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Personality Factors and Operant Heart Rate Conditioning

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PERSONALITY

FACTORS AND OPERANT HEART RATE CONDITIONING

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Abstract

The present study was concerned with certain individual differences that relate to a subject's ability to increase his heart rate on command when given appropriate external feedback. The main purpose was to extend to the operant conditioning paradigm Eysenck's theory that introverts classically condition more readily than extraverts. A second purpose was to determine which personality factors - extraversion, anxiety, and ability to perceive autonomic responses - contribute to heart rate control in operant conditioning. The Eysenck Personality Inventory and the Autonomic Perception Questionnaire were administered to 46 undergraduate males who attempted to accelerate their heart rates, with visual proportional feedback provided, during 20, 30-sec trials. Results indicated that heart rate acceleration did not correlate with any of the variables examined. The findings are discussed in light of previous related studies and suggestions for future research are provided.

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Introduction

Recent advances in psychological and physiological recording technology have allowed scientists to probe deeper into the human mind and body than traditional psychophysical methods have done. As recently as only twenty years ago, responses mediated by the autonomic nervous system were considered to be beyond voluntary control. Since then, modern researchers have questioned this assumption, and actively begun to disprove it, and to delineate parameters which may be related to successful control of autonomically innervated responses.

Research concerned with the autonomic nervous system (particularly the response of the heart) is plagued with a host of inherent complexities. The problem is to select from the mass of data a meaningful response event. The task is further complicated by the fact that the heart is constantly responding to internal stimuli (vascular, neural, glandular, and respiratory) which are largely beyond the experimenter's control (Lang & Hnatiow, 1962).

Despite the apparent complexities, interest and research in this area is expanding at an increasing rate. The present study focuses on certain personality parameters which are being studied in the current literature. Anxiety and extraversion have correlated with conditionability in classical conditioning, and anxiety and the ability to perceive internal responses have been related to successful operant conditioning. In this study, the abovementioned personality variables were examined in operant heart rate conditioning.

Review of the Literature

In the last three decades, a number of investigators have examined individual differences in learning and conditioning to uncover personality traits that account for such differences. In the study of personality and conditioning, two theoretical positions are Eysenck's (1957) and Hull's (1952). Using basic notions derived, at least in part, from different aspects of Hullian theory Eysenck (1957) and Spence (1956) have developed two different but not necessarily mutually exclusive hypotheses concerning the relationships of personality characteristics to conditioning. "Conditionability", if such a general factor exists, refers to the ease of acquiring conditioned responses. These responses are thought to be due to hypothesized excitatory processes in the cortex (Eysenck, 1957; Morgenson, 1967). From related research results, Eysenck (1957) suggested that extraversion would correlate inversely with eyelid conditioning, while Spence (1964) suggested that anxiety would correlate positively.

Eysenck (1957) has proposed that individuals in whom reactive inhibition develops rapidly and dissipates slowly tend to develop extraverted behavior patterns. Since reactive inhibition interferes with the repetition of a conditioned response, Eysenck predicted that extraverts will condition less rapidly than introverts. On the other hand, Spence (1958) hypothesized from Hull's model that the higher emotional reactivity of the anxious person acts like other drives in increasing reaction potential during conditioning; therefore, a positive relationship can be predicted between the degree of manifest anxiety and level of conditioning (cited in Becker & Matteson, 1961).

These different conceptions have been the cause of considerable controversy, both theoretical and empirical in content (Eysenck, 1965; Jones, 1960; Spence, 1964). Studies from Eysenck's laboratory have supported Eysenck, whereas studies from Spence's laboratory have supported Spence. A number of experiments have attempted to assess the relative importance of drive and extraversion-introversion in the contribution they make to the individual differences in eyelid conditioning (e.g., Field & Brengelmann, 1961; Eysenck, (1965; Franks, 1957; Spence & Spence, 1964), galvanic skin response (GSR) conditioning (e.g., Eysenck, 1965; Franks, 1956), salivary conditioning (e.g., Bindra, Paterson, & Strzelecki, 1955) and so on.

Classical Conditioning

The personality variable which has been most studied in relation to conditioning performance is anxiety (Lovibond, 1964). Kelly, Brown and Shaffer (1970) have defined anxiety as an unpleasant subjective experience of tension, apprehension, or anticipation, imposed by the expectation of danger or distress or the need for a special effort. However, within the context of the Hull-Spence model, a refinement is desirable -- in that, anxiety is considered to be a predisposition rather than a static morbid state i.e., a proneness to react in anxiety-inducing situations (Morgenson, 1967).

The aspects of Hullian theory which are of relevance to the relation between conditioning and anxiety have been stated by Taylor (1956) as follows:

> According to Hull, all habits (H) activated in a given situation, combine multiplicatively with the total effective drive state (D) operating at the moment to form excitatory potential or E [E=f(HxD)]. Total effective drive in the Hullian system is determined by the summation of all extant need states, primary and secondary, irrespective of their relevancy to the type of reinforcement employed. Since response strength is determined in part by E, the implication of varying drive level in any situation in which a single habit is evoked is clear; the higher the drive, the greater the value of E and hence, of response

> strength. Thus, in simple non-competitional experimental arrangements involving only a single habit tendency, the performance level of high drive subjects should be greater than that for low drive groups. (p.304)

Spence proposes to use his theory to incorporate personality into the Hullian formulation; his suggestion is that anxiety acts like a drive, so that persons who are characterized by strong anxiety are, in part, in a state of high drive (Bindra, Paterson & Strzelecki, 1955; Eysenck., 1972).

For the measurement of anxiety, Spence uses the Taylor Manifest Anxiety Scale (MAS), a conglomerate of anxiety related statements derived from the Minnesota Multiphasic Personality Inventory (Eysenck, 1972). The originators (Farber, 1955; Taylor, 1951, 1953, 1956) of the MAS considered it to be a measure of drive, and were primarily interested in relating it to the concept of the response hierarchy. In simple one response situations such as eyelid conditioning, it was predicted that high anxious subjects would perform at higher levels than low anxious subjects.

Spence measured or manipulated drive in three ways: (1) using extreme scores obtained from the MAS; (2) threats of noxious stimuli; and (3) using real life situations which are thought to produce anxiety (Morgenson, 1967). The literature contains a number of studies within this framework which have yielded conflicting results with regard to significant relationships between MAS scores and conditioning performance (e.g., Barratt, 1971; Becker & Matteson, 1961; Bindra, Paterson, & Strzelecki, 1955; Bitterman & Holtzman, 1952; Lacey, Smith & Green, 1955; Spence & Farber, 1953; Spence, Farber & Taylor, 1954; Taylor, 1951; and Welch & Kubis, 1947). Spence (1964) reviewed the literature involving comparisons of eyelid conditioning performance of subjects scoring at the extremes of the MAS. In 21 of 25 independent comparisons, the differences between groups were in favour of high anxiety subjects. He concluded that these results provide substantial confirmation of the implication of the drive interpretation of the MAS, that high anxious subjects should exhibit a higher level of conditioning performance than low anxious subjects.

Eysenck (1957, 1963, 1967) has proposed a two-dimensional theory of personality: neuroticism (anxiety or high drive) and introversion-extraversion. The former is a dimension of general stability of the autonomic nervous system (ANS) where the latter is a dimension of the reactivity of the central nervous system to a given stimulus value. The highly neurotic person is characterized by high variability in autonomic reactivity. Eysenck and Eysenck (1969) consider these two dimensions to be produced by certain physiological, biochemical and neurological peculiarities of the organism.

Eysenck (1965) hypothesized that conditioning would correlate with extraversion. This hypothesis is based on two assumptions: (a) extraversion is a phenotypic set of behavior patterns which is related to genotypic differences in the relative ease of arousal of cortical excitation and inhibition, extraverts showing greater inhibition, introverts greater excitation, and (b) cortical inhibition depresses conditioning and facilitates extinction. It would follow that cortical excitation would facilitate conditioning provided that the optimal degree of excitation has not yet been reached. In making his predictions, Eysenck (1966, 1967) followed arguments which have been successfully used to make predictions for the dimension of strength of the nervous system as developed by Pavlov and Teplov (cited in Gray, 1964). In the case of UCS intensity, the more highly aroused introvert will, relative to the extravert, act as though he amplifies stimulation (Gray, 1970).

The process of socialization is thought to be a function of conditioning and/or learning as social controls exerted over impulses become established through conditioning processes. Therefore, the introvert conditions well, i.e., becomes over-socialized whereas the extravert appears to condition poorly resulting in an under-socialized individual (Morgenson, 1967). Eysenck's theory predicts that an introverted subject (neurotic or normal) should form conditioned responses readily and these responses, once formed should be difficult to extinguish, whereas an extraverted subject (neurotic or normal) should form conditioned responses poorly and these responses once formed, should extinguish readily (Franks, 1960; Lovibond, 1964).

In hypothesizing an interaction between extraversion and neuroticism, Lovibond (1964) reported that, as nonanxious subjects tend to be extraverted (Bendig, 1957), the decreasing order of predicted aversive conditioning performance for four sub-groups is anxious introvert, nonanxious introvert, anxious extravert, and nonanxious extravert. Furthermore, he predicted that the order for appetitive conditioning is nonanxious introvert, anxious introvert, nonanxious extravert, and anxious extravert.

As with the Hull-Spence model, Eysenck's theory has been tested in a variety of experiments which attempted to substantiate or refute his hypotheses, e.g., Becker & Matteson, 1961; Franks, 1956; Franks, 1957; Fremont, Means & Means, 1970; and Sadler, Mefferd & Houch, 1971. Eysenck (1966) identified three conditions enhancing the differentiating powers of conditioning: (1) a weak UCS shows introverts to be more conditionable; (2) a short CS-UCS interval favours introverts, whereas a long interval does not differentiate between the groups; and (3) partial reinforcement is a condition wherein introverts are favoured (cited in Morgenson, 1967). The greater conditionability of the introvert is attributed by Eysenck to relatively lower susceptibility to processes of inhibition, to a relatively higher level of general arousal or to both (Eysenck, 1957, 1967).

In summary, there are two main theories linking classical conditioning with personality. Spence and Taylor (1951) and Spence and Spence (1964) have argued for a positive association between conditionability and anxiety; and Eysenck (1957) has put forward the hypothesis that conditioning would correlate with introversion. Reporting on a number of studies, Taylor (1956) states that when the entire range of MAS scores is used, the magnitudes of the obtained correlations with conditionability are approximately 0.25. A level of significance was not identified by the author. When subjects are unselected instead of in extreme groups, the correlation between extraversion and conditioning is -0.46 for acquisition and -0.34 for extinction trials (Franks, 1957). These correlations are significant at the .01 level of confidence. Franks (1956, 1960) observes that Taylor's anxiety scale is largely a measure of neuroticism and argues that anxious subjects score high on tests of both neuroticism and introversion. He suggests that it is not their neuroticism that accounts for the rapid conditioning of anxious subjects but rather their excessive introversion. As pointed out by Eysenck (1965), the trait of susceptibility to anxiety, measured by the MAS (Spence, 1956, 1964; Taylor, 1956) is loaded on both the Eysenckian dimensions of introversion and neuroticism, though the correlation with neuroticism is somewhat higher. Thus Eysenck would agree with Spence (though for different reasons) in expecting those high in anxiety to form conditioned responses with particular ease.

Operant Conditioning

There are relatively few studies in the literature which have attempted to apply the Spencian or Eysenckian models within the framework of operant conditioning, particularly of the autonomic nervous system. The question of whether or not responses mediated by the autonomic nervous system can be conditioned instrumentally has been a subject of continuing controversy because of its theoretical and practical implications. Major problems with research in this area include inappropriate controls, systematic biasing effects, and focusing on alternative explanations of positive findings (Katkin & Murray, 1968). Traditionally, learning theorists have assumed that for "autonomically" mediated behavior, the evidence points unequivocably to the conclusion that such responses can be modified by classical, but not instrumental training methods (Kimble, 1961, p.100).

In the last decade, contributions to the literature have included studies examining galvanic skin response (GSR) and heart rate (HR) conditioning and control in varying feedback situations (Brener, 1966; Brener & Hothersall, 1966; Brener & Hothersall, 1967; Engel & Chism, 1967; Engel & Hansen, 1966; Frazier, 1966; Greene & Nielsen, 1966; Hnatiow & Lang, 1965; Lang, Sroufe & Hastings, 1967; Miller & Di Cara, 1967;

Shearn, 1962; and Trowill, 1967). The general consensus is that GSR, HR, and other ANS responses can be controlled to a moderate degree by both animal (e.g., curarized rats) and human subjects.

Although some authors have suggested that the observed HR changes may have been due to factors such as muscular and respiratory mediators (e.g., sinus arrhythmia), a number of studies have suggested that operant control of the HR response is independent of such mediators (Brener, Kleinman & Goesling, 1969; Sroufe, 1969; and Sroufe, 1971). With these conclusions it became important to know what conditions, factors or personality dispositions, if any, were associated with the control of autonomically mediated responses (Bergman & Johnson, 1971; Blanchard, Young & McLeod, 1972; Greene & Nielsen, 1966; Mandler, Mandler & Uviller, 1958; and McFarland & Coombs, 1974).

