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Enhancing Perceptual-Motor Accuracy Through Flotation REST

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Previous studies using flotation Restricted Environmental Stimulation Technique (REST) to enhance motor performance have focused on relatively gross arm and leg movements and have combined the technique with a variety of imaginal practice and relaxation training procedures. This study independently varied REST and an imaginal training and relaxation script to improve accuracy among novice, intermediate, and expert darts players. REST by itself and REST combined with the script were equally effective in enhancing performance (*M* change about +12%). The imagery script alone and a no-treatment control condition resulted in no change on test–retest measures. The results indicate that in the area of perceptual-motor coordination, REST is not merely a potentiator of other techniques, but a useful and efficient unimodal intervention, which takes a short time and does not require further rehearsal or repetition.

The Restricted Environmental Stimulation Technique (REST) has had a controversial history within psychology. It began with a spate of studies on "sensory deprivation" that reported a variety of mostly adverse effects. Later research, benefiting from successive improvements in methodology, demonstrated that stimulus-reducing environments are in fact pleasant for most subjects. Such environments also consistently enhance some therapeutic and skill-learning approaches to the point that in some papers the technique is referred to as Restricted Environmental Stimulation Therapy (e.g., Suedfeld, 1980; Suedfeld & Borrie, in press).

Starting in the late 1980s anecdotal reports claimed that individual athletes and athletic teams have used the technique successfully to improve performance as well as postperformance recovery from fatigue (Hutchison, 1986; Stanley, Mahoney, & Reppert, 1987). In the past few years, four experimental studies have been published on this topic. All of the experiments utilized a version of REST usually called flotation REST, which involves subjects floating for approximately 1 hour per session in a warm saline solution. The flotation tank

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is usually located in a dark, quiet room, and is equipped with an intercom so that instructions and messages can be presented to the subject during the session (and so that the monitor can respond to any questions or problems the subject may have).

Lee and Hewitt (1987) compared the effects of visual imagery practiced either on a mat or in a flotation tank with those of an untreated control condition. The dependent variables were competition performance and physical symptoms (sports injuries and general health) of novice and intermediate gymnasts. Performance scores were highest and physical symptoms were lowest among members of the imagery plus REST group, while the imagery-only group did no better than the controls. In the second study (Suedfeld & Bruno, 1990), recreational basketball players tested 1 day before and 1 day after a REST-plus-imagery treatment showed a mean improvement of 37% in free-throw success. This improvement was significantly more than those achieved by subjects receiving the same imagery training in a comfortable cocoon-like chair or in an armchair in a normal office.

McAleney, Barabasz, and Barabasz (1990) reported that points won on first serve increased significantly among intercollegiate tennis players who had experienced flotation and imagery training, compared to an imagery-only control group. No significant difference was found on keyshot success and total points won or lost. The most recently published study (Wagaman, Barabasz, & Barabasz, 1991) again used imagery with or without REST on a group of intercollegiate basketball players. The REST group improved significantly more in varsity game performance, as measured both by coaches' ratings (done blind as to experimental condition) and by objective performance statistics. Further, subjects who completed two float sessions between games did better in the second game than those who had only one session.

The reasons for the effectiveness of REST in improving sport performance are not clear. One possible explanation would be in terms of a nonspecific artifact. However, Suedfeld and Bruno (1990) found no intergroup differences in subjects' expectancy of improvement before the session and neither Suedfeld and Bruno (1990) nor Wagaman et al. (1991) found differences between the REST and non-REST groups' judgments of treatment effectiveness at the end of the session. Thus, the results are not easily explained away as an expectancy or placebo effect (the same is true of clinical applications of REST; e.g., Suedfeld, 1980, 1990).

We must therefore turn to explanations of REST as an active agent in performance enhancement. Flotation REST is known to induce a state of deep relaxation in which the participant nevertheless stays mentally alert. These effects were first noted in anecdotal self-reports and observer reports (Hutchison, 1984; Lilly, 1977). They have been confirmed by established verbal indices of mood and cognitive processes. Such instruments typically show that flotation REST is associated with lowered stress, anxiety, fatigue, and depression, coupled with higher ratings of calmness, alertness, and vigor (e.g., Barabasz, Barabasz, Dyer, Rather, & Sayger, in press; Jacobs, Heilbronner, & Stanley, 1985; Suedfeld, Ballard, & Murphy, 1983).

