OXYGEN CONSUMPTION AND OTHER PSYCHOPHYSIOLOGICAL VARIABLES DURING AN ACTIVE COPING TASK

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Received: 14/04/92; Revised: 21/01/93; Accepted: 28/02/93

ABSTRACT: In an attempt to observe the energy demands during the performance of a mental task, whole body oxygen consumption was measured while subjects solved a series of abstract reasoning problems of different levels of difficulty. Simultaneously, cardiovascular activity and peripheral temperature were recorded. The measurement of oxygen consumption failed to indicate any changes in energy requirements related to information processing; but when subjects were classified according to their oxygen consumption during the initial rest period, a positive correlation between changes in oxygen consumption and performance with the most difficult tasks was observed. Thus, correlations between body oxygen consumption and cognitive work can be appreciated only with very high levels of task difficulty, and when variations due to "stress" are normalized. Almost all cardiovascular measurements were sensitive to the experimental task, although none responded differently when the level of difficulty varied. Heart Rate Variability (HRV) showed the most regular and significant pattern of change. Some specific patterns of physiological reactivity emerged in relation to personality and emotional characteristics of the subjects and to the level of cognitive demand. Of special interest is the opposite correlation found between oxygen consumption, and neuroticism and extroversion with tasks of medium difficulty. Key words: oxygen consumption, cardiovascular activity, abstract reasoning, information processing.

INTRODUCTION

The measurement of metabolic costs and specially, energy expenditure changes during the performance of tasks which involve information processing, problem solving and active coping has proved to be a productive line of research. Physiological variations produced by this type of tasks are usually evaluated through the measuring of cardiovascular, respiratory and skin conductance indicators, and many others. Now, the use of oxygen consumption as a direct indicator of energy requirements and as a predictor of performance during psychological tasks appears to be a promising evaluator of psychophysiological activity.

Most research results point to the fact that brain energy requirements increase with task complexity. Still, very little information exists concerning the energy demand changes from baseline to performance levels. Two recent studies report the use of oxygen consumption as a psychophysiological indicator focusing in the linkage between cardiovascular adjustments and metabolic requirements. In these studies it was found that there were significant increases in oxygen consumption, as well as in other psychophysiological indicators of activation, from baseline to task levels during a video-game and a mental arithmetic task. It was also found that the increase was less in the mental arithmetic, supposedly more difficult, than in the video-game. They also found that Heart Rate increases...
were much greater than could be predicted by the metabolic demands. This happened only with mental tasks but not during physical exercise where the increase in effort was accompanied by proportional increases in Heart Rate and oxygen consumption.

The main purpose of the present study was to investigate further the possible changes in oxygen consumption, various cardiovascular indicators and peripheral temperature during the processing of information using only one task with increasing levels of difficulty. This should help to extend the findings on energy requirements during mental tasks and about the relationship between metabolic and other psychophysiological indicators of activation.

It was hypothesized that there would be an increase in oxygen consumption from baseline to task level and that there would be variations in this indicator of energy demands depending on the difficulty level of the task.

Various measurements of peripheral cardiovascular activity were included in order to inquire further about the specificity of the cardiovascular response in active coping tasks. Furthermore, this would allow us to examine better specific relationships between cardiovascular and metabolic indicators of mental activity.

The associations between physiological, performance and subjective variables is also an important objective of this investigation aiming to extend the findings of other studies and others interested in the correlations between the three levels of response, behavioural, subjective and physiological. Questionnaires of Self-control, Anxiety and personality were included and it was expected that some specific patterns of physiological response would emerge in relation to cognitive and behavioural coping strategies.

METHODS

SUBJECTS

The subjects were 30 undergraduate male students between the ages of 19 and 25 years from the Simón Bolívar University. They received course credits for participation. None suffered from any cardiovascular or respiratory disorder or from visual impairments according to a preliminary questionnaire.