The use of naturally occurring feedback in HR control presupposes some accurate perception of autonomic activity on the part of the subject. From a total of 166 subjects, Mandler, Mandler, and Uviller (1958) selected two groups who showed consistency in reporting autonomic activity as based upon scores obtained on the Autonomic Perception Questionnaire (APQ). The APQ deals with the perception of bodily activity: heart rate, perspiration, temperature changes, respiration, gastrointestinal disturbance, muscle tension and blood pressure.

High perceivers (n=19) were subjects who reported a high level of autonomic feedback in both general and specific stress situations. Low perceivers (n=13) reported a low degree of autonomic feedback in both situations. Both groups were monitored for physiological reactions (HR, GSR, etc.) while exposed to an intellectual stress situation where task items were purposely made to be difficult. They were subsequently interviewed as to their autonomic perception during the stress experience. The records of the 14 subjects who obtained high scores on both the questionnaire and the interview and the 9 subjects who scored low on both instruments were then examined for level of autonomic reactivity. The results showed (a) positive correlations between scores on the APQ and other paper-and-pencil tests of anxiety reactions at the .01 level of confidence, e.g., 0.515 with the MAS; (b) high perceivers tended to overestimate their autonomic responses, while low perceivers tended to underestimate them; (c) high perceivers showed significantly greater autonomic reactivity than low perceivers. This study suggests that subjects may be able to perceive autonomic activity to some degree without the aid of external feedback.

The effect of contingent and noncontingent reinforcement on unelicited GSRs by high and low autonomic perceivers was examined by Greene & Nielsen (1966). They hypothesized that subjects who are more aware of their autonomic activity, i.e., score highly on Mandler's test, and are reinforced whenever they emit a GSR, would condition better than subjects who report little autonomic awareness, i.e., score low, "since high perceivers would 'know' the state of their autonomic activity when they were reinforced, while low perceivers would be unable to differentiate the 'feeling' of responding from not responding" (p.359). From a pool of 160 subjects, they used those 20 who scored highest and the 20 who scored lowest on the APQ. Subjects received 10 minutes of rest, 16 minutes of reinforcement and 10 minutes of extinction. The low perceivers were more sensitive to reinforcement contingencies than the high perceivers. The explanation which Greene and Nielsen advanced was that being "aware" of one's autonomic activity may hinder any attempt to modify this activity.

Related to these findings, Blanchard, Young, and McLeod (1972) predicted that high awareness of heart activity and self-control of HR were positively correlated. Five females and 11 males who were high and low in awareness of heart functioning as determined by APQ scores were given 20, 60-sec trials in which they attempted to raise and lower HR with continuous proportional feedback, i.e., how far and in what direction the polygraph needle indicating heart rate moved. A mean HR from all of the individual HRs from a period was calculated. Differences between rest period HR and self-control period HR were calculated for each individual trial as the difference scores, with appropriate sign, served as data for the experiment. The mean HR differences for the two groups for the 10 increase and 10 decrease trials were subjected to an analysis of variance where results showed that low-aware subjects successfully raised and lowered HR on command but high-aware subjects were not able to make significant alterations in HR. Moreover, the investigators found that the correlation between the APQ and HR control was negative and not significant ($r=-0.28$, $p>.05$). Blanchard et al. concluded that subjects who are less aware of their own heart activity as measured by the heart functioning items of the APQ, learn self-control of HR more readily than subjects who are more aware of it. This conclusion was consistent with the result of Engel and Hansen (1966) who reported that subjects learned the response of HR slowing better when they did not correctly infer what response they were controlling. Similarly, these results support the results obtained by Greene and Nielsen (1966), that low-anxious subjects control their GSR more successfully than high-anxious subjects.

Blanchard, Young, and McLeod (1972) also reported that initial tonic (resting) HR did not affect HR control. This finding is not in accord with Gatchel's (1974) results in a study concerned with frequency of feedback and learned heart rate control. In two related experiments, he found that negative correlations between initial heart rate resting level and average speeding performance, i.e., HR acceleration during feedback trials, were significant. He concluded that low resting rate was associated with greater speeding performance. Furthermore, Gatchel found that heart rate variability during initial rest was positively correlated with average speeding performance during feedback trials. He suggested that greater variability in heart rate during rest, which can be viewed as an indicant of cardiac system lability (Lacey, 1959) is associated with greater subsequent HR acceleration.

McFarland and Coombs (1974) also found a significant negative rank order correlation between resting heart rate and mean heart rate control for low-anxiety subjects, whereas a non-significant positive correlation was found for high-anxiety subjects. They hypothesized a relationship between manifest anxiety and the degree of HR control attained. "It was suspected that such relationships might be found since cardiac symptoms (e.g., increased basal HR and large increases in HR under stressful conditions) are among the more reliable physiological correlates of anxiety" (p.53). On the basis of MAS scores, 33 subjects were divided into three groups: low (LA), medium (MA), and high (HA) in manifest anxiety. Each subject "mentally" attempted to synchronize his HR with a series of clicks, 0.2 sec in length, presented via earphones. They were tested alternately with externally augmented and non-augmented (i.e., interoceptive) feedback during several test periods. The authors reported that "...subjects were found to be able to produce a significantly higher than chance percentage of heartbeats in the 0.2 sec interval..." (sic). However, MA subjects scored significantly higher than HA or LA subjects. There was no significant difference between the augmented and interoceptive feedback conditions. Their conclusions are consistent with the findings reported by Mandler, Mandler, and Uviller (1958) that MA subjects show more ability than either LA or HA subjects to correctly perceive and control biofeedback from various viscera, including the heart.

Concordant results were reported by Bergman and Johnson (1971) who predicted that subjects can increase or decrease HR in the absence of feedback since

Murray (1968) suggested that voluntary control through conscious mental activity may be a more crucial mediator of HR change than some of the reinforcement contingencies utilized to this end. Their results were positive and they further proposed that these changes did not appear to be mediated by respiration or skin resistance variations. Their procedure involved telling 54 female subjects in three instructional groups to increase or decrease HR over 30 trials in response to an auditory signal (a tone). The control group was told nothing. Subjects were also divided on the basis of APQ scores. The group with the middle scores displayed more HR control in both directions than subjects with high or low APQ scores. There were no significant differences between subjects who scored high on the APQ and those who scored low. Changes in HR did not seem to be accompanied by changes in respiratory amplitude or skin resistance. This study was replicated with 42 subjects but the investigators were able to find support only for the findings concerned with acceleration but not for those concerning HR deceleration.

Although there is abundant evidence that heart rate can be controlled with the use of exteroceptive feedback, it appears that this may not be a necessary requirement in the demonstration of this phenomenon.

Moreover, the results of Gatchel's (1974) work suggest that the degree of system lability is predictive of speeding control acquisition. Gellhorn (1964) has argued that autonomic and somatic responses are interactive, as well as parallel to one another, because they are centrally integrated systems. In the heart rate speeding task, certain individuals may learn more than others because their cardiovascular systems are more labile and may activate and be more responsive to the somatic-cardiac coupling mechanism. Heart rate speeding may not involve any new learning of a visceral response. Rather, it may merely reflect the recruitment and tuning of somatic responses, such as respiration and muscle tension, which prompt heart rate acceleration (Gatchel, 1974). Furthermore, as a personality trait related to heart rate control, it is not clear whether it is the level of anxiety, the perception of autonomic responses, or another as yet untested parameter, e.g., extraversion, which is responsible in aiding subjects to acquire successful heart rate control. The present study is concerned with examining these possibilities.

Purpose and Rationale

Since the APQ correlates highly with the MAS, it seems conceivable that the APQ measures not only the ability to perceive autonomic responses, but also a general predisposition to respond in anxiety-inducing situations. If such be the case, it might be hypothesized by Spence and his colleagues that highly anxious subjects, i.e., high perceivers, by nature of their high drive state, would perform in a superior manner in an operant conditioning situation given that a general factor of conditionability is an acceptable construct. The studies concerning autonomic conditioning reported above do not support such a position as the hypotheses of several authors, predicting that high scoring subjects would perform better, were not borne out. Although the findings of Mandler et al. (1958), Bergman and Johnson (1971) and McFarland and Coombs (1974) show some degree of uniformity in concluding that middle-anxious subjects perceive and control their internal responses in a superior manner, it is not clear why the results of Engel and Hansen (1966), Greene and Nielsen (1966) and Blanchard et al. (1972) have indicated that subjects who are not aware of their internal state should appear to be in better control of these responses. Such findings are difficult to reconcile with the Hull-Spence model. It is then feasible to argue, as Eysenck and his collaborators have done, that extraversion and not anxiety is a correlate of conditioning.

According to Eysenck (1961) and Lovibond (1964), the introvert is characterized by a high level of aspiration, an emphasis on accuracy and sensitivity and responsiveness to his environment. Extraverts, on the other hand, are low in level of aspiration and show a lack of sensitivity to their environment resulting in "undersocialized" individuals. If nonanxious subjects tend to be extraverted (Bendig,1957; Franks, 1956), and extraverts are not as sensitive as introverts, then nonanxious subjects will tend to be less sensitive also. This relationship may hold for the perception of internal body states as well as for sensitivity to the external environment.

The present study addresses itself to examining the extraversion hypothesis within the confines of the operant heart rate control framework. Moreover, it appears that the discrepant findings of the APQ may be further clarified if related to positive findings that introverts are more capable of perceiving and controlling their heart rate if augmented feedback is provided.

Statement of Hypotheses

The work of Eysenck and his collaborators has shown that introverted subjects are more responsive than extraverted subjects in classical conditioning. In the current study, it was hypothesized that:

1. introverts would demonstrate a higher degree of heart rate control, in terms of heart rate acceleration, than extraverts.

In the operant conditioning paradigm, several investigators (e.g., McFarland & Coombs, 1974) obtained results which do not support the hypotheis as formulated by Spence, that anxiety would correlate positively with conditionability. Moreover, some researchers (e.g., Blanchard, Young, & McLeod, 1972) have put forth the thesis that low anxiety is related to conditioning performance. However, Bendig (1957) and Franks (1956) suggest that nonanxious subjects are less sensitive, and inasmuch as other investigators (e.g., Bergman & Johnson, 1971) have contended that middle-anxious subjects control their heart rates better than high- or low-anxious subjects, it was predicted that:

2. middle-anxious subjects would accelerate their heart rates more successfully than either low- or high-anxious subjects as measured by the Autonomic Perception Questionnaire.

Inasmuch as the Autonomic Perception Questionnaire and Taylor's Manifest Anxiety Scale correlate (Mandler, Mandler, & Uviller, 1958), and Eysenck's neuroticism scale and the MAS correlate (Eysenck, 1957) it was expected that:

3. a positive correlation would be obtained between neuroticism and the Autonomic Perception Questionnaire.

Eysenck (1957) has shown that introverts condition better than extraverts, whereas Spence (1956) claimed that high-anxious subjects condition better than low-anxious subjects. In the interaction of extraversion and anxiety, Lovibond (1964) predicted that the descending order for appetitive conditioning is nonanxious introvert, anxious introvert, nonanxious extravert, and anxious extravert. As the conditions of the present study did not involve aversive consequences and the knowledge of successful heart rate acceleration was assumed to be positively reinforcing, it was predicted that:

4. the descending order of operant heart rate conditioning would be: nonanxious introvert, anxious introvert, nonanxious extravert, and anxious extravert.

Method

Subjects

From a pool of volunteer undergraduate males enrolled at Wilfrid Laurier University, 98 students were selected as subjects. The Autonomic Perception Questionnaire (APQ) and the Eysenck Personality Inventory (EPI) were administered to all subjects prior to their taking part in the experiment. These tests were scored by an assistant who had no other role in the study. Additional information consisted of items concerned with state of health, with particular emphasis on the heart (see Appendix A for this information). Subjects who did not meet the criteria with regard to health or who were not later available for the laboratory part of the experiment did not participate in the study.

Eysenck and Eysenck (1964) have recommended that a lie score of approximately 5 or more casts doubt upon the validity of that particular EPI protocol; for this reason 6 subjects were eliminated. Due to artifacts found in their heart rate protocols, another 3 subjects were eliminated. Hence, a total of 46 subjects were used in the analyses.

Apparatus

Heart rate was monitored and recorded via a Narco BioSystems Biotachometer, Model BT-1200, and Physiograph, Model DMP-4A. An audio generator (Mercury, Model 1000), with sound attenuating earphones, was used to produce signal stimuli. Experimental timing and contingencies were programmed on standard 28V electromechanical modules.

Test Material

The Autonomic Perception Questionnaire (developed by Mandler, Mandler and Uviller, 1958) consists of 28 items designed to evaluate a subject's perception of feeling. The response to each item is measured on a continuum of 1-10 where the score 1 indicates a tendency toward low perception and the score 10 indicates the opposite. A copy of the scale appears in Appendix B.

The Eysenck Personality Inventory, consisting of 57 items (9 of which are lie items) designed to measure introversion-extraversion and neuroticism, is scored in a forced choice manner requiring a yes or no answer only. This test has an established reliability of r=0.75 (Buros, 1965). A copy of the Eysenck Personality Inventory appears in Appendix C.