Reduced stress and increased alert relaxation as a function of REST have also been established through psychophysiological and biochemical assays. These show increased density of EEG alpha waves (e.g., Barabasz & Barabasz, 1985), and decreases in such measures of stress and arousal as heart rate, blood pressure,

muscle tension (Francis & Stanley, 1985; Jacobs et al., 1985; O'Leary & Heilbronner, 1985; Turner, Fine, McGrady, & Higgins, 1987), plasma cortisol, ACTH, and plasma β-endorphin (Turner, Bayless, & Fine, 1989; Turner & Fine, 1983). Subjective reports associated with these findings point to two possible, not mutually exclusive, explanations of the effects of REST on athletes:

1. Many floaters, including experienced practitioners of meditation or systematic relaxation techniques, report having reached previously unattained levels of relaxation while in the tank. In followup interviews, some also indicate that they have been more capable of again reaching such levels when they try to do so after the first tank experience. Floating may enable athletes to avoid levels of tension and arousal that might impair their performance in competition.
2. Many REST participants describe an improved ability to focus their concentration on topics that concerned them prior to entering the tank (usually personal problems or goal-directed plans). This effect may contribute to improved athletic performance, particularly in sports that require a tight attentional focus on a particular percept or motor behavior.

The two hypothetical explanations above also have implications as to the kind of sport for which REST could have beneficial applications. For example, there is no evidence that it would aid in activities that overwhelmingly emphasize brief bursts of speed or strength, or quick changes in motion or attention in reponse to the acts of other competitors. It may be more effective in relatively long-duration efforts where endurance can be increased by controlling arousal level and concentration. However, we hypothesize that the skills most likely to benefit from flotation are those that require relatively low arousal and a full measure of control over a complex coordinated movement. Salient examples are sports that involve both mental and motor precision and accuracy, obtained by a combination of such factors as judgment and planning, visual-motor coordination, breathing control, and the ability to screen out peripheral irrelevant stimuli. Events such as shooting, archery, golf, bowling, and diving come to mind.

An additional consideration is the combining of REST with more traditional approaches. In other contexts, such as smoking cessation, REST has been identified as a powerful intervention that may be even more effective as a potentiator of other successful techniques with which it interacts synergistically (e.g., Suedfeld, 1990). In the domain of motor or perceptual-motor skill enhancement, the studies summarized previously showed that flotation and visualization together are effective. We do not know whether REST merely potentiates the effects of imagery, interacts synergistically with it, or is itself responsible for all or most of the effect. Because the four studies described above did not include REST-only treatment groups in their design, their results cannot answer this question.

No strong empirical test has been made of the interaction between flotation REST and imagery training, and the question is probably not critical to the application of the techniques to performance enhancement. Nevertheless, an answer to it could improve the cost-effectiveness of training by directing attention to the more powerful technique. The present study was designed to answer the applied question: Will a REST plus imagery training combination have different

effects from either REST or imagery training alone? In accordance with the considerations raised above, a skill was sought in which performance could be more precisely measured than the gross motor skills involved in gymnastics, basketball, and tennis. For that reason, the study tested dart-throwing accuracy, with the dependent measure being the number of millimeters of the dart from the bull's-eye. An element of motivation specific to the test performance (i.e., as opposed to general competition motivation expected of varsity or club team members) was also introduced.

Method

Subjects

Campus and community center bulletin boards were used to obtain volunteers to participate in a study on "dart throwing hand-eye coordination." An attempt was also made to recruit expert players by circulating the invitation to local darts leagues. Only right-handed volunteers were accepted to avoid possible interaction effects between REST and lateral dominance. The final group of participants consisted of 40 individuals (32 men and 8 women) who had all played darts at least twice during the previous year. Four of the volunteers, all male, qualified as "experts" (i.e., regular league competitors). Subjects were assigned to treatments randomly, except for the experts and the female volunteers who were evenly distributed across the four treatment conditions. All subjects signed an informed consent form before being allowed to participate.