APPARATUS

Oxygen consumption ($O_2$) and Respiratory Rate (RR) were monitored using a McKesson Metabolor model 185 connected to a Yokogawa register. Subjects were fitted with an Ambu 5 mask which covered mouth and nose and was held in place with an elastic four-point head-strap sealing it around the face. Subjects breathed medically pure Oxygen through the mask. The exhaled CO2 was absorbed using Barium Hydroxide. The reduction of oxygen volume in the metabolor under constant pressure and temperature was registered. Inhalation and exhalation waves were automatically recorded on paper following the temporal changes in oxygen volume of the Metabolor. Peripheral Heart Rate (HR) and Peripheral Temperature (T) were recorded on a Grass Polygraph model 79D using an EKG-pulse preamplifier model 7P8E and a Low Level DC Pre-Amplifier model 7P122B respectively. A photoelectric plethysmograph (Grass model PTTL-6) was attached to the subjects index finger of the left hand providing a record of the pulsating blood flow. In addition, Heart Period was monitored and automatically converted to a beat-by-beat record using a Tacograph Pre-Amplifier model 7P122B connected to the plethysmograph. This provided an instantaneous and continuous recording of the direction and magnitude of HR variations (HRV).

For the measurement of local body temperature a thermocouple was attached to the middle finger of the left hand. It was recorded in degrees centigrade.

Presentation of the visual stimuli for the experimental task was automatically controlled by an Apple II Plus microprocessor connected to an 18 inches RCA Monitor (model XL100), to a Kodak slide-projector and to an answering keyboard. The stimuli were presented through the projector and instructions through the monitor placed at 1.5 meters in front of the subject. They responded by pressing one of three keys on the keyboard placed on the right arm of the chair.

ABSTRACT REASONING TASK

The items from the Raven Standard Progressive Matrices were used. They were categorized in three difficulty levels for the University population in a preliminary study were 60 students completed the test. Items answered correctly by 90% to 100% of the students were classified as "easy"; items answered by 60% to 89% were classified as "medium difficulty" and items answered by less than 60% of the students were classified as "difficult". The rationale behind this categorization was to observe the possible gradual changes in physiological variables with increasing level of difficulty in one task in this population.

Each trial started with the presentation of one item of the Raven on the slide projector in front of the Subject. Subjects were instructed to press the first key on the keyboard as soon as they had found the answer. Immediately after, a selection of responses (numbers 1 to 8) appeared on the monitor screen situated below the projection. When pressing the first key the cursor would move left and when pressing the second key the cursor would move right. Once the subject had chosen the number he had elected as corresponding to the right answer he had to press the third key which accepted the selected response number. Immediately after, the next slide was presented starting another trial. Maximum exposure time for each slide was 45 seconds. If the subject had not answered within this time, the next slide would appear and this would be computed as a wrong answer. Key pressing required a minimal motor activity.

The experimental session consisted of four blocks which started after a baseline period. Each block was formed by a task period (TP) where subjects responded to items of the
Raven Test, and by a rest period (RP) immediately after, when they rested for two minutes with their eyes closed. The first one was an adaptation block (BL-A) where items of various levels of difficulty were included. The task periods in the other three blocks where graded according to level of difficulty (TP-1;TP-2 and TP-3), and they consisted of 21, 19 and 13 trials respectively. The Performance measures registered were time to respond (TR) for each trial and average time, number and percentage of correct responses per TP (% CR).

PROCEDURE

On arrival at the laboratory for the experimental session, subjects filled a form with their personal data and answered questions about cardiovascular, respiratory disorders or sight problems. Subjects also provided information on cigarette consumption and exercises habits. After this, they filled in a series of questionnaires. These included the State-Trait Anxiety Inventory20 (STAI); Self-Control Inventory19 (Selfcon); Eysenck Personality Inventory5 (EPI); Fear of Negative Evaluation Questionnaire24 (F.E.); Individual Excitability Test7 (Ind.Ex.); and the Fears Inventory6 (Fr). Then they were then moved to a small chamber adjacent to the instrumentation area and, after being seated in a heavily-padded recliner in the upright position, they were allowed to familiarize with the laboratory environment while receiving explanations about electrodes attachment and the oxygen mask. They had a few minutes practice breathing through the mask (only one subject had problems in doing so and he did not continue with the experiment). None of them had taken part in an experiment of this sort before. Subjects were then told that following the placement of the recording devices they would rest for a few minutes under dimmed light with their eyes closed and as still as possible. They all received brief relaxation instructions. The initial rest period lasted for 6 minutes. After this, instructions were presented on the monitor.