Procedure

The subject was informed that he was participating in an experiment which involved the physiological recording of heart rate while he was attempting to control it. He was shown how to relax in a reclining chair while the experimenter placed heart rate electrodes 15 cm to either side of the sternum on the plane of the heart, with a ground electrode approximately 7.5 cm above the navel. The experimenter orally gave the instructions to the subject (for instructions, see Appendix D) after which the experimenter placed the earphones (connected to the audio generator) on the head of the subject, ensuring that they were correctly placed and that the subject was able to hear a sample tone (i.e., 1000 Hz at 60 db delivered to both ears). After it was determined that the subject understood the instructions, the experimenter retired to a darkened adjoining room to observe the subject during the subsequent trials. From the beginning to the end of data collection there was no further verbal interchange between the subject and the experimenter. A 10-min adaptation period began at this point.

A pilot study, using 20 subjects was performed to determine and refine the appropriate techniques, i.e., laboratory procedures and the scoring and analysis of the data employed in the experiment proper.

As a result, the procedure involved two blocks of 10, 30-sec trials separated by 30-sec intertrial intervals. A 10-min rest period was allowed between the two blocks of trials. During the 30-sec heart rate control trials the subject received a tone as a signal stimulus during which he "mentally" attempted to increase his heart rate while observing continuous proportional feedback as indicated by the biotachometer placed on a table about 30 cm in front of the subject. The meter was illuminated so that the subject was able to see it only when the tone was on. After the completion of the testing trials, the experimenter returned and removed the earphones and heart rate electrodes from the subject. The experimenter then debriefed the subject and asked him not to mention anything about the experiment to anyone. The experimenter also informed the subject that he might obtain information regarding the outcome of the experiment at a later date (for debriefing information, see Appendix E).

Scoring and reduction of data

Heart rate data were scored according to the method advanced by Blanchard, Young and McLeod (1972). This technique was modified by eliminating the first and last 10 seconds of any period to preclude the measurement of possible confounding orienting responses. A mean heart rate from all of the individual heart rate scores of a 10-sec period was calculated. This interval consisted of seconds 11-20 for any given 30-sec interval. In order to avoid the overall trend to a decreasing heart rate over the course of the experiment as observed by Brener and Hothersall (1967) and also to remove some of the inter-subject variability in baseline HR, differences between rest period heart rate and self-control period heart rate were calculated for each individual trial. The latter difference scores, with appropriate sign, served as data for the experiment. Since trial by trial changes in ability to control heart rate were not of major interest in this study, and since variation of degree of heart rate control over trials tends to contribute to an increased error variance (Young & Blanchard, 1974), the data were further reduced by calculating a mean change score for the 20 increase trials for each subject. A measure of heart rate variability was obtained for each subject by calculating the mean range of all scored intervals in the two periods designated as basal heart rate (20 intervals) and rest period heart rate (20 intervals).

Results

The following measures for each subject were obtained: the score on the Autonomic Perception Questionnaire, extraversion, neuroticism, basal (tonic) heart rate, heart rate variability, and net heart rate acceleration score. The distribution of these six parameters appeared to be normal when plotted. Tables showing mean scores and standard deviations obtained on each variable for the analyses discussed, may be found in Appendix F.

General Analysis

Of the 46 subjects, 32 (i.e., 70%) obtained a net positive heart rate acceleration score, were accelerators, whereas 14 obtained a net negative heart rate acceleration score, were decelerators. A Sign-Test (Siegel, 1956) showed that there was a significant difference (z=2.5) between the number of accelerators and the number of decelerators beyond the .05 level of confidence.

Using six variables and a total N of 46, a multiple regression analysis showed no variables correlating significantly with the dependent variable of heart rate acceleration. However, a significant correlation of +0.68 ($p < .05$) was observed between scores obtained on the Autonomic Perception Questionnaire and scores obtained on neuroticism. Hence, subjects who reported being more aware of their internal autonomic functioning tended to score higher on neuroticism as measured by the EPI. A significant correlation of -0.31 ($p < .05$) was obtained between basal heart rate and heart rate variability. Thus, more heart rate variability was observed with a lower basal heart rate. The multiple correlation coefficient was not significant. Figure G1 of Appendix G illustrates the mean heart rate change scores by trials for the entire sample of 46 subjects.

Autonomic Perception Questionnaire and heart rate acceleration

As the perception of autonomic responses was hypothesized to be related to successful heart rate control, scores obtained on the APQ were divided into three groups: a low group (n=15) with scores ranging between 57 and 103, a middle group (n=16) with scores ranging between 104 and 134, and a high group (n=15) with scores ranging between 135 and 174. An analysis of variance on heart rate acceleration scores revealed no significant differences between the means of the three groups, F (2, 43)=0.21, $p > .05$. Thus, there was no evidence that the ability to perceive internal autonomic functioning had an effect on the ability to accelerate the heart upon command. Figure G2 of Appendix G shows the mean heart rate change scores by trials for the three groups.

Extraversion ahd heart rate acceleration

Inasmuch as extraversion was hypothesized to be related to heart rate control, the entire sample was divided at the median on the basis of extraversion scores, yielding two groups of 23 subjects each, labeled as introverts (range of scores, 5-14) and extraverts (range of scores, 14-20). Five subjects who scored on the median of the extraversion distribution were arbitrarily placed in the low or high group. An analysis of variance on heart rate acceleration scores showed that the two groups did not differ significantly, F (1, 44)=0.08, $p > .05$. Hence, extraversion did not appear to affect heart rate acceleration. Mean heart rate change scores by trials for introverts and extraverts are shown in Figure G3 of Appendix G.

Neuroticism and heart rate acceleration

Hull (1956) hypothesized that anxiety (or neuroticism in Eysenckian terminology) is related to conditionability. To examine this hypothesis, the sample was divided at the median on the basis of neuroticism scores where two groups of 23 subjects were obtained. The scores for the low neuroticism group ranged between 1 and 10, and the scores for the high neuroticism group ranged between 10 and 20. Four subjects who scores on the median of the neuroticism distribution also were arbitrarily placed in the low or high group. An analysis of variance on heart rate acceleration scores showed no significant difference between the two groups, F (1, 44)=0.16, $p > .05$. Thus, neuroticism appeared to have no effect on the ability to accelerate heart rate. Figure G4 of Appendix G illustrates mean heart rate change scores by trials for subjects scoring low and high on neuroticism.

Basal heart rate and heart rate acceleration

As basal heart rate has been considered an indicator of phasic anxiety (e.g., increased arousal), two groups of 23 subjects each made up the low and high groups when the scores obtained in basal heart rate were divided at the median. The scores ranged between 48.8 and 68.5 beats per minute (bpm) for the low group, and between 68.8 and 90.9 bpm for the high group. An analysis of variance on heart rate acceleration scores indicated that the two groups did not differ significantly, F (1, 44)=1.94, $p > .05$. Basal heart rate did not seem to be related to heart rate acceleration. Mean heart rate change scores by trials for subjects with low and high basal heart rates are shown in Figure G5 of Appendix G.

Heart rate variability and heart rate acceleration

Gatchel (1974) has stated that heart rate variability is an indicant of cardiac system lability. To determine whether lability was related to heart rate acceleration, two groups of 23 subjects each were formed by dividing heart rate variability scores at the median. The scores ranged between 5.1 and 10.5 bpm, and between 10.9 and 19.5 bpm for the low and high heart rate variability groups, respectively. An analysis of variance on heart rate acceleration scores showed that there was no significant difference between the two groups, F (1, 44)=0.19, $p > .05$. In view of this analysis, heart rate variability did not appear to be related to the criterion variable of heart rate acceleration. Mean heart rate change scores by trials for subjects with low and high heart rate variability are shown in Figure G6 of Appendix G.

Effects of extraversion and neuroticism

Eysenck (1957) has extensively used the interaction of extraversion and neuroticism in clinical contexts. To test this relationship, the next analysis of variance on heart rate acceleration scores involved splitting the subjects at the medians of the two dimensions yielding four groups in the quadrants labeled as stable introverts (n=8), neurotic introverts (n=15), stable extraverts (n=15), and neurotic extraverts (n=8). The analysis shows that the main effects of neuroticism, F (1, 42)= 0.24, $p > .05$, and extraversion, F (1, 44)=0.16, $p > .05$, were not significant. Similarly, the interaction of extraversion and neuroticism was not significant, F (1, 42)=1.35, $p > .05$. Consequently, heart rate acceleration did not appear to be affected by extraversion, neuroticism, nor the interaction of these two variables. Figure G7 of Appendix G illustrates mean heart rate change scores by trials for the four groups.

Effects of extraversion and the APQ

As the APQ and neuroticism correlate significantly in the current study, an examination of the interaction between the APQ and extraversion was thought to be warranted to compare findings concerned with extraversion and neuroticism in the abovementioned analysis. By dividing at the median the scores obtained on the APQ and extraversion, four separate groups of subjects were obtained. The groups were identified in the following way: nonanxious introverts (n=11), anxious introverts (n=12), nonanxious extraverts (n=12), and anxious extraverts (n=11). The analysis of variance on heart rate acceleration scores showed that the main effects of the APQ, $F\ (1, 44)=0.66,\ p > .05$, and extraversion, $F\ (1, 44)=0.10,\ p > .05$, were not significant. The interaction of these two variables was also not significant, $F\ (1, 42)=0.79,\ p > .05$. Thus, there was no evidence that heart rate acceleration was affected by the APQ, extraversion, or the interaction of the two variables. Mean heart rate change scores by trials for the four groups are shown in Figure G8 of Appendix G.

Accelerators and decelerators

As some subjects were successful at accelerating their heart rates whereas others were not, it was decided that this difference should be further investigated. Procedurally, this involved dividing all subjects on the basis of whether they obtained a net positive or negative score on heart rate acceleration, 32 accelerators and 14 decelerators, respectively. It should be noted that this analysis is qualified by the fact that two distinct groups were obtained by dividing the variable analyzed, i.e., heart rate acceleration scores . An analysis of variance indicated that the means of the two groups differed significantly, F (1, 44)=33.93, $p < .05$. Mean heart rate change scores per trial ranged between +0.10 and +10.50 bpm for the accelerators, and between -0.10 and -3.20 bpm for the decelerators. The mean heart rate change scores by trials are shown in Figure G9 of Appendix G.

Summary of results

The results of the analyses of variance showed that there was no evidence that heart rate acceleration was affected by the APQ, extraversion, neuroticism, basal heart rate, or heart rate variability. The multiple regression analysis also showed that there were no variables which were significantly related to successful heart rate acceleration. The only significant correlations computed were between the APQ and neuroticism (*r*=+.68) and between basal heart rate and heart rate variability (*r*=-.31). The groups identified as accelerators and decelerators differed significantly with respect to heart rate acceleration.

Discussion

The results of the present study did not support either the Spencian or Eysenckian models. However, the phenomenon of voluntary heart control has been substantially demonstrated as 32 of 46 subjects (i.e., 70% of the entire sample) were able to raise their heart rate upon command. In the Bergman and Johnson (1971) study, a comparable percentage was obtained where 11 of 18 subjects showed significant heart rate increases. Ax (1957) proposed that the aptitude for physiological learning is distributed among the population as widely as the familiar IQ, although it may be very little correlated with the aptitude for intellectual learning.

As the Autonomic Perception Questionnaire correlates with the Taylor Manifest Anxiety Scale, (Mandler, Mandler, & Uviller, 1958) it is not surprising that the APQ also correlated positively with Eysenck's neuroticism scale as both the MAS and the neuroticism scale are considered measures of anxiety. Thus, the hypothesis concerning the relationship between the APQ and neuroticism was supported by the results. This is in accord with Morgenson's (1967) report that the neuroticism scale and the MAS correlated significantly.

Although subjects who scored in the middle range of the APQ appeared to display relatively more heart rate control than either of the low or high groups, the difference was not significant. Hence, there was no evidence for the prediction that middle anxious subjects would accelerate their heart rates more successfully than either low- or high-anxious subjects. Furthermore, a negative correlation between the APQ and heart rate acceleration approached zero and was not significant. It is not possible to confirm the findings of Bergman and Johnson (1971) and others who found similar but significant results.

It might be noted that in the current study, the APQ failed to predict conditionability as did the MAS in a study by Gilbertstadt and Davenport (1960). They assessed 19 psychiatric patients for clinical anxiety, i.e., low, medium, and high, on three dimensions: MAS scores, brief psychiatric interviews, and hospital admission data. Under optimum GSR conditioning procedures with a one-half second CS-UCS interval, the investigators reported that groups ranked on the basis of hospital admission data were found to be significantly different in conditionability. Yet anxiety groups ranked either on the basis of MAS scores or brief psychiatric interviews were not significantly different in conditionability.