Procedure

The procedure was designed to provide an independent assessment of the effects of REST, imagery training, and a combination of both. Subjects were given the instructions for their particular treatment upon reporting to the laboratory. Each treatment session lasted 1 hour. The treatments were as follows:

Imagery Only (I). Subjects sat in a small room, reading or studying. After 40 min, they were instructed to sit on a comfortable futon couch, the light was dimmed, and the subject heard a 13-min tape recording. The tape began with a brief relaxation exercise and then slowly and vividly described the "feel" (including visual and motor sensations) of throwing a perfect bull's-eye. Subjects were instructed to experience the imagery as they listened to the tape, and to continue practicing it until the end of the session (which occurred 7 min after the tape ended).

REST Only (R). After showering, subjects floated in a dark, sound-reducing environment. Standard flotation parameters were in effect, as follows. The tank contains a solution of Epsom salts in skin-temperature water. The density of the solution is approximately 1.30 g/cm^3, which makes it possible to float on one's back with the face and chest out of the water so that breathing is normal, and it is almost impossible to turn over. The solution is about 30 cm deep. Subjects wear earplugs to reduce ambient noise, but otherwise wear only a bathing suit or nothing at all, as they prefer. The subject showers again after the session to remove the Epsom salts residue. A monitor in the next room listens over the intercom to make sure the subject has no questions or problems. As is almost always the case, all subjects in this study completed the scheduled float without problems.

REST Plus Imagery (RI). The same flotation condition as in R, but 40 min after the float session began the same procedure as for group I was initiated by a tape played through the tank's built-in stereo speakers. The REST session ended 7 min after the end of the tape.

Control (C). Subjects spent their entire session in the room described under I. They were told that they could read, study, or otherwise spend the time as they wished, but were not allowed to leave the room nor to consume anything.

Measures

Baseline dart-throwing accuracy was measured immediately prior to the treatment session. The task was to throw a 22-g brass dart from a distance of 3.05 m at the bull's-eye of a standard dartboard (10 practice throws followed by 20 recorded throws). After completing the baseline test, subjects were told that after the session they would repeat the performance and were informed of the financial awards for improvement ($20 for the subject showing the most improvement, with $10 each for the next three most improved participants). The posttest, which was identical to the baseline test in procedure, was administered immediately after the treatment session.

Subjects were then debriefed and informed that if any procedure was found to be more effective than the others, those assigned to the other groups would be given the opportunity to experience it after the experiment was finished.

Results

Performance scores were measured in millimeters from the center of the bull's-eye (see Table 1). Pretreatment differences among the groups did not reach statistical significance. ANCOVA was performed on the posttest scores, using baseline scores as the covariate. There was a significant main effect for REST, $F(1,35) = 6.91$, $p = .01$. Neither the main effect for imagery nor the interaction approached statistical significance. Mean pre- to posttreatment changes in accuracy are shown in Table 1.

The groups were then divided into novice (self-reported darts playing 2–10 times during the previous year), intermediate (more than 10 times) and expert

Table 1

Baseline and Postsession Performance (in mm)

Group	Baseline		Postsession		% change
	M	*SD*	*M*	*SD*	in accuracy
I	106	26	108	30	− 1.9
R	93	16	82	25	+ 11.5
RI	85	28	75	28	+ 13.3
C	86	23	87	25	− 0.5

Note. Scores represent distance from bull's-eye; therefore, lower scores (but higher percentage *changes*) indicate higher accuracy.

(competitive league play). Tukey's test showed that these three groups differed significantly on baseline performance, $p < .01$. When experience was used as the covariate, ANCOVA still showed REST to have a significant main effect on postsession accuracy, $F(1,38) = 5.62$, $p < .05$.

Because a few extreme outliers could distort group results on ANCOVA, the number of subjects improving in each group was noted. Improvement was found among 8 of the 10 RI subjects, 9 of the R, and 6 each in I and C. Thus, the mean improvements in the REST groups were not due merely to one or a few unusual participants.

Discussion

The results indicate a reliable improvement in dart-throwing accuracy after flotation REST, regardless of whether the subject had received imagery training during the float. Imagery training in itself was not effective, and no synergistic interaction occurred. It appears that the four previous studies, which confounded REST and imagery training, may have been reporting straight REST effects. This finding is compatible with others reporting a lack of synergism between REST and relaxation exercises (Ballard, 1989; Wallbaum, Rzewnicki, Steele, & Suedfeld, 1991), although a longer and/or more elaborate imagery script might be more successful. The results also support the negative side in the ongoing controversy as to whether REST enhances imagery (cf. Barabasz, 1982; Suedfeld, Ballard, Baker-Brown, & Borrie, 1985-86). However, from the viewpoint of actual application it may be useful to administer more float sessions as well as more elaborate and more often repeated imagery training (Feltz & Landers, 1983).