After each RP the mask was removed, subjective measurements were taken, performance scores were printed and oxygen was refilled in the Metabolor. Subjective ratings of anxiety (Anx) were recorded as follows: at the end of the baseline and of the RPs subjects had to answer verbally to an anxiety thermometer (0= no anxiety at all to 10= maximum anxiety) to rate their anxiety both, during the TPs and during the two-minute RPs. Also, subjects rated the perceived level of difficulty of each TP using a three-point scale (1=easy; 2=medium, 3=difficult). The session lasted for about an hour.

PHYSIOLOGICAL DATA REDUCTION

Nine mean values were obtained for each physiological variable corresponding to the baseline phase and to the eight measuring periods, namely TP-A, RP-A, TP-1, RP-1, TP-2, RP-2, TP-3, RP-3.

All cardiovascular and respiratory measurements were hand scored over the same periods on the poligraphic records. For the baseline measurement, the last minute of the initial rest period was scored. During the TPs the second minute was considered and during the RPs the first minute just after the TP finished was analyzed.

To obtain Heart Rate (HR), R waves in the photo-plethysmographic record were simply counted over each selected period. For the converted Inter-beat-Intervals (IBI), the maximum and minimum beats were determined over the same periods, (IBImax and IBImin).

Oxygen consumption and respiratory rate were determined graphically, the first in cycles per minute (cpm) and the second by converting the graphic score to ml per minute (mlpm). RR was scored by counting the respiratory cycles in the same periods. The amplitude (Amp) of the respiratory wave was determined using a three-point scale.

As temperature may take more time to show variations, it was scored at the very last moment in both, task and rest periods.

Statistical analysis used were a Pearson correlation and ANOVA for dependent variables using the SPSS statistical package.

RESULTS

SUBJECTIVE AND PERFORMANCE VARIABLES

The level of anxiety reported by the subjects at the end of the baseline and after each task and rest period are presented in Fig. 1a. They were significantly different as measured by a one-way ANOVA (F = 34.21; p < 0.001). Also, a significant increase in verbal reports of difficulty appreciation were observed from one level to the next (F=16.52 p<0.001, Fig.1b). Mean performance scores, that is time of processing and number of correct responses were also significantly different for the three blocks of task (F=4.22 p<0.05 and F=5.20 p<0.025, respectively, Fig.2).

PHYSIOLOGICAL VARIABLES

A one-way ANOVA showed significant main effects of baseline and TP and RP for HR, HRmin and RR (F=4.63, p<0.05 ; F=6.48; p<0.01; F=23.25 p < 0.001, respectively, Figs. 3, 4, 5). No significant differences were found for Ox or T between task and rest. Nevertheless, changes occurring in T are worth observing. In Fig.6 it can be seen that there was an important decrease in T from baseline to all rest and task periods. A significant difference was found between the baseline and TP-A values (t=2.61 p<0.01).

CORRELATIONS BETWEEN PHYSIOLOGICAL VARIABLES

Pearson correlations were determined between physiological values and it was observed that they varied markedly in the three blocks of task, being HRV the variable showing more associations with other physiological indicators (Table I). During baseline, only one significant correlation was found, between respiration amplitude and RR. In TP-1 and
Oxygen consumption during an active coping task

(a) ANX (1-10)
(b) DIFF. (1-3)

Figure 1: Mean ratings of Anxiety (a) and Difficulty (b) during various test periods

TABLE I
Correlations between physiological variables (Pearson correlation coefficients)

<table>
<thead>
<tr>
<th>Test Period</th>
<th>Variable</th>
<th>r</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP-1</td>
<td>HR</td>
<td>0.40</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td></td>
<td>Ox</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HR</td>
<td>-0.42</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>-0.50</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>HRVupp</td>
<td>-0.55</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>HRVtot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP-2</td>
<td>RR</td>
<td>-0.49</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>HRVupp</td>
<td>-0.53</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>HRVlow</td>
<td>-0.61</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>HRVtot</td>
<td>-0.47</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>TP-3</td>
<td>RR</td>
<td>-0.47</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>HRVtot</td>
<td>0.59</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ox</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TP-2, a number of associations start to emerge which tend to disappear in the most difficult level, TP-3.