Contrary to Spence's (1956) hypothesis, subjects scoring high on neuroticism in this study were not able to accelerate their heart rates more successfully than subjects scoring low on this measure. Inasmuch as the relationships between the MAS and neuroticism, and the MAS and the APQ have already been established, the above-mentioned result is consistent with the author's finding with the APQ where the low, middle, and high-anxious groups were undifferentiated with respect to conditionability. Perhaps the apparent failure of the neuroticism scale to predict conditionability is due to the fact that subject selection was not done on the basis of extreme scores but rather on the basis of splitting the entire range of scores at the median. This suggests that the groups in the present study may not have been sufficiently differentiated with respect to neuroticism to result in significant differences in conditionability. This possibility warrants future examination.

In the current study, introverts were not significantly more successful at heart rate control than extraverts. This unexpected finding is inconsistent with Eysenck's theory. In his study, which examined classical conditioning of autonomic responses, Morgenson (1967) was also unable to substantiate Eysenck's position. A possible explanation for this result may lie in the fact that all subjects received full proportional feedback or reinforcement (as they were inextricably linked in this study) during the self-control trials. Eysenck (1973) stated that partial reinforcement favours introverts, whereas 100% reinforcement (subjects received heart rate feedback during an entire self-control period in the current study) does not. In addition, all subjects in the current study were aware of the experimental contingencies. Gidwani (1971) reports that among aware subjects, extraverts condition well (cited in Eysenck, 1973). However, in pooling the groups, as in the regression analysis of the current study, the correlation between extraversion and conditioning is not significantly different from zero (Gidwani, 1971). Hence, the conditions of the present experiment according to Eysenck (1973) were unfavourable to introverts, and according to Gidwani (1971), were favourable to extraverts.

In the analyses where the interaction of extraversion and anxiety (i.e., extraversion and the APQ and extraversion and neuroticism) was examined, no significant differences were obtained between the different subgroups. An inspection of the hierarchy of conditioning (i.e., means and figures) in the current study revealed that whether measured by the APQ or the neuroticism scale, the subgroups assumed the following order of conditioning: anxious extravert, non-anxious introvert, anxious introvert, and nonanxious extravert. This is in contrast to Lovibond's (1964) predicted order for appetitive conditioning, non-anxious introvert, anxious introvert, nonanxious extravert, anxious extravert. It is worth noting that Otis and Martin (1968) found that anxious extraverted subjects performed better in an instrumental avoidance procedure than nonanxious extraverts, while the reverse held for the introverts. This is not in support of Lovibond's prediction concerning the order of aversive conditioning: anxious introvert , non-anxious introvert , anxious extravert, nonanxious extravert. Clearly, there are many apparent inconsistencies pertaining to the interaction of extraversion and anxiety which demand empirical study.

An interesting discovery in the current study was that a significant negative correlation was obtained between basal heart rate and heart rate variability. This relationship is in keeping with Wilder's (1957)

Law of Initial Values which states that a lesser amount of fluctuation in an autonomic response can be expected if the basal or resting rate is higher. Secondly, neither basal heart rate nor heart rate variability correlated significantly with heart rate acceleration in this study whereas they did in Gatchel's study (1974).

The results of the present research and other experiments do not indicate any variable which consistently correlates with heart rate control. Perhaps, it is useful to examine the Laceys' (1958) hypothesis of individual response stereotypy that autonomically mediated responses are independent of stimulus and unique to the responder (Engel, 1960). Shnore (1959) maintains that individuals differ with respect to which physiological measures show the greatest change under "standard conditions of stimulation". A person exhibits response stereotypy to the extent that whatever the nature of the activating stimulus, one or more response systems in the ANS usually show the greatest magnitude of change as compared to other response systems (Sternbach, 1966). This suggests that some subjects exhibit more lability within given response systems than other subjects. If a labile subject shows large amounts of spontaneous activity of heart rate during rest (Lacey, 1959), and Gatchel's (1974) work indicates that heart rate control is correlated with resting heart rate and heart rate variability, then cardiac system lability may be related to heart rate control. This possibility merits further investigation.

Conclusion

The results of this study do not appear to lend themselves to any interpretation which would clarify the anxiety-extraversion controversy. This study, as well as others which have examined the differential effects of anxiety and extraversion are an indication of the disparate conclusions that researchers have often put forward in an attempt to resolve the very controversial issues surrounding the phenomenon of learning.

Researchers in this particular area in the past have not been sufficiently critical and many earlier research findings should perhaps be reinvestigated. It is proposed that paper-and-pencil tests, from which personality parameters are drawn, be investigated to further establish validity and reliability in the interest of future experiments relying on these variables. For instance, Eysenck (Eysenck & Claridge, 1962) has recognized that the extraversion scale is not unidimensional, and in fact measures a "behavioral" extraversion factor, as well as a "constitutional" extraversion factor, the former being irrelevant to predictions from the original theory. Moreover, Willet (1960) has argued that the extraversion scale is a very poor measure of extraversion and cites a study by

Claridge which showed that careful behavioral ratings produced predicted relationships whereas questionnaire scores did not. Similarly, the Autonomic Perception Questionnaire may be interpreted as reflecting not only a subject's perception of autonomic feeling and his willingness to report it, but also his relative state of anxiety or a predisposition to behave in a particular manner in anxiety producing situations as well. The fact that there may be confounded variables, as yet undefined, operating within the framework of the questionnaire itself has become evident.

Future experiments which deal with this area of interest, should focus upon parameters which may not be associated with the variables of anxiety and extraversion as they contribute to the voluntary control of autonomic responses. More attention should be paid to variables such as basal heart rate, heart rate variability, autonomic lability, Wilder's (1957) Law of Initial Values and its effect on autonomic response systems, and the Laceys' (1952, 1953, 1958) hypothesis concerning individual autonomic response stereotypy. Although current investigations are attempting to delineate variables which are instrumental in the control of autonomic responses, it is felt that the interaction of several of the variables discussed as well as other, as yet unknown factors may be responsible for successful learning in the autonomic nervous system.

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APPENDIX A

STATE OF HEALTH QUESTIONNAIRE

Department of Psychology

Please note that the information in the following questionnaires will be kept confidential. However, it is important that you PRINT your name and telephone number at the bottom of this page so that we may contact you at a later date to participate in the second phase of the experiment concerned with attention variables. Participants in phase II of the experiment will NOT experience any pain or harm during its course. Please answer all questions truthfully and completely.

Have you recently suffered from any of the following:

	Yes	No
Migraine headaches	___	___
Ulcers	___	___
Heart ailments	___	___
Respiratory disorders	___	___
Arthritis	___	___
Rheumatism	___	___
Hay fever	___	___
Allergies	___	___
Kidney ailments	___	___
Muscle tension	___	___

Name ______________________________ Telephone number __________

APPENDIX B

THE AUTONOMIC PERCEPTION QUESTIONNAIRE

Questionnaire on the Perception of Feeling

NAME: ______________________________
(please print)

This questionnaire is designed to give you an opportunity to describe your subjective experience in relation to several dimensions of emotion.

For each question there is a line or scale on the ends of which are statements of extreme feelings or attitudes. You are required to put a mark (X) on that point on the line which you think best indicates the state of your feeling or attitude about the particular question. You may put the mark anywhere on the line. Please read each question at length. Answer all questions. Do not omit any.

You may find it difficult to answer some of these questions. This is because people differ widely in their emotional experiences. It is this variation in individual experiences which we are trying to assess. Therefore, it is extremely important that you give as much thought as possible to each of your answers. When you find it difficult to mark a particular question, use your best possible estimate of how you might feel.

There are no catch questions in this questionnaire. Its success depends entirely upon your cooperation. Needless to say, your answers to the questions will be kept strictly confidential.

THINK ABOUT EACH QUESTION CAREFULLY BEFORE YOU ANSWER. REMEMBER, YOU MAY PUT THE MARK ANYWHERE ON THE LINE.

1. When you feel anxious, are you aware of many bodily reactions?

Aware of very many ____________________ Aware of very few

2. When you feel anxious, how often are you aware of your bodily reactions?

Always ____________________ Never

3. When you feel anxious, does your face become hot?

Does not change ____________________ Becomes very hot

4. When you feel anxious, do your hands become cold?

No change ____________________ Very cold

5. When you feel anxious do you perspire?

Not at all ____________________ A great deal

6. When you feel anxious, does your mouth become dry?

Always ____________________ Never

7. When you feel anxious, are you aware of increased muscle tension?

No increase of tension ____________________ A great deal of tension

8. When you feel anxious, do you get a headache?

Always ____________________ Never

9. When you feel anxious, how often are you aware of any change in your heart action?

Never ____________________ Always

10. When you feel anxious, do you experience accelerated heart beat?

No change — Great acceleration

11. When you feel anxious, does the intensity of your heart beat increase?

Does not change — Increase to extreme poundin

12. When you feel anxious, how often are you aware of change in your breathing?

Always — Never

13. When you feel anxious, does your breathing become more rapid?

No change — Very rapid

14. When you feel anxious, do you breathe more deeply?

Much more deeply — No change

15. When you feel anxious, do you breathe more shallowly?

Much more shallowly — No change

16. When you feel anxious, do you feel as if blood rushes to your head?

Always — Never

17. When you feel anxious do you get a lump in your throat or a choked-up feeling?

Always — Never

18. When you feel anxious, does your stomach get upset?

Not at all — Very upset

19. When you feel anxious, do you get a sinking or heavy feeling in your stomach?

Never — Always

20. When you feel anxious, do you have any difficulty talking?

Never — Always

21. When you feel anxious, are you bothered by your bodily reactions?

Bothered very much — Not bothered at all

22. When you feel happy, are you aware of any change in your heart action?

Always — Never

23. When you feel happy, are you aware of many bodily reactions?

Aware of very many — Aware of very few

24. When you feel happy, do you experience accelerated heart beat?

No change — Great acceleration

25. When you feel happy, does your face become hot?

Does not change — Becomes very hot

26. When you feel happy, do you ever feel weak or shaky?

Always — Never

27. When you feel happy, do you get a lump in your throat or a choked-up feeling?

Always — Never

28. When you feel happy, do you have any difficulty talking?

Never — Always

APPENDIX C

THE EYSENCK PERSONALITY INVENTORY

1. Do you often long for excitement? . . . . Yes No

2. Do you often need understanding friends to cheer you up? . . . . Yes No

3. Are you usually carefree? . . . . Yes No

4. Do you find it very hard to take no for an answer? . . . Yes No

5. Do you stop and think things over before doing anything? . . . . Yes No

6. If you say you will do something do you always keep your promise, no matter how inconvenient it might be to do so? . . . . Yes No

7. Does your mood often go up and down? . . . . Yes No

8. Do you generally do and say things quickly without stopping to think? . . . . Yes No

9. Do you ever feel "just miserable" for no good reason? Yes No

10. Would you do almost anything for a dare? . . . . Yes No

11. Do you suddenly feel shy when you want to talk to an attractive stranger? . . . . Yes No

12. Once in a while do you lose your temper and get angry? . . . . Yes No

13. Do you often do things on the spur of the moment? . . . Yes No

14. Do you often worry about things you should not have done or said? . . . . Yes No

15. Generally do you prefer reading to meeting people? . . Yes No

16. Are your feelings rather easily hurt? . . . . Yes No

17. Do you like going out a lot? . . . . Yes No

18. Do you occasionally have thoughts and ideas that you would not like other people to know about? . . . . Yes No

19. Are you sometimes bubbling over with energy and sometimes very sluggish? . . . . Yes No

20. Do you prefer to have few but special friends? . . . . . Yes No

21. Do you daydream a lot? . . . . Yes No

22. When people shout at you, do you shout back? . . . . . . Yes No

23. Are you often troubled about feelings of guilt? . . . . . . Yes No

24. Are all your habits good and desirable ones? . . . . . . Yes No

25. Can you usually let yourself go and enjoy yourself a lot at a gay party? . . . . Yes No

26. Would you call yourself tense or "highly-strung"? . . . Yes No

27. Do other people think of you as being very lively? . . . Yes No

28. After you have done something important, do you often come away feeling you could have done better? . . . . . Yes No

29. Are you mostly quiet when you are with other people? Yes No

30. Do you sometimes gossip? . . . . Yes No

31. Do ideas run through your head so that you cannot sleep? . . . . Yes No

32. If there is something you want to know about, would you rather look it up in a book than talk to someone about it? . . . . Yes No

33. Do you get palpitations or thumping in your heart? . . . Yes No

34. Do you like the kind of work that you need to pay close attention ? . . . . Yes No

35. Do you get attacks of shaking or trembling? . . . . Yes No

36. Would you always declare everything at the customs, even if you knew that you could never be found out? . . Yes No

37. Do you hate being with a crowd who play jokes on one another? . . . . Yes No

38. Are you an irritable person? . . . . Yes No

39. Do you like doing things in which you have to act quickly? . . . . Yes No

40. Do you worry about awful things that might happen? . . Yes No

41. Are you slow and unhurried in the way you move? . . . Yes No

42. Have you ever been late for an appointment or work? . Yes No

43. Do you have many nightmares? . . . . Yes No

44. Do you like talking to people so much that you would never miss a chance of talking to a stranger? . . . . . . Yes No

45. Are you troubled by aches and pains? . . . . Yes No

46. Would you be very unhappy if you could not see lots of people most of the time? . . . . Yes No

47. Would you call yourself a nervous person? . . . . Yes No

48. Of all the people you know are there some whom you definitely do not like? . . . . Yes No

49. Would you say you were fairly self-confident? . . . . . . Yes No

50. Are you easily hurt when people find fault with you or your work? . . . . Yes No

51. Do you find it hard to really enjoy yourself at a lively party? . . . . Yes No

52. Are you troubled with feelings of inferiority? . . . . . . Yes No

53. Can you easily get some life into a rather dull party?. Yes No

54. Do you sometimes talk about things you know nothing about? . . . . Yes No

55. Do you worry about your health? . . . . Yes No

56. Do you like playing pranks on others? . . . . Yes No

57. Do you suffer from sleeplessness? . . . . Yes No

PLEASE CHECK TO SEE THAT YOU HAVE ANSWERED ALL THE QUESTIONS.