As one would expect, differential experience in throwing darts resulted in differing baseline scores. However, the positive effect of REST still remained when this variable was partitioned out. It appears that REST may be useful for players at all levels of experience. This had been implied by the consistent results of previous experiments, which had used groups differing widely in expertise (e.g., recreational and varsity basketball players in Suedfeld & Bruno, 1990, and Wagaman et al., 1990, respectively). It is regrettable that the small number of true experts in the current study makes this conclusion only tentative.

The findings also support our analysis of the kind of athletic performance that is most likely to benefit from REST, although the issue is far from settled. Objective measures used so far have confirmed that REST improves accuracy and precision in sports that do not depend upon bursts of speed or strength, rapidity of reactions, or the ability to make quick changes of motion or attention. Dart-throwing accuracy is, of course, the most prototypical example studied to date: It can be measured both more precisely and more objectively than many other athletic performances. The measurement in this study was precise to the level of millimeters, attainable in only a few other sports such as shooting. Similar findings were obtained in studies that used relatively gross units of accuracy such as basketball free-throw success or failure (Suedfeld & Bruno, 1990) and first-service winners in tennis (McAleney et al., 1990). In the latter study, it is relevant that only service accuracy showed a significant REST effect: Tennis components that rely more heavily on reacting to the opponent's performance, such as keyshot success and points scored, did not improve.

Still, we must remember that basketball players did better on both objective and subjective measures after REST (Wagaman et al., 1991), and a subjective

measure (judges' ratings) showed improvement in gymnastics (Lee & Hewitt, 1987). No test has yet been made in events emphasizing speed and/or power, such as sprints, field sports, or martial arts. There has been no test of our hypothesis that endurance could be improved by REST, although Barabasz (1992) has reported a case study in which the performance of a potentially Olympic-level rower had improved greatly after four sessions of combined flotation and imagery.

There has been no followup of Lee and Hewitt's (1987) finding that REST aids in reducing adverse physical symptoms. In fact, REST may facilitate both recovery from minor injuries and overcoming fatigue. If so, it would be a desirable tool in situations where the athlete has to perform repeatedly, with free intervals between events or trials.

The small body of literature on the use of REST to improve sport performance has ranged surprisingly widely considering that it consists of only five studies, but it also has limitations. Although skill levels have varied from occasional recreational players to club and college varsity competitors, no systematic research has involved high-performance athletes at the national or international level. Similarly, motivation has ranged from no special incentive, through a small financial reward for improvement, up to victory in actual tournaments and games; but the extremely high levels associated with championship play have not been included.

It would also be interesting to test whether REST differentially affects individuals who fill different roles in the same sport—baseball pitchers as compared to other players, for example. Similarly, more precise tests should be made of the influence of REST on different performance components in one sport (e.g., throwing, batting, and fielding) or the various components of such events as the decathlon or pentathlon.

The compatibility between the results of this study and those of the four previous experiments using flotation REST to improve athletic performance (Lee & Hewitt, 1987; McAleney et al., 1990; Suedfeld & Bruno, 1990; Wagaman et al., 1991) lends strength to the claim that flotation per se is indeed an effective tool in this regard. Additional support comes from findings that flotation REST reduces anxiety and enhances performance in both simulated (Melchiori & Barabasz, 1990) and actual (Barabasz, 1992) instrument flying, implying that a wide range of relatively precise perceptual-motor coordination and focusing skills may be improved through the use of REST. Future research will need to address the issue of identifying the limits of REST's effectiveness in enhancing such performances.

A note on the practical implications of these data is also appropriate. Flotation tanks are both easily affordable and accessible. Hutchison's (1984) report that several professional teams in the United States already possess and use tanks is fully credible. Many health clubs and other commercial facilities throughout North America, Europe, and Australia "rent" tank time, usually at around $20–$25 per hour. Athletes and trainers need not rely on the presence of such a facility in their area. Tanks can be bought for under $2,000; their maintenance requirements are of approximately the same order as that of a whirlpool or Jacuzzi, with the exceptions that they should be located in a quiet room and only one person can use them at a time. The usefulness of REST in the context of sport does not need to remain a theoretical issue: flotation tanks can easily be made available to many athletes.

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