Oxygen consumption correlated with HR in TP-1, with respiration amplitude in TP-2 and with T in TP-3.

No significant correlations were found between physiological reactivity values (Block minus baseline values).

CORRELATIONS BETWEEN PHYSIOLOGICAL REACTIVITY, SUBJECTIVE AND PERFORMANCE VARIABLES

These correlations are shown in Table II. Subjective anxiety reported at the end of each level of task correlated significantly with temperature reactivity. This association was not found for absolute values during baseline or tasks. No other correlations were found between anxiety and other measures of physiological reactivity or between perception of difficulty and physiological reactivity in any of the three blocks of task.

With respect to performance variables, a significant correlation was found between oxygen consumption change from baseline to TP-3, and percentage of correct responses in that level (Table II)

To examine further this last finding, subjects were separated in two groups according to the amount of oxygen consumed during baseline. It was found that those subjects consuming more than 333 mlpm during the initial baseline period, had a better performance i.e. higher number of correct responses, in TP-3 (52.30 % CR) than those consuming less than 233 mlpm (32.16 % CR). This difference was significant (t=2.6; p<0.05).
PSYCHOLOGICAL TEST SCORES AND PHYSIOLOGICAL VARIABLES AS PREDICTORS OF PERFORMANCE

Correlations between scores in each psychological questionnaire and physiological reactivity indicators are shown in Table III. These varied markedly from one PT to another. The Individual Excitability Test correlated significantly with several physiological measures only in TP-3 with maximum difficulty, whereas the STAI showed a greater number of correlations in TP-1 and TP-2, that is in the easy and medium difficulty periods. The Self-Control questionnaire was highly associated with cardiovascular activity in TP-1. Oxygen consumption, on the other hand, showed a positive correlation with EPI-N and a negative correlation with EPI-E in PT-1 and PT-2 differentiating in this way the two personality dimensions only when the level of difficulty was not high.
Oxygen consumption during an active coping task

TABLE III
Correlations between physiological reactivity and psychological characteristics (p<0.01 for all cases; Pearson correlations coefficient)

<table>
<thead>
<tr>
<th>Psychological test</th>
<th>Physiological variable</th>
<th>RP</th>
<th>TP-1</th>
<th>TP-2</th>
<th>TP-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selfacon</td>
<td>HR</td>
<td>0.66</td>
<td>-0.64</td>
<td>-0.52</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HRV upp</td>
<td>-0.55</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>HRV low</td>
<td>0.73</td>
<td>-0.55</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>HRV tot</td>
<td>-0.60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IBImax</td>
<td>-0.68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IBImin</td>
<td>-0.60</td>
<td>-0.55</td>
<td>-0.66</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RR</td>
<td>0.54</td>
<td>-0.52</td>
<td>-0.57</td>
<td></td>
</tr>
<tr>
<td>STAI-S</td>
<td>HRV tot</td>
<td>0.54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T</td>
<td></td>
<td>0.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STAI-tot</td>
<td>HR</td>
<td>0.56</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>EPI-N</td>
<td>IBImax</td>
<td>0.54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HR</td>
<td>0.63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ox</td>
<td>-0.54</td>
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<td>0.54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>-0.59</td>
<td></td>
<td></td>
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<tr>
<td>EPI-E</td>
<td>HR</td>
<td>-0.69</td>
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<tr>
<td></td>
<td>IBImax</td>
<td>-0.68</td>
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<tr>
<td></td>
<td>Ox</td>
<td>-0.57</td>
<td>-0.53</td>
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</tr>
<tr>
<td>FE</td>
<td>HR</td>
<td>0.51</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HRV upp</td>
<td>0.50</td>
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<td></td>
<td>IBImax</td>
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<tr>
<td>Ind. Ex. (co)</td>
<td>HR</td>
<td>0.58</td>
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<td>0.66</td>
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<td>Ind. Ex. (phys)</td>
<td>T</td>
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<td>0.63</td>
<td>0.61</td>
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<td>Ind. Ex. (mot)</td>
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<td>Ind. Ex. (tot)</td>
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<tr>
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<td>HRV upp</td>
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<td>0.70</td>
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<td></td>
<td>IBImax</td>
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<td>0.75</td>
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</table>

