p > .05$; felony $F = 103.89$, $df = 2/27$, $p < .001$; imprisonment $F = 8.86$, $df = 2/27$, $p < .01$; Lykken $F = 9.57$, $df = 3/36$, $p < .01$). Multiple comparison tests using Tukey's HSD (Kirk, 1968) were then performed. Psychopath and recidivist groups obviously did not differ from each other in the number of felony arrests, but the differences between the normal prisoners and all other groups were significant (HSD = .55, $p < .05$). For proportion of lifetime spent in prison, the psychopath differed significantly from all other groups (HSD = 11.07, $p < .05$). On the Lykken scale the psychopath group differed significantly from the freeman group (HSD = 5.74, $p < .05$).

Apparatus. An exercycle set at a moderate loading level was used to increase heart rate. An electrocardiograph (EKG) running at a paper speed of 25 mm per sec was used to record heart rate change due to exercise and rest. It was attached to the two wrists of each subject by stainless steel electrodes and placed so that a subject could not observe it while seated on the exercycle.

Procedure. The subjects were run one at a time. Upon entering the testing room each subject was seated on the

exercycle, his wrists were prepared with electrode jelly, and the EKG electrodes were attached to his wrists. The experimenter then instructed the subject verbally:

"Today you will be participating in a test of physical fitness. The object of this test will be to determine whether you have adequate knowledge of your physical stamina to be able to report changes in your heart rate accurately as measured by the recording apparatus attached to your body. You are to begin pedaling the exercycle when I say 'Go.' You are to report any change in heart rate you are able to detect as a result of this exercise."

A monetary system of rewards and punishments was employed so that the subjects would not report a change in heart rate before an actual change occurred. The average prison has limited opportunity to earn money in the prison, with most jobs paying less than \$35 a month. With this in mind a meaningful maximum reward of \$2.00 was established, thus enabling an attentive subject to earn in less than half an hour the equivalent of nearly two days' wages. Since the prisoners were not allowed to have money in their possession, the reward was administered in symbolic form. Each subject's attention was directed to four silver-dollar-sized Nevada gambling tokens lying on a table directly in front of him. These represented the dollar with which the subject began, each token representing 25 cents. As the earnings changed over the trials they were announced verbally and by the

addition or subtraction of tokens from the table. The subjects were instructed regarding the reward as follows:

"You will be given a dollar to begin the test. A 25 cent penalty will be charged against your dollar for every incorrectly reported heart rate change; a 25 cent bonus will be given for every correctly reported change. The test will consist of four heart rate measurements in the following sequence: Increased heart rate while exercising, decreased heart rate while resting, increased heart rate while exercising, decreased heart rate while resting. You are to report any change in your heart rate during these measurements by saying 'Change.' I will answer 'Right' or 'Wrong,' and then announce your earnings. You will continue the test until you have correctly identified the four changes."

After the subject had correctly reported, "Change," while exercising the experimenter said, "Stop. Now rest." When he had correctly reported "Change" while resting, the command, "Go," was repeated. This cycle was repeated until the four trials had been completed.

The EKG recording was begun while the subject listened to the instructions to provide a heart rate base line. After reading the instructions, the experimenter gave the signal, "Go," and then constantly monitored the EKG.

Each time the subject responded, "Change," the experimenter marked the EKG tape by actuating an event marker pen. He then responded to the subject, "Right," or, "Wrong,"

according to his real time judgments of the number of EKG tape divisions occupied by the ongoing EKG cycles. This proved in practice to be quite easy, as all of the subjects were conservative in their report of heart rate change in comparison to its detectability from the moving EKG tape. The experimenter also actuated the event marker at the beginning and end of every exercise and rest interval to provide a record of individual trial durations. Upon completion of the test the subject was advised of his earnings and sent out of the room. The procedure was the same for the freeman subjects except that each was given his earnings in cash at the end of the test session.

Results

Detection of heart rate change was scored in terms of the change in beats per minute that occurred before a subject said "Change." (On only one occasion did a subject announce a change when it had not occurred.) This was accomplished by estimating heart rate from the 25 mm tape lengths immediately preceding exercise initiation and "Change" event marks for ascending thresholds and from the 25 mm tape lengths immediately preceding exercise termination and "Change" event marks for descending thresholds. The heart rate change score on each trial was then a function of the difference between heart rates at "Change" marks and the preceding exercise initiation or termination marks. The mean change values for each group and trial are presented in Table 2. Each subject was also given a time score for each trial indicating the latency of each heart rate change report from initiation of exercise or rest. The mean values for each group and trial are also presented in Table 3.

Table 2
 Mean Beats per Minute of Detected Heart
 Rate Change for Subject Groups

Group	Trial			
	1	2	3	4
Psychopath	42.6	27.5	25.0	20.6
Recidivist	47.9	31.7	39.9	35.7
Normal Prisoner	53.2	37.2	37.1	30.6
Freeman	44.3	44.5	39.3	37.0

An analysis of variance on the heart rate data (SPF-2.4, Kirk, 1968) indicated no significant difference between groups ($F = 1.32$, $df = 3/36$, $p > .25$), but there was a significant trials effect ($F = 60.81$, $df = 3/108$, $p < .001$) and a significant interaction of Groups with Trials ($F = 6.01$, $df = 9/108$, $p < .001$). An analysis of the simple main effects indicated the interaction was due in part to a separation of the groups on Trial 4 ($F = 3.14$, $df = 3/144$, $p < .05$), with a Newman-Keuls multiple comparison test revealing that the psychopath group was significantly more sensitive to heart rate change than the freeman or recidivist groups ($p < .05$) on Trial 4. The simple main effects analysis also indicated that all four groups became more

sensitive to heart rate change over trials (psychopaths, $F = 29.27$, $p < .001$; recidivists, $F = 15.40$, $p < .001$; normal prisoners, $F = 29.72$, $p < .001$; freemen, $F = 4.46$, $p < .01$, all $df = 3/108$).

