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O_2 CONSUMPTION, HEART RATE AND SUBJECTIVE RATINGS UNDER CONDITIONS OF RELAXATION AND ACTIVE COPING

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Summary—Oxygen consumption, respiratory rate, minute volume, heart rate (HR) and subjective ratings from 12 graduate students were monitored under conditions of relaxation and active coping. The controlled, within-*S*s, cross-over design consisted of the two experimental conditions alternating between three control periods. The relaxation condition consisted of an autogenic procedure which the *S*s had practiced daily for more than a week. The active-coping condition involved avoidance of an aversive noise during a reaction-time task. In terms of O_2 consumption, there was a slight (3%) but nonsignificant decrease during relaxation. There was a trend for HR to increase during active coping, although this finding was attenuated by the presence of a subset of *S*s who responded with a marked and unexpected decrease in HR under this condition. Subjective ratings obtained at 1-min intervals throughout the experiment indicated that the *S*s achieved significant levels of subjective relaxation during the procedure. The results of the study failed to support the presence of a hypometabolic state during relaxation as proposed by Benson.

In 1970 an article by Wallace appeared in *Science* reporting that O_2 consumption decreased some 20% from baseline values under conditions of meditation. In addition, heart rate decreased by approx. 5 bpm, and skin resistance increased. This pattern of physiological responses coupled with a distinct pattern of EEG activity led Wallace to conclude that meditation resulted in a state of consciousness that was different from that experienced during sleep or under hypnosis. Furthermore, since Wallace reported that "transcendental meditation is easily learned and produces significant physiological changes in both beginners and advanced students" (p. 1754), this type of relaxation procedure appeared to have numerous practical applications.

Wallace followed up this initial report with another study (Wallace, Benson and Wilson, 1971) in which he reported similar findings, including a 17% reduction in O_2 consumption during meditation. Three years later, a study by Beary and Benson (1974) reported a 13% decrease in O_2 consumption during a meditative type of relaxation when compared to a control period during which the *S*s sat with their eyes closed. By this time, however, the focus was less on a specific technique, such as transcendental meditation, and more on what Benson termed the 'relaxation response' (Benson, 1974).

Benson's position was that there are a number of relaxation-based procedures that can achieve the same physiologically-beneficial state. These include progressive deep-muscle relaxation, biofeedback-assisted relaxation, various forms of meditation, autogenic training and hypnosis (Benson, Beary and Carol, 1974; Beary and Benson, 1974). Benson identified four basic elements that are usually necessary to achieve this response in human beings. First, there should be a constant stimulus, such as a sound, word or phrase, which serves to minimize one's attention to external stimuli. Also, it is important for the *S* to assume a passive attitude and disregard distracting thoughts. Third, a comfortable posture should be maintained so that a minimum of muscular work is required. And finally, these techniques must be performed in a quiet environment, free from distracting stimuli.

In spite of these promising, early results, a number of methodological questions were raised, especially concerning the observed reductions in O_2 consumption. It was particularly important to document reliable reductions in O_2 consumption since claims that the relaxation response resulted in a hypometabolic state were based on this finding.

One methodological question dealt with the manner in which O_2 consumption was measured. The earlier studies measured O_2 consumption at several different points during the protocol. Benson and his associates (Benson, Steinert, Green-Wood, Klemchuk and Peterson, 1975) addressed this issue by attempting to replicate the Beary and Benson (1974) results using continuous rather than periodic measurements. They found that the mean decrease in O_2 consumption, while significant, was much reduced (approx. 5% from control periods). However, since there were brief periods during relaxation when reductions of a greater magnitude were observed, Benson concluded that these data were consistent with the earlier findings. Also he once again emphasized that this "wakeful hypometabolic state is not unique to transcendental meditation" (p. 43).

Another methodological issue concerned the baseline against which O_2 consumption during relaxation was compared. Fenwick and his associates (Fenwick, Donaldson, Gillis, Bushman, Fenton, Tilsley and Serafinowicz, 1977) found only slight reductions in O_2 consumption (from 4 to 5%) during relaxation when compared to other restful conditions, such as sitting in an easy chair. However, when relaxation was compared to a control condition involving greater somatic demands, such as sitting in a hard chair, the amount of reduction increased substantially (approx. 10%). The authors concluded that reductions in O_2 consumption and changes in other physiological variables must be compared against a true, relaxed basal level during which somatic activity has been controlled. To fail to do so might give the misleading impression that physiological changes were due to the relaxation procedure when, in fact, they could be explained more parsimoniously by changes in muscular activity.

