CARDIOVASCULAR PERCEPTION AND VOLUNTARY CONTROL OF HEART RATE

A. E. PUENTE, L. S. CLARK, AND I. H. BEIMAN
University of Georgia

Summary.—From 519 participants administered the cardiovascular functioning items of the Autonomic Perception Questionnaire, 42 were chosen and divided into groups low, middle, or high in perception based on the total score. Each participant was given six 2-min. trials during which they were to raise or lower heart rate. The short version of the questionnaire did not predict ability to control heart rate. However, the three groups were able to increase and decrease heart rate on command.

The control of cardiovascular activity using nonpharmacological intervention has become of increasing importance to psychologists. Blanchard, Young, and McLeod (1972) attempted to account for the large intersubject variability in the ability to control heart rate by using pretest measures of heart-rate perception as measured by the five cardiovascular function items on Mandler, Mandler, and Uviller's (1958) Autonomic Perception Questionnaire. In a feedback paradigm, high perceivers were not able to alter heart rate, while low perceivers increased and decreased heart rate on command. More recently, McFarland (1975) in a more elaborate experiment reported no significant correlation between the short version of the questionnaire and heart-rate control in a feedback and reinforcement paradigm.

Although the short version does not seem to predict consistently control of heart rate in a feedback and reinforcement paradigm, Bergman and Johnson (1971) reported that individuals scoring midrange on the 29-item questionnaire were more effective in controlling heart rate in an instructional control paradigm than either high or low scorers.

The present study examined whether the short version of the questionnaire would predict ability to control heart rate in a non-feedback or reinforcement paradigm.

METHOD

Subjects

The short version of the questionnaire, i.e., five cardiovascular function items, was administered to 519 undergraduate psychology students 2 wk. prior to experimentation. Three groups of 14 participants (7 males and 7 females) were formed on the basis of the total score of these items (5 to 35). Parts...
participants scoring less than 11 formed the pool for the low group, those scoring between 19 and 21 formed the pool for the middle group, while the high group was selected from those scoring above 29.

Each participant was seated in a reclining easy chair, which was housed in an air-conditioned, sound-attenuated, and electrically shielded chamber. Respiration was transduced by a small nasal thermistor, while heart beats were obtained by a small Model PTTI digital photoplethysmograph placed on the left index finger. Both signals were recorded on a Grass Model 7 polygraph. Number of heart beats was quantified by 15-sec. intervals by an experienced technician.

Procedure

Prior to experimentation, each participant was told: "... in this study we are interested in cardiovascular activity. Specifically we are attempting to develop a heart-rate feedback model in which the questionnaire which you filled out in group testing should help to predict one's ability to control heart rate with the help of feedback. In this situation, however, you will not be receiving feedback, but you will be asked to attempt to influence your cardiovascular activity using any strategy you think will help you. As the transducers are extremely sensitive, it is imperative that you remain comfortable, but still, during the recording session. You will not be stressed, shocked, or otherwise discomfor ted in any way." After answering any questions, the experimenter connected the transducers while explaining their function. The experimenter left the chamber after giving the participant two sheets of typed instructions. Prior to the beginning of each phase, the experimenter read the appropriate instructions over the intercom while the participant read them silently.

The first phase of the experiment began with a 15-min. adaptation period, the last minute of which was recorded as the initial baseline. In the second phase were six 2-min. experimental trials (3 increase and 3 decrease, in random order), during which the participant was asked to either increase or decrease heart rate. Experimental trials were divided into eight 15-sec. intervals and were separated by 1-min. rests. The last 15-sec. of the rests served as baseline for the following trial.

Results and Discussion

Means and standard deviations of increases and decreases in heart rate by intervals appear in Table 1. The data indicate that scores on the short version of the questionnaire are not associated with ability to control heart rate. However, they show that, when participants were instructed to raise heart rate, the increase heart rate. Experimental trials were divided into eight 15-sec. intervals. Thus, a group X sex X interval analysis of variance was performed on heart rate recorded during the same trials. The four-way analysis of variance showed no group effects but there was a significant effect of instruction (F = 18.89, p < .01). This was qualified by an interaction of instruction X interval (F = 1.72, p < .01). The means for the main effect of instruction, 19.70 (SD = 2.01) and 18.49 (SD = 2.76), respectively, suggest differential responding to instructions. The means for interaction are presented in Table 1. The three-way analysis of variance performed on respiration rate showed instruction was significant (F = 3.10, p < .01). The means for this effect, 36.28 (SD = 11.65) and 24.64 (SD = 7.66), respectively, suggest that participants increased respiration in attempting to increase heart rate while they decreased respiration rate in attempting to decrease heart rate.

These results do not support the findings of Bergman and Johnson (1972). However, their participants were grouped by score from the 29-item questionnaire. Not only was heart-rate perception recorded but so was perception of other physiological indices. Also, Bergman and Johnson assigned participants to groups by third of the total range of scores on the questionnaire. We optimized the chance to demonstrate significant effects by choosing three groups separated by a minimum of 6 points in total score for the five cardiovascular items. Finally, the control manifested by participants in Bergman and Johnson's study was over six interbeat intervals. In the present study, the 2-min. trials enabled us to observe the trend of the eight 15-sec. intervals.

These findings suggest that voluntary control of heart rate is mediated by

TABLE 1

<table>
<thead>
<tr>
<th>Interval</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>σ</td>
<td>2.72</td>
<td>3.03</td>
<td>3.04</td>
<td>3.05</td>
<td>3.24</td>
<td>3.11</td>
<td>3.08</td>
<td>3.06</td>
</tr>
<tr>
<td>Decrease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>18.44</td>
<td>18.34</td>
<td>18.46</td>
<td>18.47</td>
<td>18.48</td>
<td>18.66</td>
<td>18.54</td>
<td>18.50</td>
</tr>
<tr>
<td>σ</td>
<td>2.75</td>
<td>2.85</td>
<td>2.70</td>
<td>2.80</td>
<td>2.88</td>
<td>2.82</td>
<td>2.77</td>
<td>2.72</td>
</tr>
</tbody>
</table>
some mechanism other than perception of interoceptive cardiovascular cues as measured by the five items of the questionnaire. The results, however, support the idea that heart rate can be altered in the absence of feedback and reinforcement. Participants increased and decreased heart rate on command without external cues or any type of reinforcement. Although one may extrapolate from the results that these heart-rate changes were mediated by respiration, Engel and Chism (1967) have reported that large changes in RR sustained for 10-min. periods do not produce changes in heart rate. Considering that each of the six experimental trials was 2 min. long and that they were separated by 1-min. rests, it seems unlikely that respiration rate (RR) could have mediated the observed heart-rate changes. Furthermore, while respiration has often been controlled in experiments of this kind to reduce the presumed mediational effects, this restriction introduces a great deal of unnaturalness into the experimental situation.

REFERENCES


MCFARLAND, R. Heart rate perception and heart rate control. Psychophysiology, 1975, 12, 402-405.

Accepted April 10, 1980.