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RESTRICTED ENVIRONMENTAL STIMULATION TECHNIQUE IMPROVES HUMAN PERFORMANCE: RIFLE MARKSMANSHIP[1,2]

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Summary.—This study controlled for relaxation and guided imagery confounds noted in much previous research on enhancement of human performance using the restricted environmental stimulation technique (REST). Dry flotation REST was used where subjects lay ("floated") on a salt-water-filled bladder in a sound-attenuated, light-free chamber. 9 men and 3 women in a rifle marksmanship training course, exposed to dry-flotation REST, showed significantly higher rifle marksmanship scores than the university students who as matched controls were exposed to relaxation (9 men and 3 women). Further, only the former showed a significant pre- to posttest improvement in scores, which suggests REST's positive effects on marksmanship go beyond the induction of relaxation by hypnosis. The results support hypotheses summarized in 1982 by Barabasz regarding potentiation by REST of internally generated imagery and subsequent improvement observed in a nonREST posttest environment.

The reduction of external stimulation was once thought to elicit the ascendence of phylogenetically older and lower levels of neuronal integration in the organization of brain functions and behavioral regulation. The process was thought to reverse upon resumption of normal stimulation (Reyher, 1964; Sanders & Reyher, 1969). Were this true, effects on human performance skills produced by reduced stimulation would not be observed in the context of normal stimulation. The hypothesis was rejected. Instead, the earlier sensory-deprivation work and later, especially the restricted environmental stimulation (REST), appears to "force the organism to focus, perhaps as seldom before, on internally generated imaginal activity" (Barabasz, 1982, p. 162). This dissociative reaction serves to maintain integration of brain function and follow-up data gathered 10 to 14 days after REST showed that this imagery or absorptive capacity, acquired during REST, could be reactivated later in the normal environment (Barabasz, 1982; Barabasz, Barabasz, & Mullin, 1983). It is noteworthy that such REST-produced imaginal capacity is achieved without any formally specified guided imagery during REST.

Curiously, when REST was introduced in an effort to improve sports performance, studies often combined guided imagery with wet flotation REST (wet-REST). In all of these studies, participants floated supine on a solution of water at skin temperature and epsom salts in a pleasant light-free,

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sound-attenuated tank resembling a large enclosed bathtub. Lee and Hewitt (1987) used multiple wet-REST sessions with novice and intermediate competitive gymnasts and found later improvement in judges' ratings of performance. Our first studies which included expert collegiate athletes (Wagaman & Barabasz, 1990; Wagaman, Barabasz, & Barabasz, 1991) compared multiple sessions of wet-REST and guided imagery with imagery-only training. Wet-REST subjects showed significantly greater improvement in objective basketball performance and on coaches' blind ratings of passing and shooting than subjects in the imagery-only group. For recreational basketball players, Suedfeld and Bruno (1990) reported a significant improvement in basketball foul-shooting after a single session of wet-REST with guided imagery in contrast to an imagery-only or no-treatment control condition. McAleney, Barabasz, and Barabasz (1990) showed wet-REST with guided imagery produced significantly greater improvement for winners of a first service in tennis during actual intercollegiate play than did imagery-only training.

These recent studies show an improvement in sports skills after exposure to wet-REST when specific guided imagery was used during REST. The most dramatic effects appear when the required performance is essentially under the complete control of the individual (e.g., first service in tennis, basketball foul-shooting) rather than interactive.

Despite the apparent promise of this intervention, no data are available to assess the effects of the wet-REST procedure on human performance without guided imagery. This is remarkable considering our original REST studies showing potentiation of imagery did not include guided imagery (Barabasz, 1982; Barabasz, *et al.*, 1983). Further, there is evidence that expert athletes perceive guided imagery during REST to have an interfering effect on the positive effects of REST (McAleney, *et al.*, 1990). The introjection of taped or live auditory guided imagery during REST might be expected to attenuate effects of REST following the potentially distracting effects on mental processes of the auditory stimulation.

REST is also known to produce profound relaxation (Barabasz, Barabasz, Dyer, & Rather, 1993; Jacobs, Heilbronner, & Stanley, 1984; Turner & Fine, 1982) similar to that which can be produced by a hypnotic induction (Miller, Barabasz, & Barabasz, 1991). To date, no data are available contrasting REST alone with any procedure, such as hypnosis, known to produce deep relaxation.

A new form of REST using a "dry-flotation" methodology has been developed. This form of REST is more convenient and easier to use than the conventional wet-REST. For example, use of "dry-flotation" REST precludes the need for subjects to shower before and after sessions. Maintenance, clean-up, and germicidal requirements of dry-flotation REST are

considerably less demanding and more economic than those for wet-REST. Unfortunately, other than a few promising case studies (Barabasz, 1993), there are no data to support this method as a legitimate alternative to conventional wet-REST methodology for enhancement of performance.

The present study tested the efficacy of dry-flotation REST against a relaxation control group without the use of guided-imagery training in either condition. Rifle marksmanship was chosen because an effect of REST has been described as altering subjects' electroencephalograms in ways which are associated with attentional processing (Barabasz, 1990; Crawford, 1993) and because mental control of attention is seen as essential to high performance in marksmanship (Hall & Hardy, 1991). We hypothesized that subjects exposed to dry-REST would show significantly higher marksmanship scores than their matched controls and significant enhancement of scores from pre- to post-REST.

METHOD

Subjects

Subjects were enrolled in a university rifle marksmanship training class taught by Army Reserve Officer Training Corps (ROTC) instructors. Twenty-four volunteers were assigned into either a control or an experimental group (9 men and 3 women in each group). Control and experimental groups were matched, within 3 points (range 51 to 91), on the basis of marksmanship scores in the unsupported prone position. These data were obtained on a standardized class target-shooting test identical to that used in this experiment.