DISCUSSION

The nonverbal reasoning task had the effect of producing an activation on most of the cardiovascular variables recorded. There was a significant increase in all cardiovascular measurements from baseline when subjects were performing the task at any of its three increasing levels of difficulty. Therefore, this task is confirmed as an effective active coping task specifically with respect to cardiovascular activation in this university students sample.

OXYGEN CONSUMPTION

The amount of oxygen consumed failed to discriminate between periods of task and rest. Our main hypothesis was not, therefore, supported by the results obtained. We expected an increase in oxygen consumption parallel to the activation of the cardiovascular system, but this was not observed. Turner and Carroll\(^ {22} \), found a disproportionate increase in HR with respect to the oxygen consumed during a mental task. In our study, the results showed that there can also be an increase in the cardiovascular measures which is not accompanied by major changes in oxygen consumption, even during a task with a high level of difficulty.

Although oxygen consumption had not shown an important discriminating value with respect to differences between task and rest periods, it was very interesting to observe that it emerged as a good predictor of performance when task difficulty was maximal. In Table II it can be observed that the number of correct responses is associated with changes in amount of oxygen consumed from baseline to TP-3. In other words, those subjects with a greater oxygen consumption during the initial rest period or base-line and with a greater capacity to vary the amount of oxygen they used, performed better and this was made evident only in the most difficult level of the task. It seems plausible to consider that the relationships between metabolic requirements and performance during active coping tasks becomes evident only when task difficulty reaches very high levels.

Thus, a lack of a direct correlation between oxygen consumption and task performance is very probably due to variable levels of "stress" among subjects. Stress activates cardiovascular activity and muscular tone among other features, and thus has a strong effect over body oxygen consumption. Effects of mental work on oxygen consumption can only be detected if the consumption due to stress is normalized. Thus, when we selected subjects according to oxygen consumption levels of the pre-test period, significant correlations with very difficult tasks appeared.

CARDIOVASCULAR VARIABLES

When observing each cardiovascular variable separately to evaluate any specificity of response within this system, it was found that, when HRup, HRlo and HR are compared, HRlo (that is, the lowest IBI during a certain period of time), showed the most consistent and regular pattern of change between task and rest (Fig. 3). Besides, this measure was the most sensitive of the three to the experimental manipulation. This could be interpreted as the result of parasympathetic influence on cardiovascular activity since the variations between task and rest were most clearly observed in the low levels of HR (HRlo).

TEMPERATURE

The changes observed in T throughout the experimental session are of considerable interest. First, there was an important decrease in T from baseline to the adaptation level which would seem a reasonable indicator of anxiety increases. Now, one would have expected a decrease tendency in T as difficulty level and anxiety increased but in fact, a gradual increase throughout the session was observed. This tonic change may have hidden phasic activity as a result of task presentation and we do not put aside the possibility that it was in fact a product of changes in environmental temperature\(^ {23} \). Actually, room temperature was registered and there were increases of about 2°C from beginning to end of the session. There remains the abrupt decrease in T from baseline to TP-A which may then be explained by the novelty of the task. Once the novelty effect was over, temperature was not sensible to the other task demands such as difficulty level and it just varied as a function of room temperature. Although there were significant differences
in the perceived anxiety ratings in the three task periods, the relationship between temperature reactivity and anxiety was comparable implying that even at low, medium or high levels of anxiety the external body temperature is sensitive to the subjective expressions of tension.