A second group of investigators (Warrenburg, Pagano, Woods and Hlastala, 1980) have also raised the issue of appropriate baseline levels against which to compare the effects of relaxation. In their study, reductions in O_2 consumption ranged from 4 to 5% for both meditation and progressive muscle relaxation. Warrenburg suggested that these significant but less impressive results could in part be explained by the use of a 'low-stress' baseline which more accurately reflected true basal metabolic levels. This led Warrenburg to suggest that Wallace's results (1970) may have been due to the stressful protocol involved in his study (i.e. arterial cannulation).

On the other hand, methodological intrusiveness may also interfere with the ability of *S*s to achieve levels of relaxation comparable to that experienced in a more naturalistic setting (Benson *et al.*, 1975; Fenwick *et al.*, 1977; Wallace, 1970; Warrenburg *et al.*, 1980; Wenger and Bagchi, 1961). Thus, investigations of the relaxation response in the laboratory are faced with a dual challenge. First, the baseline values against which physiological changes during relaxation are compared must not be elevated due to the procedure itself. And second, the procedure must not be so intrusive as to interfere with the *S*s ability to relax.

The purpose of this study was to investigate O_2 consumption and heart rate under conditions of relaxation. Special efforts were made to insure that *S*s were able to achieve a normal relaxation state during the experimental period and to control as much as possible for somatic activity during the control periods. The experimental design was that used by Beary and Benson (1974) in their successful demonstration of decreases in O_2 consumption during a brief relaxation procedure using untrained *S*s. In this case, however, another widely-used relaxation technique—autogenic training (Luthe, 1969)—was used to determine the generality of the earlier findings. In addition, a stressful task—active coping (Obrist, 1981)—was introduced during the second experimental period in an effort to drive the dependent variables in a direction opposite from that expected during relaxation. It was hoped that this maneuver would provide further information concerning the sensitivity of these measures under these conditions.

METHOD

Subjects

Subjects consisted of 15 graduate students (8 male and 7 female) ranging in age from 23 to 34 with a mean age of 27.1 yrs. Participation in the experiment, while voluntary, was nevertheless incorporated as part of a class taught by the senior author. Initial training in relaxation was conducted in the classroom itself.

Apparatus

O_2 consumption, respiration rate (RR) and minute volume (VOL) were obtained using a Beckman Metabolic Measurement Cart equipped with the LB-2 Medical Gas Analyzer and the OM-11 O_2 Analyzer. The OM-11 uses a polarographic analysis technique to measure O_2.

Subjects were fitted with a Bennett mask which covered both the mouth and nose. The mask was held in place with an elastic, four-point head strap which achieved a seal around the face. The one-way breathing valve which prevented expired air from re-entering the room was held in place by a head brace. Light-weight headphones (Realistic Nova-50) were placed over the headband of the brace. Care was taken to make the fitting of this apparatus as comfortable as possible.

Heart rate (HR) was obtained using a Cyborg BL907 Pulse Wave Velocity and Heart Rate Instrument. The acoustic motion sensor was placed over the radial artery to monitor HR in beats/min (bpm). Readings from the BL907 were transmitted directly to a Cyborg Q740 Digital Panel Printer.

Custom-built circuitry coordinated the presentation of the warning light, the signal tone and the aversive stimulus for the reaction-time (RT) task. The aversive stimulus, a 110 dB 2000 Hz tone, was generated by a Belltone Audiometer. A Wollensack Audio Cassette Programmer (Model 2570) was used to provide white noise, to time the experimental periods and to initiate the presentation of the six RT trials. A standard Kodak Carousel projector mounted 6 ft from the floor and equipped with a remote control switch was used to present slide material during the control periods. The study was conducted in a small (approx. 4 × 2.5 m), darkened, windowless room.

Measures

O_2 consumption, RR and VOL were monitored continuously with printouts at 1-min intervals expressed in ml/min, breaths/min and l/min, respectively. HR was also monitored continuously, averaged over 5 beats and sampled at 10-sec intervals. These values were then averaged over 1-min periods.

In addition to the physiological variables, subjective ratings of relaxation were obtained at 1-min intervals throughout the experiment. Ratings were made on a 5-point scale with 1 corresponding to 'completely relaxed' and 5 'not relaxed at all'. A finger-signaling system was developed so that raising the thumb indicated 'completely relaxed' while raising the little finger meant the opposite. For some *S*s, it was easier to indicate their rating by lightly tapping the index finger the appropriate number of times. *S*s were given the option of responding using either system.