APPENDIX D

TRANSCRIPTS OF INSTRUCTIONS TO SUBJECTS

Instruction to all subjects

This study deals with controlling your heart rate. The majority of people can increase their heartbeat when they are given a signal to do so. Increasing your heart rate is possible if you concentrate on your heart and try very hard to make your heart go faster. In this experiment you will hear tones lasting for 30 seconds. During the time interval that you hear the tone, I want you to try to make your heart go faster by trying to make this needle (experimenter points to it) move toward the right. Movements of the needle to the right reflect increases in HR while movements to the left reflect decreases. This meter will be illuminated so that you will see it only when the tone is on. We will go through this procedure 20 times with a 30-sec rest period between trials. A 10-min rest period will be allowed between the tenth and eleventh trials. You might notice that as the experiment progresses, you will be more and more successful in your efforts to control your heart. Please do <u>not</u> change your breathing rate, move any limbs or induce any muscle tension in your body. Try to relax and lie as still and quietly as possible for the duration of the experiment. The experiment will take approximately 40 minutes.

APPENDIX E

TRANSCRIPTS OF DEBRIEFING INFORMATION

Debriefing Information

The experiment you have participated in was designed to determine how certain personality factors (e.g., introversion, neuroticism, and the perception of feeling) relate to your ability to control your heart. It was necessary to determine by means of a preliminary questionnaire, whether you were suffering from or had suffered any health problems or psychological difficulties which may be related to the heart as we did not want to endanger the subject himself.

When you arrived for the experiment, it was necessary to cleanse your skin where the electrodes connected to a physiological recording device were to be placed. It was also necessary to apply a special adherent paste to these electrodes which aids in the conduction of a small electric current.

Any data collected which concerns you will be kept confidential and your cooperation has been appreciated. Finally, I would ask you not to mention the nature or the procedure of this experiment to anyone. If you are interested in the outcome of this experiment, you may return to this lab at a later date when this information will be available for your examination. Do you have any questions? (pause, to answer questions, if any). Thank you very much (subject leaves).

APPENDIX F

MEAN SCORES AND STANDARD DEVIATIONS

The following tables contain means and standard deviations for the six variables which were used in the analyses discussed (see text). The tables are labeled and organized according to the way that the groups were divided in the analyses. The symbols used in the tables represent the following parameters:

APQ= score obtained on the Autonomic Perception Questionnaire

E= score obtained on the extraversion scale of the EPI

N= score obtained on the neuroticism scale of the EPI

BHR= basal heart rate (in beats per minute) measured during the adaptation period (10 minutes)

HRV= heart rate variability (in beats per minute) measured during the basal heart rate period (10 minutes) and the rest period heart rate (10 minutes) between the two blocks of 10 trials each

HRA= net heart rate acceleration scores (in beats per minute) summed over 20 heart rate control trials.

TABLE F1

MEANS AND STANDARD DEVIATIONS OF THE STUDIED VARIABLES

Variable	Mean	Standard Deviation
APQ	117.70	27.98
E	13.28	3.73
N	10.24	4.15
BHR	69.49	10.36
HRV	10.89	3.75
HRA	41.44	67.11

N=46

TABLE F2

MEANS AND STANDARD DEVIATIONS OF THE VARIABLES

BASED ON APQ SCORES

Low-Anxious (n=15), Middle-Anxious (n=16), and High-Anxious (n=15) Subjects

	Low-Anxious		Middle-Anxious		High-Anxious	
Variable	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
APQ	86.80	12.98	116.31	9.30	150.07	10.41
E	13.20	4.28	12.81	4.02	13.87	2.92
N	7.47	3.52	9.81	2.46	13.47	4.10
BHR	70.39	10.51	68.19	7.40	69.99	13.15
HRV	12.31	4.19	9.93	3.87	10.47	2.89
HRA	38.86	65.94	51.50	72.19	33.29	65.94

TABLE F3

MEANS AND STANDARD DEVIATIONS OF THE VARIABLES

BASED ON EXTRAVERSION SCORES

Introverts (n=23), and Extraverts (n=23)

	Introverts		Extraverts	
Variable	Mean	Standard Deviation	Mean	Standard Deviation
APQ	119.96	28.68	115.44	27.93
E	10.35	2.55	16.22	1.60
N	11.09	4.57	9.39	3.82
BHR	71.34	9.54	67.65	10.71
HRV	11.01	4.03	10.76	3.63
HRA	38.67	67.97	44.21	66.65

TABLE F4

MEANS AND STANDARD DEVIATIONS OF THE VARIABLES

BASED ON NEUROTICISM SCORES

Low Neuroticism (n=23) and High Neuroticism (n=23) Subjects

	Low Neuroticism		High Neuroticism	
Variable	Mean	Standard Deviation	Mean	Standard Deviation
APQ	101.70	23.97	133.70	21.94
E	13.70	2.92	12.87	4.57
N	7.04	2.37	13.44	2.83
BHR	69.65	9.60	69.34	11.43
HRV	11.30	4.06	10.47	3.42
HRA	37.44	68.19	45.44	67.38

TABLE F5

MEANS AND STANDARD DEVIATIONS OF THE VARIABLES

BASED ON BASAL HEART RATE SCORES

Low Basal Heart Rate (n=23) and High Basal Heart Rate (n=23) Subjects

	Low Basal Heart Rate		High Basal Heart Rate	
Variable	Mean	Standard Deviation	Mean	Standard Deviation
APQ	120.96	27.71	114.44	28.91
E	13.83	3.48	12.74	4.02
N	10.44	4.36	10.04	3.96
BHR	60.90	5.22	78.10	6.02
HRV	11.70	3.80	10.07	3.54
HRA	55.10	61.70	27.79	71.49

TABLE F6

MEANS AND STANDARD DEVIATIONS OF THE VARIABLES

BASED ON THE HEART RATE VARIABILITY SCORES

Low Heart Rate Variability (n=23) and High Heart

Rate Variability (n=23) Subjects

	Low Heart Rate Variability		High Heart Rate Variability	
Variable	Mean	Standard Deviation	Mean	Standard Deviation
APQ	121.13	26.66	114.26	29.43
E	13.39	3.62	13.17	3.93
N	10.48	3.76	10.00	4.57
BHR	70.54	11.30	68.45	9.46
HRV	7.87	1.61	13.90	2.68
HRA	37.10	53.63	45.79	79.34

TABLE F7

MEANS AND STANDARD DEVIATIONS OF THE VARIABLES

BASED ON EXTRAVERSION AND NEUROTICISM SCORES

Stable Introverts (n=8), Neurotic Introverts (n=15),

Stable Extraverts (n=15), and Neurotic Extraverts (n=8)

Variable	Stable Introverts		Neurotic Introverts		Stable Extraverts		Neurotic Extraverts	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
APQ	95.30	18.10	133.10	27.15	105.10	26.79	134.80	16.64
E	10.00	1.69	10.50	3.14	15.60	0.81	17.30	2.29
N	7.00	2.83	13.50	3.02	8.20	2.18	13.80	2.69
BHR	71.00	7.38	71.50	11.52	68.90	10.80	54.30	10.80
HRV	12.20	4.30	10.40	3.96	10.80	4.05	10.70	3.07
HRA	48.05	84.55	33.97	53.19	32.09	60.13	66.95	76.72

TABLE F8

MEANS AND STANDARD DEVIATIONS OF THE VARIABLES

BASED ON EXTRAVERSION AND APQ SCORES

Nonanxious Introverts (n=11), Anxious Introverts (n=12),

Nonanxious Extraverts (n=12), and Anxious Extraverts (n=11)

	Nonanxious Introverts		Anxious Introverts		Nonanxious Extraverts		Anxious Extraverts	
Variable	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
APQ	96.70	17.14	141.30	18.18	92.58	13.85	140.40	14.37
E	9.30	2.43	11.30	2.93	16.08	1.08	16.40	1.95
N	8.30	3.74	13.70	3.40	7.08	2.58	11.90	3.36
BHR	72.70	8.48	70.10	11.86	68.92	9.58	66.30	11.78
HRV	10.90	4.09	11.10	4.23	11.36	4.34	10.10	3.04
HRA	39.52	73.24	37.89	58.83	27.81	52.50	62.16	73.31

TABLE F9

MEANS AND STANDARD DEVIATIONS OF THE VARIABLES
BASED ON HEART RATE ACCELERATION SCORES
Accelerators (n=32) and Decelerators (n=14)

	Accelerators		Decelerators	
Variable	Mean	Standard Deviation	Mean	Standard Deviation
APQ	115.41	28.22	122.93	27.74
E	13.59	3.77	12.57	3.69
N	9.97	3.81	10.86	4.93
BHR	67.71	9.59	73.56	11.26
HRV	10.66	3.46	11.40	4.45
HRA	70.41	58.91	-24.77	22.93

APPENDIX G

FIGURES ILLUSTRATING MEAN HEART RATE CHANGE SCORES BY TRIALS

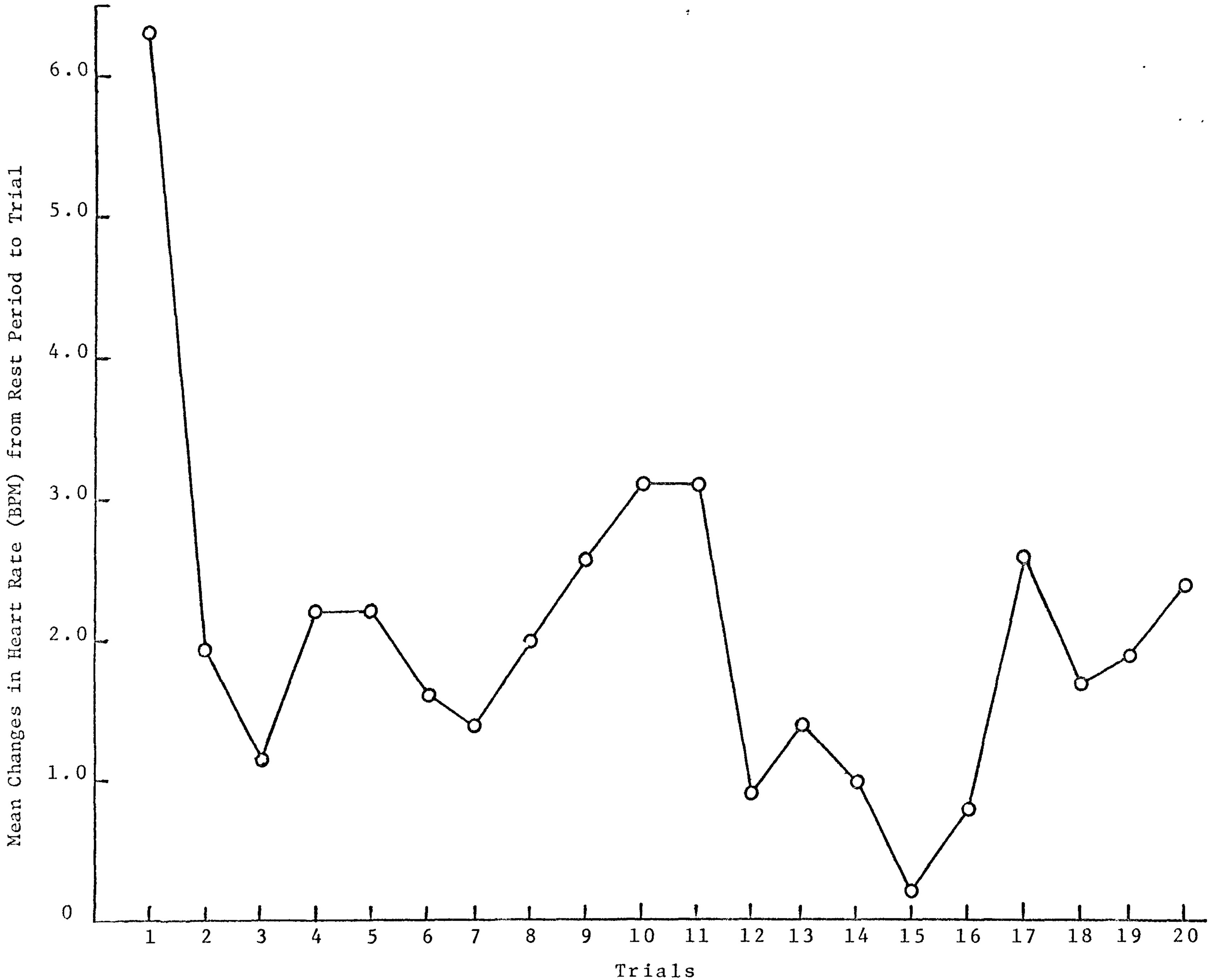

Figure 1. Mean heart rate change scores by trials for the entire sample of 46 subjects.