THE ADAPTATION LEVEL

The idea of presenting an adaptation level containing items with varying difficulty to control for the expectation effects on the upcoming task, did not seem to eliminate the effects of initial level of difficulty found by Linden et al.\textsuperscript{12} We expected to observe increases in physiological activation from TP-1 to TP-3 but no such differences were found. Cardiovascular measures varied similarly from baseline or rest to task in the three blocks independent of level of difficulty. It would be interesting to make variations on the experimental design to see whether the adaptation level would eliminate these effects when the three levels of difficulty are not presented progressively but at random. This would help to test the hypothesis that cardiovascular changes are affected by the anticipation of difficulty and that this effect is not removed by an adaptation period. This turns into a very interesting point when observing the ratings of difficulty given by subjects after each TP. Physiological changes would seem to be more dependent on the previous experience or expectations about the upcoming phase than on difficulty appreciation after each TP has finished.

PHYSIOLOGICAL REACTIVITY AND PSYCHOLOGICAL CHARACTERISTICS

With respect to the association between physiological reactivity and psychological characteristics, it was found that the Individual Excitability Test was a good indicator of physiological activation specially in the third level of difficulty. Although there was not a consistency in the correlations found and no specific response pattern emerges, this questionnaire seems to be a good predictor of the physiological activation of individuals when performing tasks which are perceived as difficult, whereas the other questionnaires used were not related at all with the physiological response in this last period of the task.

Conversely the Self-Control questionnaire held good relationships with cardiovascular reactivity only during the easiest Task Period, being HRmin reactivity the only cardiovascular measure to relate with the questionnaire at the other two difficulty levels. If the content of these two questionnaires is revised we observe that whereas the Individual Excitability Test refers to the way the individual responds in the three levels of emotional experience (cognitive, vegetative and motor), the Self-Control questionnaire refers to different coping strategies implying that physiological reactivity might be a function of self perceived responding when demands are high but might depend on the individual coping strategies when demands are low.

An interesting association was found between oxygen consumption and the Neurotic - Extroversion dimensions of personality. Apparently, this opposite dimensional categorization of personality as measured by the Eysenck Personality Questionnaire, had a parallel oxygen reactivity expressed in the opposite significant correlations found during TP-2 where the demands of the task were at a medium level. In TP-1 the correlation was significant only for the Extrovert scale in the negative direction. The relationship with the Neurotic scale was found to be positive but did not reach a significant value, \( r = 0.353 \). In general, this was the only psychological measure which showed a relationship with the changes in the amount of oxygen consumed, implying that these personality variables such as neuroticism and extroversion as measured by the Eysenck inventory could be in some way related to energy demand changes at least when the cognitive demands are not excessive.

Moreover, during the rest period, the correlation between oxygen consumption and Neuroticism was negative, meaning that when the organism is not receiving direct demands, the energy requirements are lower for those individuals who exhibit neurotic characteristics. Further investigation is required in order to reach more specific conclusions on this particular finding.

Another interesting set of correlations was found between the Sel-Control questionnaire and the cardiovascular reactivity measures mainly in TP-1 were the relationship was significantly for all the cardiovascular indicators. In TP-2 and TP-3 only HRmin and RR continued to hold a significant association.

The negative direction of the relationship between Self-Control and the physiological variables is an aspect which deserves special attention. The fact that the opposite relation was found mainly during the easiest task period points to the hypothesis that the presence of the same psychological characteristics can promote different physiological responses depending on the task demands, suggesting that low task demands have rather a calming effect on stressed individuals.

In conclusion, different psychophysiological patterns of responding emerged not only as a result of different levels of demand in the same task, but also depending on individual psychological characteristics. Specifically, Oxygen consumption varied in an opposite manner as a function of the neurotic-extroversion parameter and was related to task difficulty. Some aspects of the cardiovascular response were also related to task difficulty and the psychological variables assessed through the questionnaires. Thus, oxygen consumption promises to be a powerful physiological tool for psychological diagnosis, but the need to examine different parameters within the same physiological system when studying the organism energy demands due to mental tasks, is made evident when considering all the possible patterns of physiological responding related to individual psychological characteristics.
References