The rating procedure was introduced and explained during the initial relaxation-training session. The practice tapes used for relaxation training at home included periodic (1-min intervals on average) requests for the rating response. This was done to minimize the intrusiveness of the rating during the experiment itself. During data collection this measure was used to gain information as to whether the *S*s were experiencing subjective relaxation during the relaxation period.

Experimental Conditions

Relaxation

During preliminary work with the Metabolic Measurement Cart it was determined that an autogenic relaxation procedure (Luthe, 1969) seemed to result in the greatest reductions in O_2 consumption when compared to mediation and deep-muscle relaxation. The procedure, which is widely used, fulfills Benson's requirements for obtaining the relaxation response (Benson *et al.*, 1974). The constant stimulus consists of phrases repeated several times in a relaxed manner by the trainer. These phrases focus on both somatic relaxation as well as including imagery designed to remove distracting thoughts and induce a passive attitude. The trainer (the second author) was an experienced relaxation therapist who conducted both the initial training session, a second, in-class-practice session and the relaxation procedure during the experiment itself. In addition, training tapes for home use were recorded by the same trainer.

A log was kept by all *S*s indicating the date and time of each home-practice session. They were encouraged to practice on a daily basis for at least 8 days prior to the experiment. However, this was not required in an effort to reduce the possibility that *S*s would feel pressured to inflate the number of practice sessions. To further check whether the *S*s actually practiced at home, an anonymous survey was taken after the study was completed in which *S*s were asked to indicate exactly how many times they had practiced. Since it was impossible to identify individuals from this survey, it was hoped that an honest accounting of the actual number of practice sessions would occur under these circumstances.

The logs indicated the average number of practice sessions to be 8.3, which was verified by the anonymous survey. The range of practice sessions was from 6 to 10. The length of time between the introduction of relaxation training and data collection averaged 9.6 days with a range of from 7 to 14 days. Only 3 *S*s reported any previous experience with relaxation techniques, and no *S*s reported routinely using any of these procedures at the time of the study.

Active coping

The active-coping condition consisted of an RT task modified from Obrist, Lawler, Howard, Smithson, Martin and Manning (1974). A ready stimulus (a 12 V lamp illuminated for 500 msec) was mounted on a response board upon which the *S*'s right hand and arm rested. Eight seconds after the warning light, a 3000 Hz tone was presented through the headphones over a low level of white noise. The tone terminated with the pressing of a response button mounted on the same board. Eight seconds later, the *S* received a loud (110 dB), 500 msec, 2000 Hz tone through the headphones if he or she failed to beat an unspecified criterion time.

While the *S*s were led to believe that they were attempting to better a response criterion that normal adults could reach 50% of the time, in actuality the aversive stimulus was delivered on the first, third and fourth trials. There were a total of six trials over a 5-min period with a randomly-determined intertrial interval ranging from 40 to 65 sec. It was anticipated that the limited number of trials would keep the *S*s from realizing that the aversive stimulus was noncontingent and thus stop trying. Debriefing after data collection revealed that the deception was successful in all cases.

Procedure

A controlled, cross-over design adopted from Beary and Benson (1974) was used. This design consisted of five consecutive periods of 5 min each, with the exception of the relaxation period which was 10 min. There were three control periods during which the *S*s viewed slides projected on a surface directly above and in front of them. The slides consisted of scenes selected to be emotionally neutral in content. The *S* controlled which slides he or she viewed and the rate at which this occurred by use of a remote-control switch also mounted on the response board.

Subjects were seated in a heavily-padded recliner in a semi-reclining position throughout the study. The use of this chair coupled with the limiting of somatic responses to the movement of a single finger meant that somatic activity could be maintained at a minimum throughout the experiment. While there was, as one would expect, some movement, it was felt that this procedure controlled for movement artifact more closely than other studies of relaxation.

The relaxation condition and RT task alternated between the three control periods. *S*s were randomly assigned to either a relaxation-first or a stress-first condition to control for order effect. The randomization process resulted in 7 *S*s (3 females and 4 males) engaging in relaxation first with the remaining 8 *S*s (4 females and 4 males) responding to the RT task first.

A low level of white noise, adjusted at the beginning of the experiment to suit the *S*, was presented both through the headphones and through a two-way, acoustic suspension speaker. Debriefing indicated that the dual masking with white noise was very successful in eliminating distracting stimuli during the experiment.