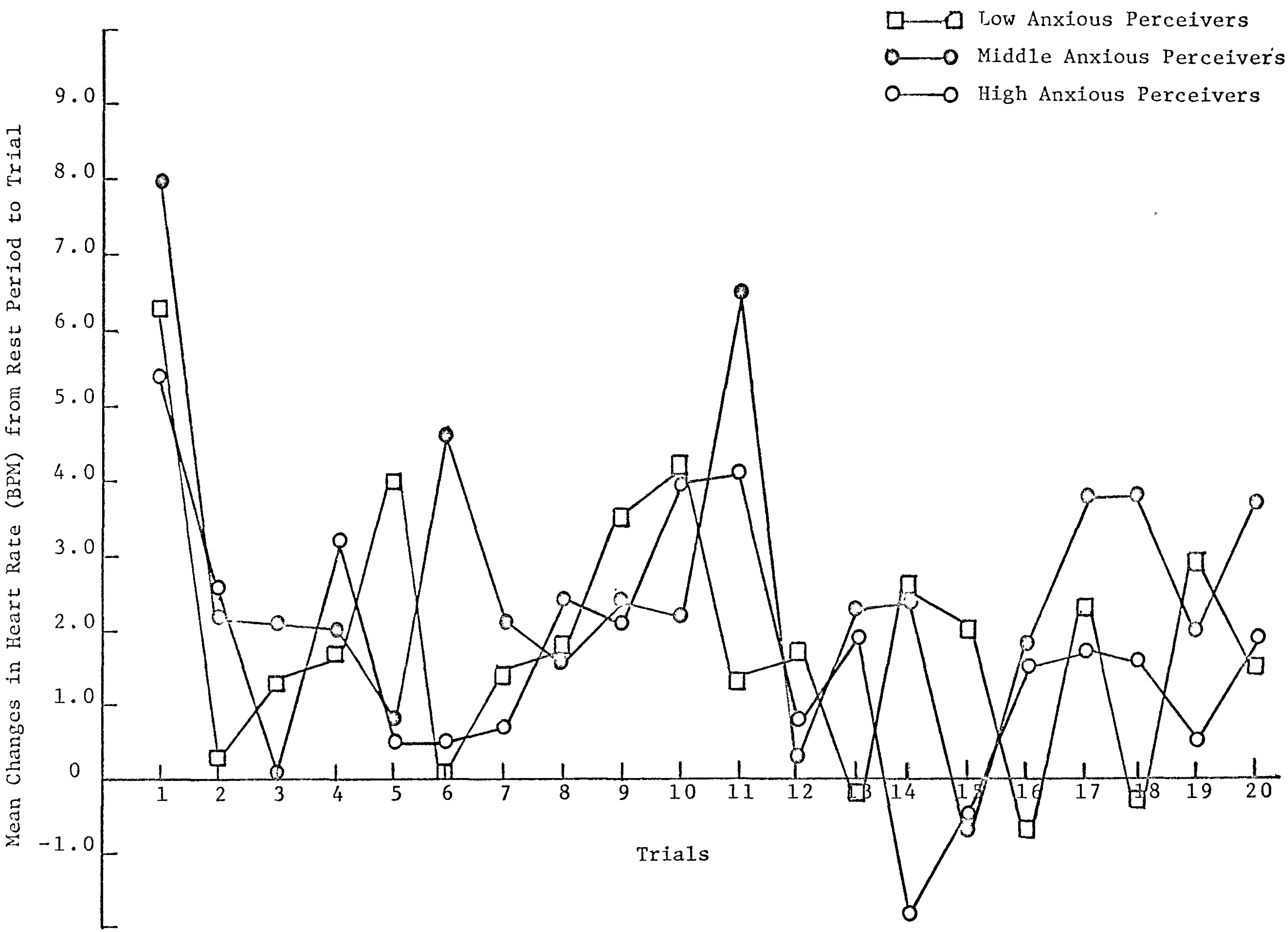

Figure 2. Mean heart rate change scores by trials for low, medium and high anxious subjects as measured by the APQ.

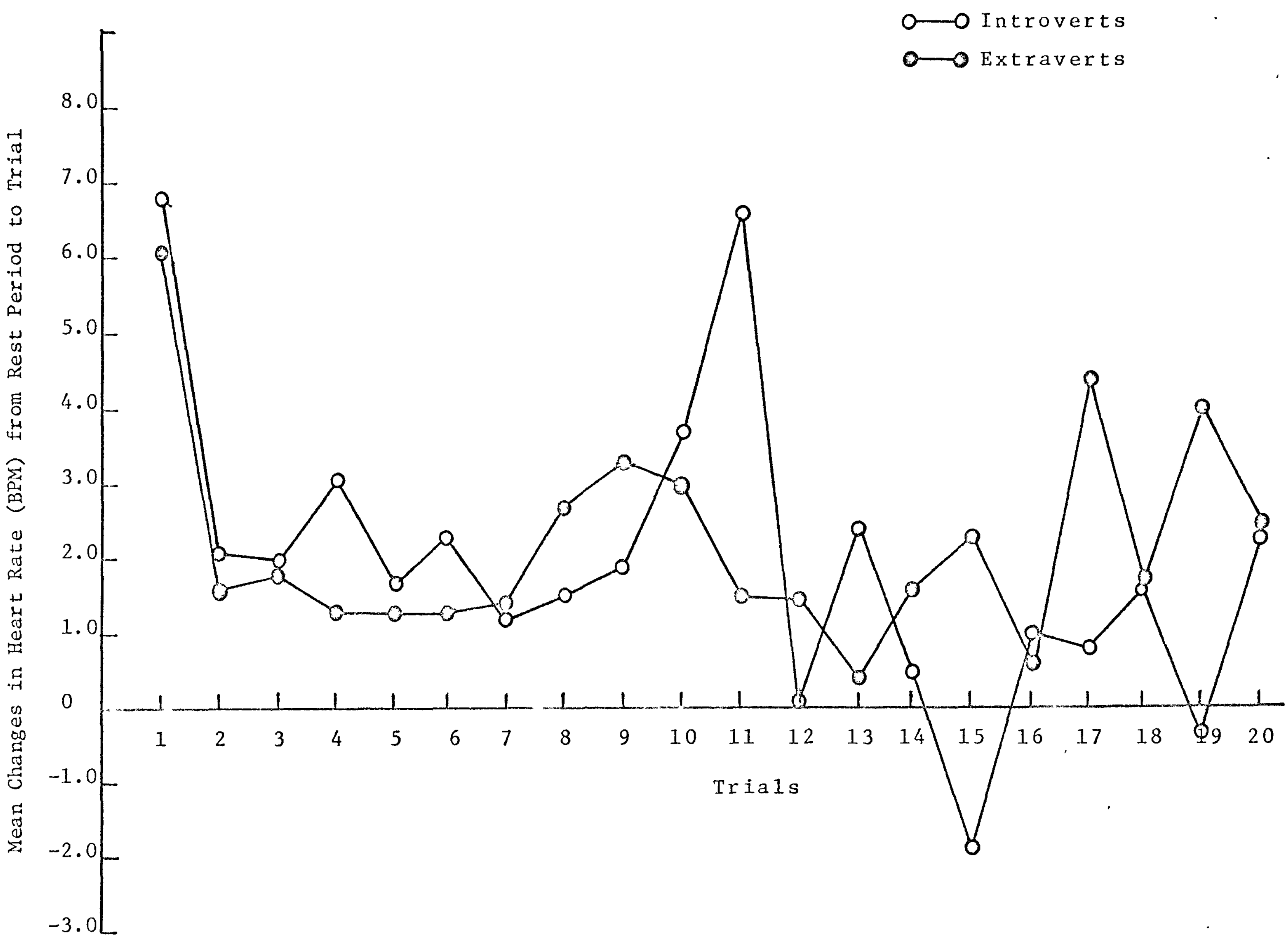

Figure 3. Mean heart rate change scores by trials for introverts and extraverts.

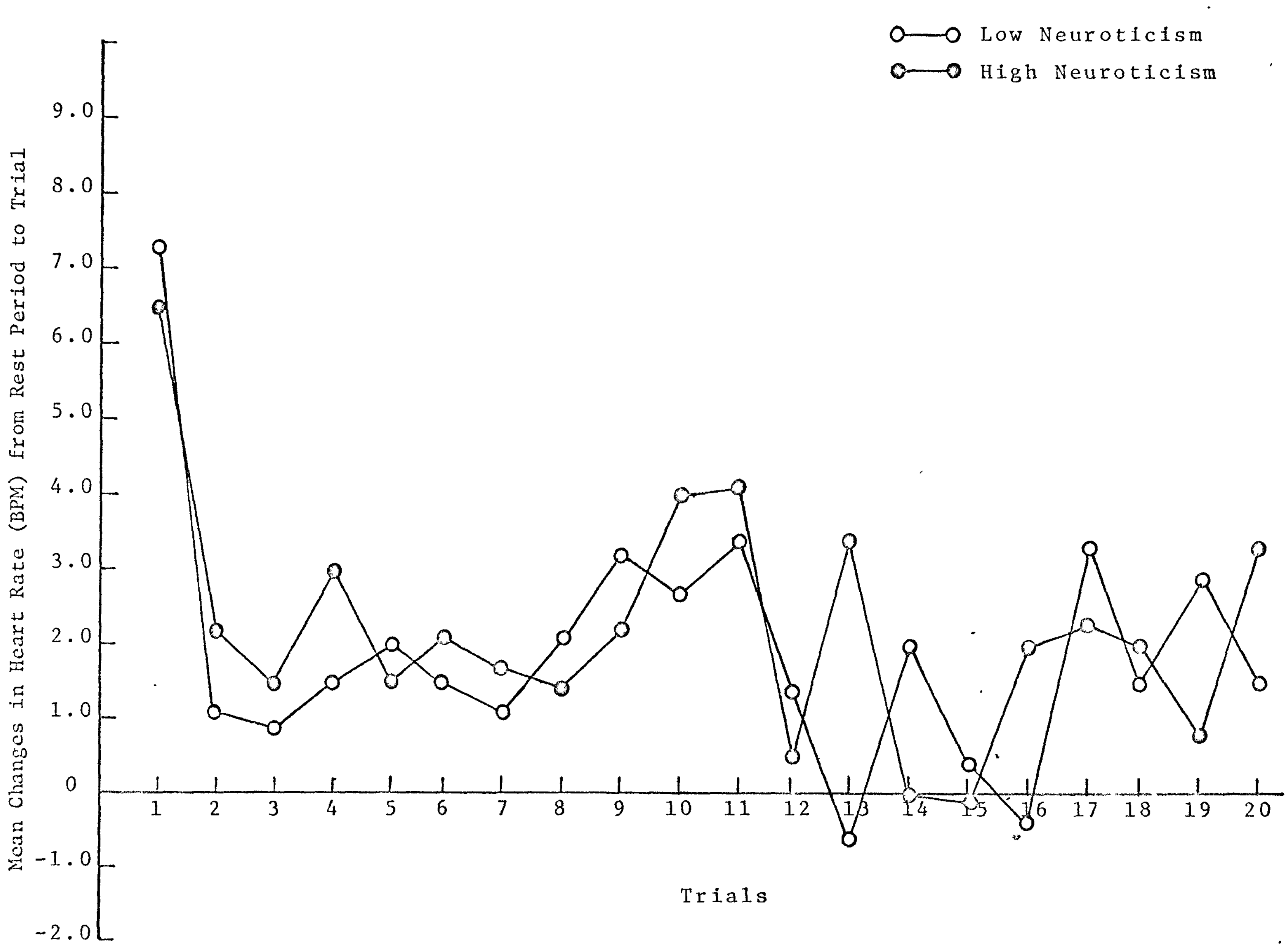

Figure 4. Mean heart rate change scores by trials for subjects scoring low and high on Neuroticism.