An examination of the means revealed that on every trial the performance of the psychopaths was better than every other group and that improvement over trials was least in the freemen. This last result may be a reflection of a lesser effect of the monetary reward among the students who served in the freeman sample.

An analysis of variance on the latency data (SPF-2.4, Kirk, 1968) indicated no significant difference between groups ($F = 2.18$, $df = 3/36$, $p > .10$), a significant trials effect ($F = 9.19$, $df = 3/108$, $p < .01$), but a lack of significance of the interaction of Groups with Trials ($F = 1.71$, $df = 9/108$, $p > .10$). An examination of the means indicates that the improvement in ability to detect heart rate change over trials is reflected in the decreasing latencies for the report of change, but that there is no regular relationship between group and latency within the obtained range of latencies. Differences in the physical conditioning of the subjects would cause the exercise and rest durations required to change heart rate to vary, and this could account for the differences in the latency and detection scores.

Table 3
Mean Latency in Seconds to Report Heart
Rate Change for Subject Groups

Group	Trial			
	1	2	3	4
Psychopath	73.0	53.9	35.0	37.0
Recidivist	40.7	48.6	26.3	41.3
Normal Prisoner	46.3	66.0	30.0	43.2
Freeman	59.9	71.1	56.5	53.8

Discussion

The results clearly indicate that psychopaths can be as sensitive as normals to at least one important autonomic correlate of fear: heart rate change (see Edelman, 1970). Their improvement over trials further indicates that at least when there is monetary incentive they can become substantially more sensitive than some of the other members of a prison population, and even freemen. This evidence would tend to negate the notion that psychopaths are innately unable to attend to autonomic cues at the same level as normals.

Several possibilities arise from these results. Psychopaths appear quite capable of attending to autonomic cues but apparently do not. Do they consciously reject these cues or have they been conditioned educationally or experientially to reject them at all but high levels of intensity? Schachter (1964) and Schachter and Singer (1962) indicated cognition or individual interpretation of autonomic cues to be in terms of one's own educational and experiential background.

The intensity of an autonomic cue such as heart rate change is just one of many stimuli which psychopaths may need for their own individual interpretation of fear. Heart rate change may not be an effective fear stimulus without sufficient pairing with stimuli which independently elicit appropriate fear cognitions. The psychopathic

deficit would in this case be considered a result of inadequate exposure to the usual conditioning experiences. Or, following Eysenck's (1957) ideas, the deficit might result from lesser conditionability, the usual conditioning experiences being inadequate for the psychopath.

Alternatively, while the psychopath may be quite capable of detecting stimuli correlated with heart rate change, and while these stimuli may be appropriately associated with fear cognitions, he may still not attend to them under circumstances where there is no incentive to do so. The importance of the monetary incentive needs to be emphasized here. In recent studies (Schmauk, 1970; Hare & Thorwaldson, 1970) it has been shown that if psychopaths were given a monetary reward they performed like normals on learning and detection tasks. When other types of incentives were used their performance was inferior to that of normals. It should be realized, of course, that all these possibilities could be only the most simplified approximations. As Skinner (1957) has so strongly emphasized, the development of accurate verbal labeling (which we might here loosely term cognitions) of internal states involves a complex set of contingencies between the verbal behavior of the subject, the internal state of the subject and its externally observable aspects, and the reinforcement behavior of another individual. Psychopathic deficit could be entangled in all of these contingencies.

The latency data failed to reveal any regular relationship between group and latency except for improvement in detection ability over trials. The differences in the physical conditioning of the subjects could easily account for the differences in the latency and detection scores.

A word should be said about the use of three different subgroups of imprisoned subjects. The difficulty in obtaining substantial numbers of strictly defined psychopathic subjects is well known, and it was felt that results meaningful to the larger prison population would have to be based upon the ordinary recidivist and non-recidivist prisoner. While the results of the present study indicate some basis for separating the psychopathic classification from other imprisoned subgroups, the failure to find main effect and simple main effect differences between the psychopath and normal prisoner subgroups should be noted.

Previous studies (Landis, 1932; Learmonth, Ackerly, and Kaplan, 1949; Jones, 1950; Lykken, 1957; Dykman, Ackerman, Galbrecht, and Reese, 1963; Valins, 1963; Schachter and Latane', 1964) showed non-emotional types such as psychopaths to be more reactive autonomically than normals. However, none of these studies dealt with the ability of non-emotional types in terms of attending to these autonomic cues. Whatever secondary conclusion may be drawn from the relationship of these results to other findings, it seems clear that some stimulus concomitants of autonomic responses associated with

fear are available to the psychopath, and he can easily detect them.

As previously proposed further research should include a comparison of psychopaths and normals on the strength of their cognitive fear reactivity (S_{ar}) the source of which in this study was increased heart rate.

Summary

Psychopath, recidivist, and normal prison inmates, and freemen were exposed to four alternating exercise and rest trials and asked to report the occurrence of correlated heart rate changes in return for a monetary incentive. While the four groups were equal in their ability to detect the heart rate changes on trial one, differential improvement over trials found the psychopath inmates significantly more sensitive to the changes than recidivist inmates or freemen by trial four. These results were considered contrary to a hypothesis that impaired avoidance behavior in psychopaths is in part a result of the ineffectiveness of stimulus concomitants of fear correlated autonomic responses.

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