Debriefing

The obvious intrusiveness of the experimental apparatus made a comprehensive debriefing of *S*s after data collection particularly necessary. Of specific concern was whether the breathing apparatus, head brace etc., interfered with their ability to engage in the relaxation procedure. In addition to open-ended questions concerning this problem, a 10-point scale was used for *S*s to rate the degree to which they had been successful in reaching a relaxation state comparable to that achieved at home during practice sessions. An *a priori* decision was made to delete data from any *S* who rated his or her ability to achieve relaxation as a $\leqslant 5$ (with a 10 corresponding to completely successful relaxation). Three *S*s did experience problems with the relaxation portion of the procedure and were thus deleted from the study, For the 12 *S*s remaining (7 males and 5 females), the rating of successful relaxation averaged 7.6 with a range from 6 to 9.

Pilots

Once the relaxation procedure had been decided upon, 2 volunteers trained, practiced, and participated in the study as described above. The only difference for these 2 *S*s was that HR was not monitored and the control conditions consisted of reading *National Geographic* magazines. The data indicated that 1 *S* achieved a reduction in O_2 consumption that was 8% and the other 17% below that obtained for an average baseline value derived from the three control periods. On the basis of these preliminary data, which met or approached our arbitrary hypometabolic criterion of a 15% reduction in O_2 consumption, the decision was made to conduct the experiment using the procedure as it stood. However, one change was made. We were bothered by the movement associated with reading the magazines during the control periods. Consequently, the projection system described above was developed and used in place of reading magazines. This, as indicated above, served the purpose of keeping somatic activity to a minimum for both control and experimental periods.

RESULTS

Values for the five dependent variables—subjective rating of relaxation during the experiment (SR), O_2 consumption (O_2), minute volume (VOL), respiration rate (RR) and heart rate (HR)—were averaged over 5-min periods and entered into a 2×6 (Order $\times$ Period) repeated-measures analysis of variance (PMD Series P2V). (The relaxation condition, which lasted 10 min, was broken into two 5-min periods for these analyses.) With the exception of VOL, no significant main effect for Order was found. Consequently, findings for SR, O_2, RR and HR will be presented in terms of a Periods effect only. A significant Order $\times$ Periods interaction was observed for SR and RR only.

Analysis of SR yielded a highly-significant F-ratio for Periods effect [$F(5,50) = 33.320$, $P < 0.0001$] as well as a significant interaction effect [$F(5,50) = 2.588$, $P < 0.04$]. *Post hoc* comparisons using the Newman–Keuls procedure indicated that while the three control periods did not differ significantly from each other, both relaxation periods and the reaction-time (RT) period were significantly different from the control periods. Inspection of the means for all six periods indicated that during the control periods the *S*s reported moderate levels of arousal and that during the relaxation periods the *S*s reported being significantly more relaxed. The mean for the second relaxation period was significantly less, indicating greater relaxation, than that for the first relaxation period. During the RT period the *S*s reported not being relaxed at all. These data would suggest that the experimental conditions were experienced by the *S*s in the manner intended. The means and standard deviations for the dependent variables are presented in Table 1.

Table 1. Means and standard deviations for the dependent measures averaged over the 5-min experimental periods

		Variable				
Experimental period		SR	O_2	RR	VOL	HR
Pre-relaxation control		3.29	196.5	12.82	7.62	73.09
	SD	0.79	43.9	3.69	1.27	13.79
Relaxation No. 1		2.68	193.5	12.12	6.75	74.17
	SD	0.78	43.9	3.75	1.03	12.62
Relaxation No. 2		2.05	192.8	12.41	6.67	73.85
	SD	0.67	51.7	3.89	1.37	12.19
Pre RT Control		3.08	204.0	13.55	7.81	74.67
	SD	0.82	45.5	3.52	1.26	12.51
RT		4.51	197.2	14.73	7.93	76.59
	SD	0.52	48.3	3.06	1.65	16.12
Final control		3.25	194.7	12.64	7.53	73.21
	SD	0.81	42.9	3.81	1.08	12.03

SR = subjective rating of relaxation on a 5-point scale with 1 being completely relaxed; O_2 = O_2 consumption (ml/min); RR = respiration rate (breaths/min); VOL = minute volume (l/min); HR = Heart rate (bpm).

Plotting the means for the interaction effect indicated that during the pre-relaxation and first relaxation periods the stress-first *S*s reported themselves as being significantly more relaxed than the relaxation-first *S*s. This finding was also true for the final control period. In other words, the stress-first *S*s reported greater subjective relaxation following the RT time task. Several *S*s reported during debriefing that completion of the aversive portion of the protocol first lessened their apprehension during the remainder of the procedure.