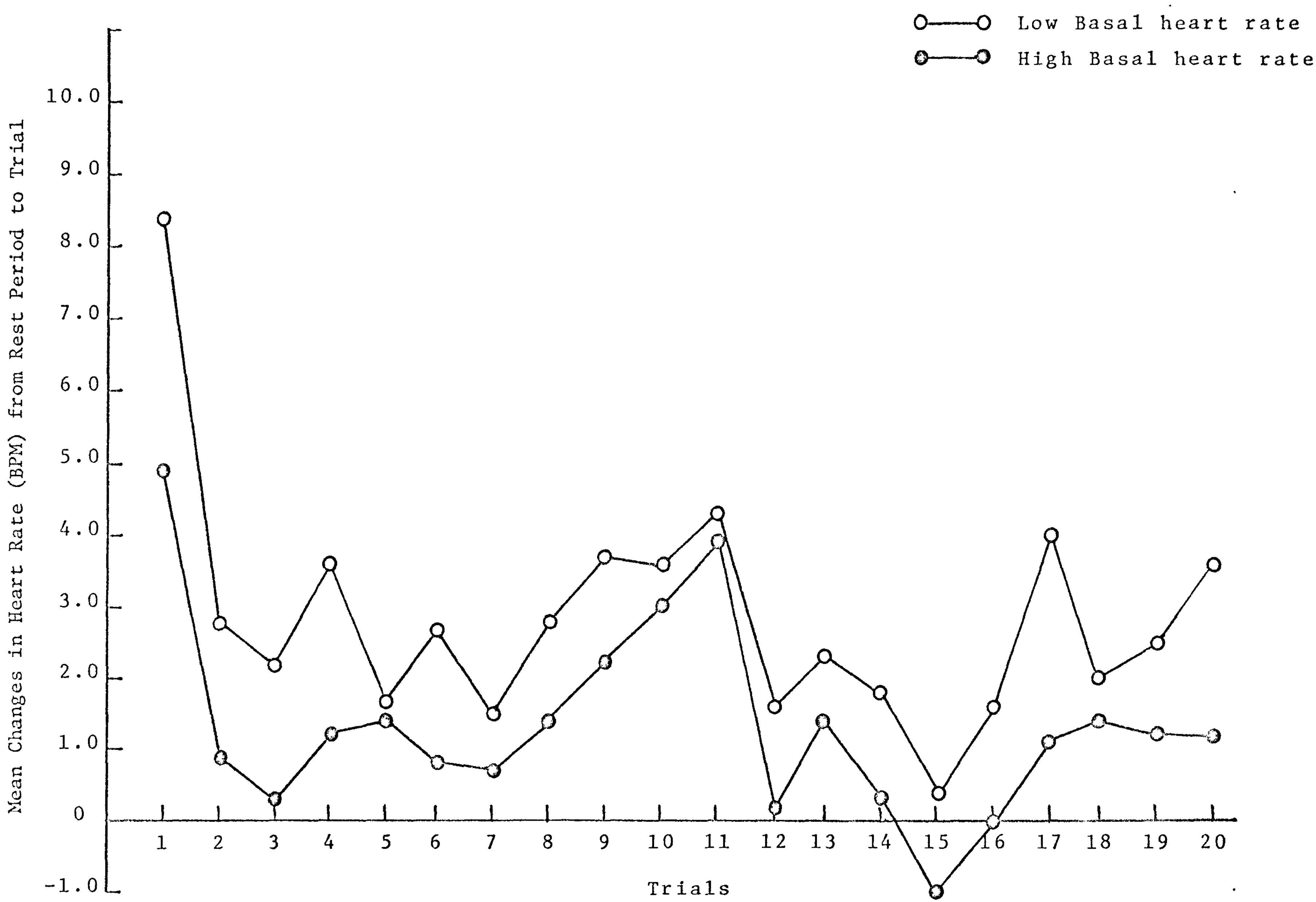

Figure 5. Mean heart rate change scores by trials for subjects with low and high basal heart rate.

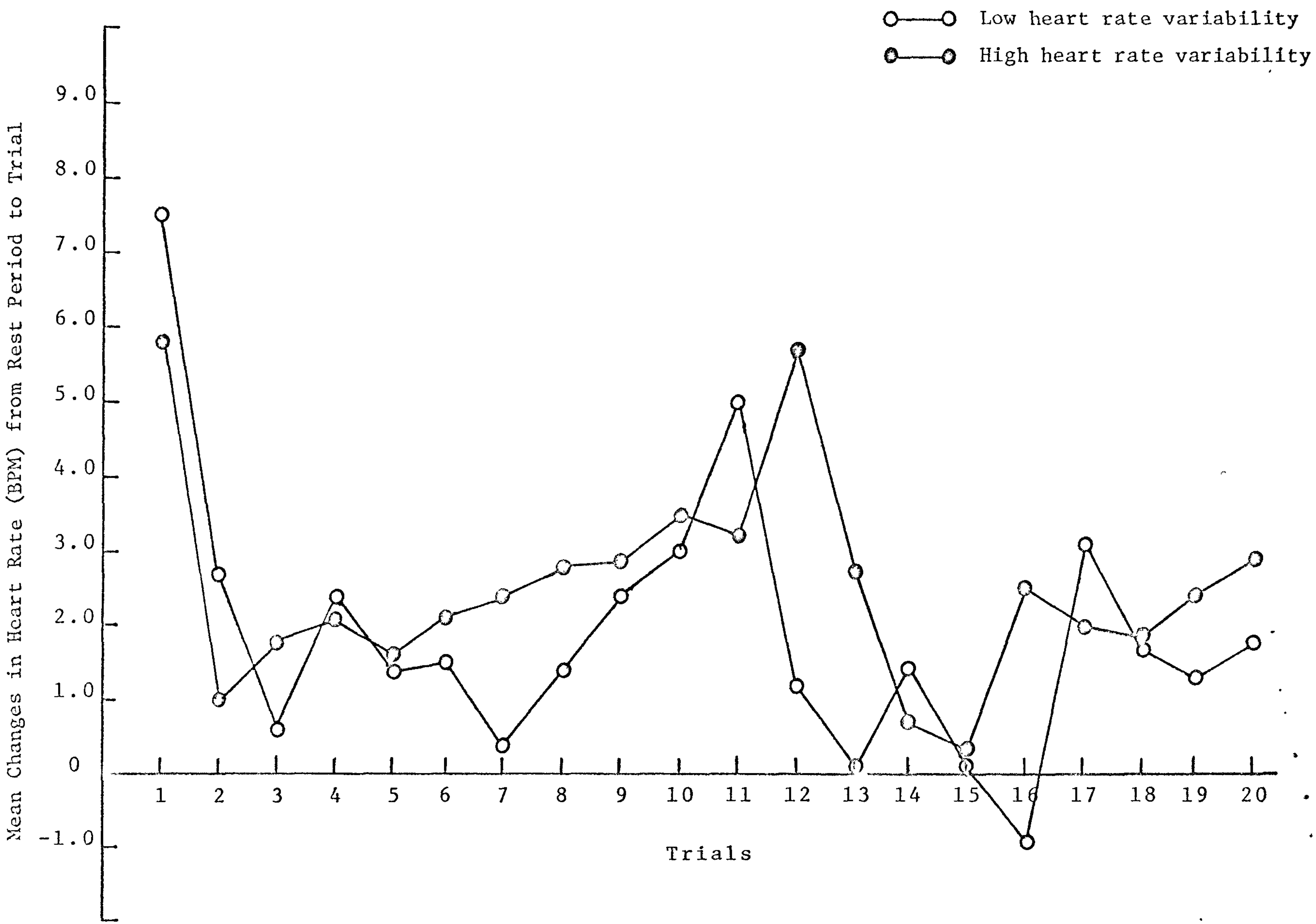

Figure 6. Mean heart rate change scores by trials for subjects with low and high heart rate variability.

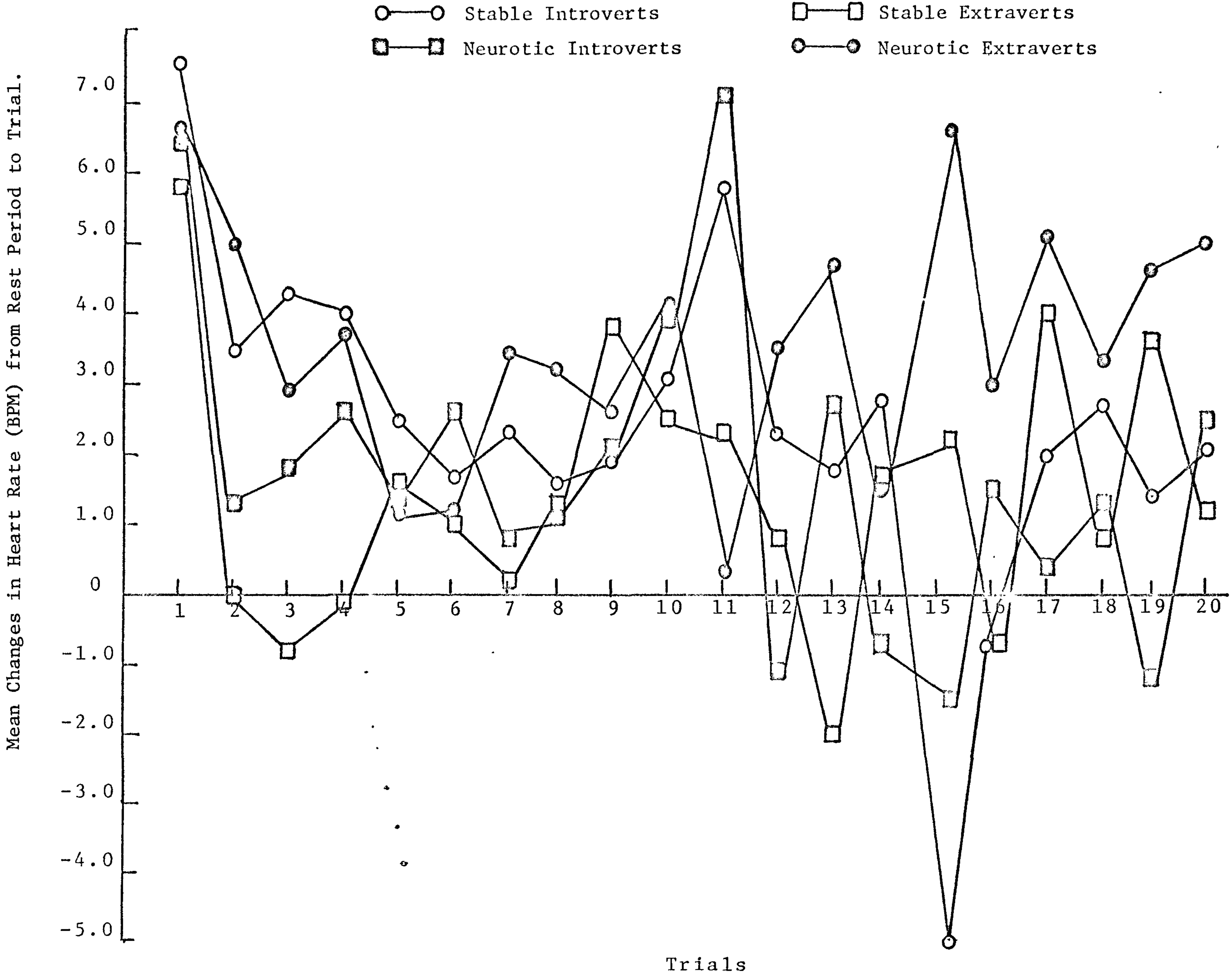

Figure 7. Meanheart rate change scores by trials for stable introverts, neurotic introverts, stable extraverts, and neurotic extraverts.

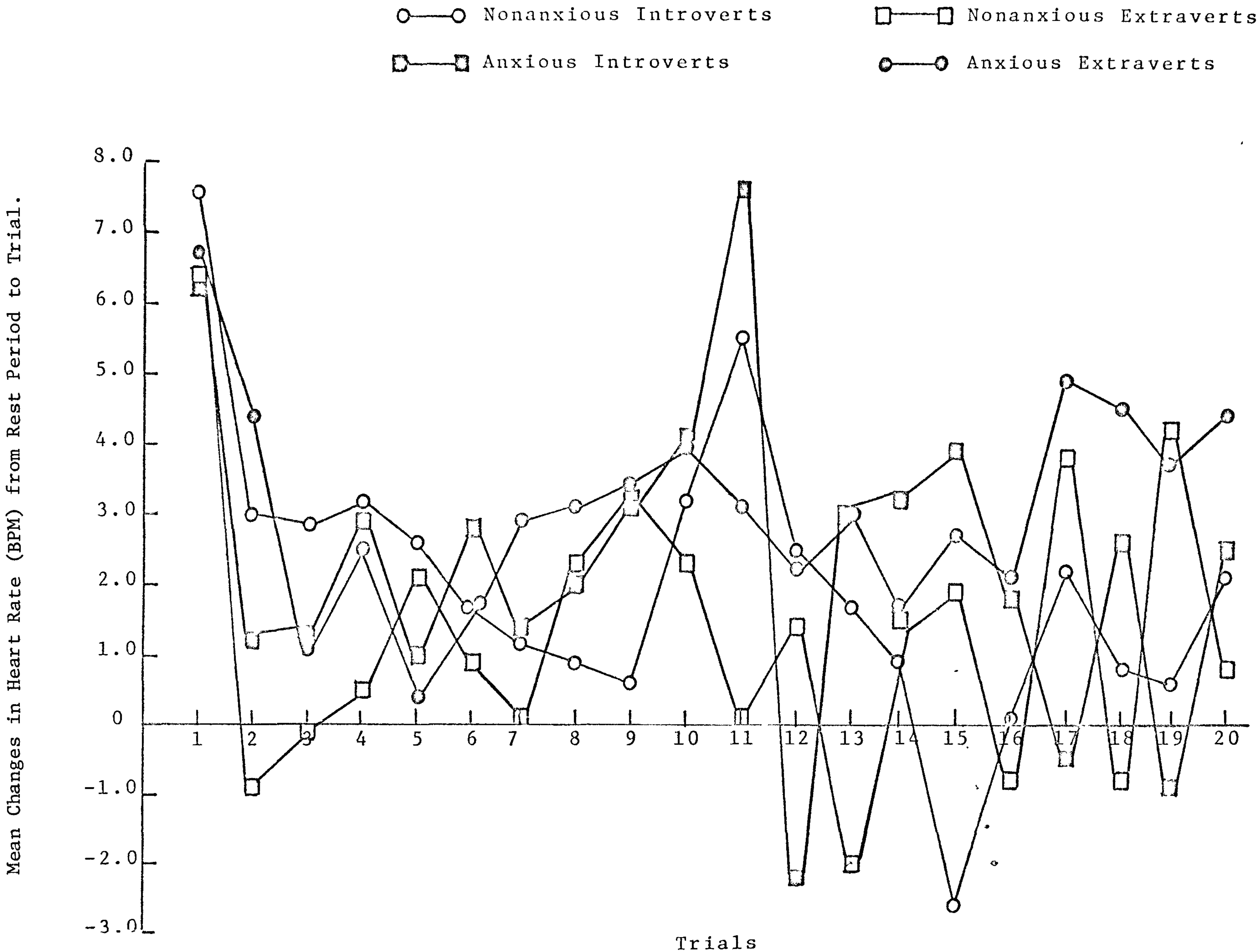

Figure 8. Mean heart rate scores by trials for nonanxious introverts, anxious introverts, nonanxious extraverts, and anxious extraverts.