Data on O_2 failed to yield a significant Periods [$F(5,50) = 1.159$, $P < 0.34$] or interaction [$F(5,50) = 0.705$, $P < 0.62$] effect. Inspection of the Period means revealed a very modest (3%) reduction in O_2 during relaxation for all *S*s combined. Although the interaction F-ratio failed to reach significance, it was noted that the relaxation-first *S*s achieved an average 5% reduction in O_2 consumption as compared to a slight increase (2%) for the stress-first *S*s.

Analysis of RR yielded both a significant Periods [$F(5,50) = 15.164$, $P < 0.001$] and interaction [$F(5,50) = 2.413$, $P < 0.05$] effect. *Post hoc* analysis of the Periods effect using the Newman–Keuls procedure revealed that during the RT period the *S*s' RR was significantly higher than during any other period. RR during the first control period (at the beginning of the experiment) was significantly higher than during the other two control periods, which in turn did not differ from each other. RR during the two relaxation periods, while not significantly different between periods, was significantly less than during the first control period. However, RR during relaxation was not significantly less than during the remaining two control periods.

Plotting the means for the interaction effect indicated that the stress-first *S*s breathed at a significantly lower rate during relaxation and the period that followed, which for them was the final control period. This finding would correspond to the SR pattern noted above in which completion of the stressful portion of the protocol first appeared to result in less apprehension for the remainder of the experiment.

Analysis of VOL yielded both a significant Order [$F(1,50) = 11.114$, $P < 0.008$] and Periods [$F(5,50) = 8.132$, $P < 0.0001$] effect. Inspection of the means for VOL revealed that during relaxation all *S*s reduced VOL significantly from the three control periods and RT period, which in turn did not differ significantly from each other. It was also observed that the stress-first *S*s exhibited smaller VOLs across all periods than the relaxation-first *S*s. This finding, which may be related to the RR differences noted above, is also of uncertain physiological importance.

The analysis of HR revealed that the Periods effect approached significance ($F(5,50) = 2.157$, $P < 0.07$], with HR being highest during the RT period. However, the standard deviation for HR during the RT period was larger than that for the other periods. Further inspection of individual data revealed a pattern of individual differences that cancelled each other out when data for all *S*s were averaged together. A group of 5 *S*s (2 male and 3 female) were found to have responded during the RT period with an average increase in HR over the entire 5-min period that exceeded 8 bpm. These *S*s were contrasted to a second group of 4 *S*s (2 male and 2 female) who essentially failed to respond in terms of HR during the RT period. Most interesting of all, however, was the remaining group of 3 *S*s (3 males) who responded throughout the 5-min RT period with a sustained bradycardia of more than 10 bpm.

DISCUSSION

The results of the study failed to support the presence of a relaxation response as proposed by Benson. SRs obtained at 1-min intervals throughout the study indicated that the *S*s achieved a state of subjective relaxation as intended. However, reduction in O_2 consumption during relaxation was slight (3%) and nonsignificant when compared to control periods. Also there was no reduction in HR during relaxation. Significant decreases were observed for RR and VOL, but these changes apparently reflected the *S*s' voluntary efforts to induce relaxation rather than attainment of a hypometabolic state.

The trend toward increased HR during active coping also was not as strong as expected. Comparing the distribution of responses for our sample with the combined distribution for 154 of Obrist's *S*s (1981, see Fig. 8, p. 100) gives the impression that the entire distribution had been shifted to the left (i.e. to levels of less responsivity). There seem to be several good explanations for this. First, the nature of our aversive stimulus (noise) was probably not as powerful as Obrist's (shock). In fact, several *S*s commented at debriefing that the aversive tone was not as discomforting as expected once it had been delivered. A less-aversive stimulus would be expected to evoke lower levels of HR reactivity.

Another consideration in explaining the HR results might involve the familiarity of these *S*s with the experimenters (Obrist, 1981). This would mean that they may have been less apprehensive than Obrist's undergraduate *S*s who were completely naive. Also, as graduate students, these *S*s may have been less apprehensive about participating in an experiment, thus blunting the novelty and uncertainty that appear to potentiate the effect of active coping (Obrist, 1981). Yet a third consideration was the unexpected finding that a subset of *S*s responded with marked changes in HR but in terms of a decrease rather than an increase. The nature of this phenomenon is at present unexplained and clearly in need of further investigation.

The failure to replicate Beary and Benson's (1974) 13% reduction in O_2 consumption is interesting, particularly since the same experimental design was used. One explanation that comes immediately to mind is that our relaxation procedure was insufficient in terms of its content, the length of training, or both. As far as content is concerned, autogenic training is specifically identified by Benson *et al.* (1974) as one of several procedures capable of achieving the relaxation response. In addition, data comparing meditation with other relaxation strategies has consistently demonstrated similar patterns of physiological responding (Benson *et al.*, 1974, 1975; Morse *et al.*, 1977). Also, it should be noted that great care was taken during the study to fulfill the four requirements for relaxation as set forth by Benson, including live rather than taped induction of relaxation during the experiment itself (cf. Israel and Beiman, 1977).

It is also hard to explain away these results in terms of insufficient training. Beary and Benson's (1974) training consisted of written instructions and 1 hr of practice. Also, other studies have found that when novice *S*s are compared with experienced practitioners of relaxation techniques the magnitude of physiological changes during relaxation are generally similar (Morse *et al.*, 1977; Wallace, 1970; Warrenburg *et al.*, 1980).

There are several procedural issues that might be advanced as explanations for this failure to replicate. For example, the intrusiveness of the instrumentation must be considered when reviewing these findings. Nevertheless, the measurement of respiratory variables in the present study was very similar in procedure, down to the wearing of a "tight-fitting face mask" (p. 116), to that reported by Beary and Benson (1974). Also it should be noted that our procedure was much less intrusive than the one employed by Wallace (1970) which involved breathing through a mouthpiece for 1 hr. Wallace specifically mentions that "respiration during meditation may also have been hindered by the large collection of moisture in the nonbreathing valve after an hour of continuous use" (p. 1752). This very problem had led to our abandonment of the mouthpiece for this reason early in our preliminary work with the Metabolic Measurement Cart. In addition, care was taken to exclude *S*s from the analyses who reported difficulty achieving a relaxed state.

Another procedural problem would concern the manner in which O_2 consumption was monitored. In this study, a continuous measure was obtained, and, interestingly enough, our results are comparable (3% vs 5%) to those Benson obtained using continuous measurement also (Benson *et al.*, 1975). Still another procedural issue might involve the length of the relaxation period itself (10 min). However, the length of the Beary and Benson (1974) relaxation period was 12 min, and other studies have demonstrated that the greatest reductions appear to occur during the first 5–10 min of relaxation (e.g. Wallace, 1970). Nevertheless, Benson *et al.* (1975) did report that an initial decrease in O_2 consumption for several minutes was followed by a brief (2–3 min) rise back toward baseline with the more stable reductions occurring during a second 10-min period. Although this was not our finding, a longer relaxation period may have resulted in more impressive results.

Given the care and effort that went into insuring the best possible conditions for demonstrating the relaxation response, it is perplexing as to why we were unsuccessful. Two aspects of the study remain as plausible explanations for these findings. For one, the interaction of the RT period with SR and RR may indicate that the inclusion of a stress condition attenuated the ability of the relaxation-first *S*s to achieve an effective level of relaxation. In other words, the relaxation-first *S*s' apprehension about the impending stress condition may have interfered with their ability to relax. Yet, looking at the O_2 data, it appears that the relaxation-first *S*s were more successful in reducing O_2 consumption than the stress-first *S*s, although the Order $\times$ Period interaction was not significant. Nevertheless, the possible confounding effect of including a stress condition in the experimental design must be considered.

The most parsimonious explanation for these results may center on the nature of the control periods against which relaxation was compared. It will be remembered that when 2 pilot *S*s read magazines during the control periods, a hypometabolic-type response was obtained (8% and 17% reductions in O_2 consumption). Yet, when we modified the procedure to reduce the somatic activity related to reading, we lost our initial results. The control periods in the Beary and Benson (1974) study had the *S*s sit "quietly and read material selected for its neutral emotional content [a Sierra Club book]" (p. 116). While this would apply to the differences between the control and relaxation periods, it would not, however, explain the reductions Beary and Benson obtained when comparing relaxation to an eyes-closed condition.

Nevertheless, the failure of the physiological measures to correspond with self-reports of relaxation in the present study can be seen as yet further evidence for the lack of synchrony between these response systems (Rachman and Hodgson, 1974). Over 15 years ago Rachman (1968) questioned whether relaxation resulted in an altered physiological state or simply subjective feelings of calmness. The results of this experiment suggest that, in spite of claims to the contrary, the issue has not been resolved. A clear demonstration that relaxation training is capable of inducing a hypometabolic state unrelated to somatic activity is still needed.

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