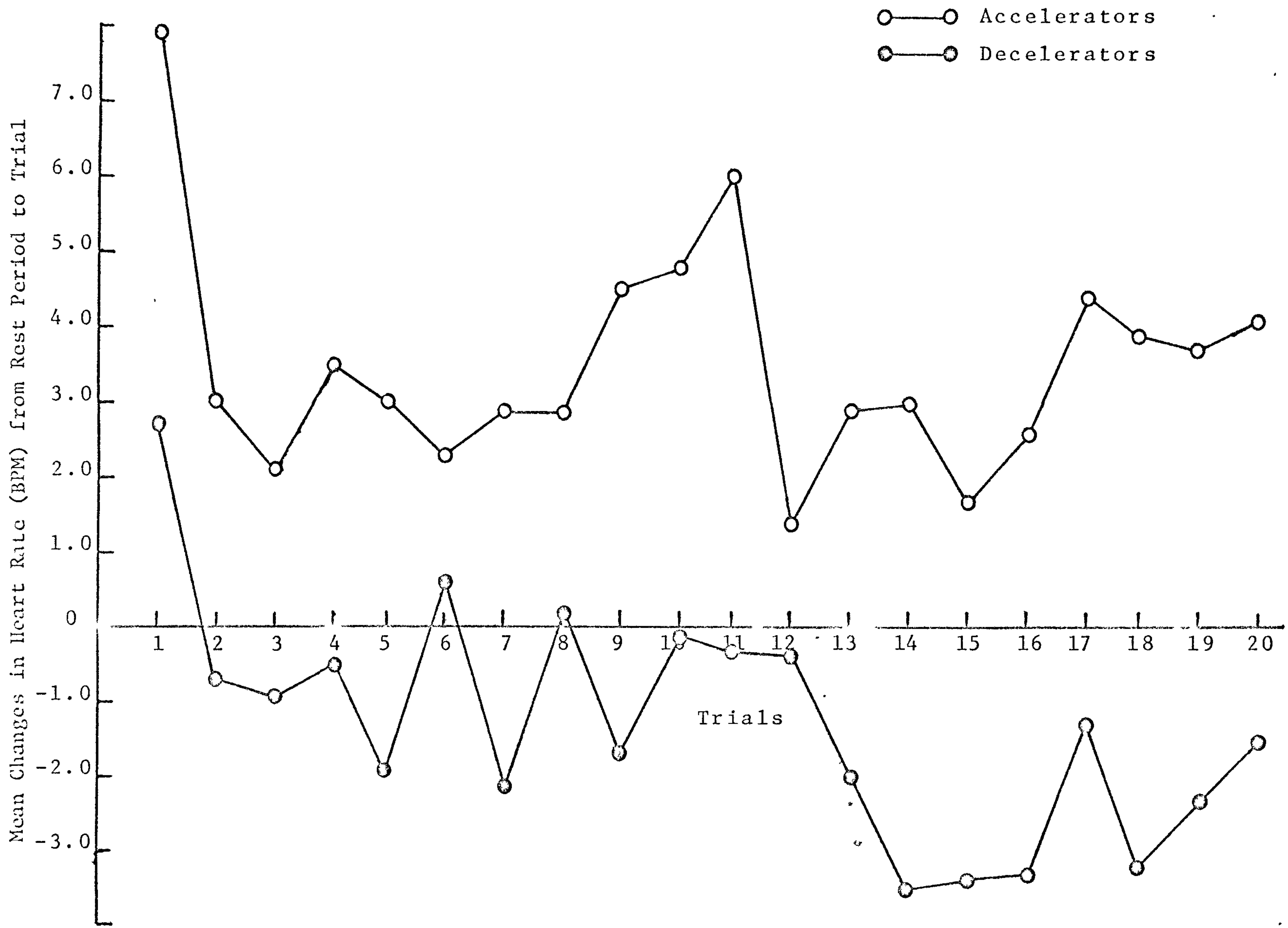

Figure 9. Mean heart rate change scores by trials for accelerators and decelerators.

APPENDIX H

MATRIX OF CORRELATION COEFFICIENTS

TABLE H1

THE INTERCORRELATION BETWEEN THE VARIABLES EXAMINED IN THIS STUDY

Variable	APQ	E	N	BHR	HRV	HRA
APQ	--	0.05	0.68*	-0.07	-0.17	-0.04
E		--	-0.13	-0.16	0.07	0.07
N			--	0.01	-0.12	0.02
BHR				--	-0.31*	-0.27
HRV					--	0.14
HRA						--

* $p < .05$

APPENDIX I

TABLES OF ANALYSES OF VARIANCE

TABLE 11

THE RESULTS OF THE ANALYSIS OF VARIANCE
OF GROUPS DIVIDED ON THE BASIS OF
APQ SCORES AS THEY AFFECT HEART RATE ACCELERATION
Low-Anxious (n=15), Middle-Anxious (n=16),
and High-Anxious (n=15) Subjects

Source of Variation	SS	df	MS	F
Between	1939.00	2	969.50	0.21
Within	198,595.20	42	4,728.50	
Total	200,534.00	44		

TABLE I2

THE RESULTS OF THE ANALYSIS OF VARIANCE OF GROUPS DIVIDED ON EXTRAVERSION SCORES AS THEY AFFECT HEART RATE ACCELERATION

Introverts (n=23) and Extraverts (n-23)

Source of Variation	SS	df	MS	F
Between	354.00	1	354.00	0.08
Within	202,292.00	44	4,598.00	
Total	202,646.00	45		

TABLE I3

THE RESULTS OF THE ANALYSIS OF VARIANCE

OF GROUPS DIVIDED ON THE BASIS OF

NEUROTICISM SCORES

AS THEY AFFECT HEART RATE ACCELERATION

Low Nueroticism (n=23) and High Neuroticism (n=23) Subjects

Source of Variation	SS	df	MS	F
Between	737.00	1	737.00	0.16
Within	201,909.00	44	4,589.00	
Total	202,646.00	45		

TABLE I4

THE RESULTS OF THE ANALYSIS OF VARIANCE
OF GROUPS DIVIDED ON THE BASIS OF
BASAL HEART RATE SCORES AS THEY AFFECT HEART RATE ACCELERATION
Low Basal Heart Rate (n=23) and
High Basal Heart Rate (n=23) Subjects

Source of Variation	SS	df	MS	F
Between	8,576.00	1	8,576.00	1.9
Within	194,070.00	44	4,411.00	
Total	202,646.00	45		

TABLE I5

THE RESULTS OF THE ANALYSIS OF VARIANCE OF GROUPS DIVIDED ON THE BASIS OF HEART RATE VARIABILITY SCORES AS THEY AFFECT HEART RATE ACCELERATION

Low Heart Rate Variability (n=23) and

High Heart Rate Variability (n=23) Subjects

Source of Variation	SS	df	MS	F
Between	869.00	1	869.00	0.19
Within	201,777.00	44	4,586.00	
Total	202,646.00	45		

TABLE I6

THE RESULTS OF THE ANALYSIS OF VARIANCE OF GROUPS DIVIDED ON THE BASIS OF EXTRAVERSION AND NEUROTICISM SCORES AS THEY AFFECT HEART RATE ACCELERATION

Stable Introverts (n=8), Neurotic Introverts (n=15), Stable Extraverts (n=15), and Neurotic Extraverts (n=8)

Source of Variation	SS	df	MS	F
Neuroticism	1,133.58	1	1,133.58	0.24
Extraversion	760.41	1	760.41	0.16
Neuroticism x Extraversion	6,287.09	1	6,287.09	1.35
Within	195,161.11	42	4,646.69	

TABLE 17

THE RESULTS OF THE ANALYSIS OF VARIANCE OF GROUPS DIVIDED ON THE BASIS OF EXTRAVERSION AND APQ SCORES AS THEY AFFECT HEART RATE ACCELERATION

Nonanxious Introverts (n=11), Anxious Introverts (n=12), Nonanxious Extraverts (n= 12), and Anxious Extraverts (n= 11)

Source of Variation	SS	df	MS	F
APQ	3,053.00	1	3,053.00	0.66
Extraversion	450.30	1	450.30	0.10
APQ x Extra-version	3,689.72	1	3,689.72	0.79
Within	195,485.03	42	4,654.4	

TABLE I8

ANALYSIS OF VARIANCE OF HEART RATE ACCELERATION SCORES

Accelerators (n=32) and Decelerators (n=14)

Source of Variation	SS	df	MS	F
Between	88,230.54	1	88,230.54	33.93*
Within	114,415.98	44	2,600.36	
Total	202,646.52	45		

* $p < .05$

APPENDIX J

RAW SCORES

TABLE J1

Raw Scores

Subject Number	Autonomic Perception Questionnaire	Extra-version	Neuro-ticism	Basal Heart Rate	Heart Rate Variability	Heart Rate Accelera-tion
15	148	12	20	81.3	6.1	-33.1
17	112	16	7	65.9	6.3	19.6
19	83	11	7	72.7	12.6	7.6
20	120	14	10	71.3	14.1	181.6
21	97	11	9	75.0	16.3	209.9
27	135	16	8	81.9	12.6	21.3
28	160	15	9	48.8	9.5	9.4
30	95	7	8	57.2	19.1	-2.3
31	146	7	15	71.9	10.9	86.5
33	139	17	13	88.1	7.7	-23.1
34	116	11	10	73.6	5.1	-58.2
35	98	16	7	68.5	9.8	132.4
36	109	10	8	65.5	7.6	88.3
37	143	13	11	58.0	14.2	-1.7
38	155	16	6	78.8	7.0	32.1
39	154	15	12	55.5	10.5	158.5
40	93	15	1	64.8	12.0	-19.4
42	118	5	11	73.5	6.4	103.3
43	105	16	8	65.2	15.7	94.5
46	157	12	15	90.9	7.0	-4.0

Raw Scores

Subject Number	Autonomic Perception Questionnaire	Extra-version	Neuro-ticism	Basal Heart Rate	Heart Rate Variability	Heart Rate Accelera-tion
49	174	9	18	63.1	16.3	-50.5
50	74	15	7	58.2	6.6	44.7
54	78	17	6	83.2	17.7	-64.3
58	107	9	10	75.2	9.5	-4.3
59	110	9	8	82.2	11.3	-54.5
61	133	14	11	59.1	6.1	64.4
62	153	14	13	58.5	13.6	4.6
63	104	10	5	65.5	9.1	92.6
66	74	16	5	53.4	19.5	64.1
72	110	16	8	78.1	6.9	7.5
74	98	16	7	80.1	12.1	-8.4
76	83	5	11	90.1	5.8	34.4
80	57	13	1	75.1	11.9	42.5
81	103	6	14	67.9	11.6	78.7
84	134	19	12	71.3	7.6	-12.6
85	102	19	12	60.5	11.3	2.1
86	129	10	13	60.8	13.9	-10.4
87	118	14	10	57.5	8.3	86.9
88	157	14	12	83.2	11.0	62.6
90	140	18	18	62.0	11.1	183.3
91	119	20	11	57.2	17.3	173.9
94	137	15	13	61.9	10.4	18.0
95	78	15	8	68.8	9.7	39.1
97	153	15	19	65.9	9.2	35.5
98	89	16	9	80.3	8.7	21.8
99	117	12	15	69.1	13.7	51.4
Mean	117.6956	13.2826	10.2390	2.1522	69.4912	41.4412
Standard Deviation	27.9840	3.7337	4.1483	1.2287	10.3604	67.1062