Apparatus

A Relaxation Dynamics brand dry-flotation REST chamber (2.4 m × 1.2 m × 1.4 m) was employed for experimental subjects. It is constructed of fine finished wood and contains 800 pounds of silica sand between double walls to produce a sound-attenuated environment. It stands on antivibration, sound-isolating mounts and is lightproof when the subject-activated doors are closed. Subjects lie or "float" supine on a low tactile fabric-covered bladder filled with about 12-cm deep salt water solution. The solution was maintained at 35° C (± .2° C). The positive-pressure, silent ventilation system includes charcoal filtration and a negative ion generator.

Procedure

Control group.—Considering the concept that experimental demand characteristics can be manipulated but not controlled in this procedure (e.g., Barabasz & Barabasz, 1992; Barabasz, Barabasz, & O'Neill, 1991), the control condition was structured to maximize subjects' expectations for improved marksmanship. However, its primary purpose was to make it possible

to assess whether potential improvements in performance previously associated with REST were associated with something other than relaxation. The use of hypnosis to produce relaxation was explained, and hypnosis procedures were given a rational basis (Barabasz & Barabasz, 1992). The relationship between learning to relax and enhanced marksmanship was described (Hall & Hardy, 1991). Subjects were then individually hypnotized, using the standardized deep relaxation induction from the Stanford Hypnotic Clinical Scale (Morgan & Hilgard, 1975). No attempt was made to provide any form of guided imagery, but subjects were told to use what they had learned about self-relaxation to help their marksmanship performance.

Experimental group.—Subjects in the experimental group were oriented to the experimental procedures and apparatus. Their questions were answered. They then spent 50 minutes in the dry-flotation chamber. There was no attempt to provide any form of guided imagery before, during, or after REST.

Once subjects had participated in the above experimental or control conditions, marksmanship skill was assessed within 48 hours at the Washington State University rifle range. The test, based on the U.S. Army Marksmanship Guide (U.S. Army, 1980), was conducted under the supervision of the ROTC instructors. All shots were fired using the unsupported prone position. All subjects completed 10 shots in no more than 10 minutes using official competition NTC small-bore rifle targets placed at a distance of 15 meters. Targets were scored blind with respect to subjects' group membership by ROTC cadet instructors, by deducting points from a possible total of 100 using the U. S. Army procedure (U.S. Army, 1980). Postexperimentally, subjects were asked how they might have used their experience to improve their marksmanship.

RESULTS

A between/within split-plot analysis of variance for correlated samples was conducted using the pre- and posttreatment scores from the experimental and control groups; see Table 1. This over-all analysis was significant for between- ($F_{1,22} = 5.8$, $p < .03$) and within-groups comparisons ($F_{1,22} = 9.1$, $p < .006$).

Univariate analyses of variance were interesting. Prior to treatment there was no significant difference between groups ($F_{1,22} = .44$, $p > .05$). After treatment the scores of the experimental (REST) subjects were significantly higher than those of the relaxed (hypnotized) control subjects ($F_{1,22} = 10.8$, $p < .003$). Within groups, the relaxed control group showed no significant difference from pre- to posttest ($F_{1,11} = 2.7$, $p > .05$), while the REST group showed significant enhancement of their scores ($F_{1,11} = 8.0$, $p < .01$).

Analysis of responses to the postexperimental inquiry appeared to suggest that REST may have potentiated subjects' internally generated imagery.

TABLE 1
MEANS AND STANDARD DEVIATIONS: NUMBER OF SHOTS OUT OF 100 ON TEST BEFORE AND AFTER DRY-REST FOR TWO GROUPS (*n*s = 12)

Group	Pre-REST		Post-REST		No. Showing Improvement
	M	*SD*	*M*	*SD*	
REST	79.9	8.7	86.1	8.9	9
Relax*-Control	77.3	10.2	72.4	11.3	3

*Hypnosis-induced.

For example, those who improved their scores noted "I kind of went through the steps (aiming-firing procedure)." "In there [the dry "float"], I felt like I was actually doing it." "I could almost feel squeezing the trigger and then watching the bullet travel to the target perfectly." The three REST subjects who did not improve their scores admitted falling asleep or engaging in satisfying fantasies unrelated to their marksmanship performance. One such subject reported increased confidence in shooting "like I dreamt I got a perfect score" but no imagery regarding any marksmanship procedures. The majority of the control group ($n = 9$ of 12) indicated that they used the relaxation (hypnotic) procedure at least once during the time before testing. Most felt improved confidence, "I'm sure I had better control" or "I was more focused when I rehearsed (the aiming procedures) in my mind before shooting."

DISCUSSION

The findings of this investigation provide the strongest evidence, to date, of the effectiveness of dry-REST in the enhancement of university students' skill in rifle marksmanship. The REST subjects significantly outscored their matched controls. Further, only the experimental REST subjects showed significantly improved marksmanship scores at posttreatment over the pretest scores.

This was the first study of rifle marksmanship in our laboratory to isolate the effects of dry-REST from those wrought by guided-imagery training during wet-REST. In contrast to earlier studies, this one was not confounded by combining guided imagery with the dry-REST procedure. Neither the experimental nor the control groups were given imagery training. The observations of the postexperimental inquiry are informative as they support the conceptualization developed in our original REST ("chamber") absorption studies (Barabasz, 1982; Barabasz, *et al.*, 1983). The findings do support the hypothesis that dry-REST potentiates internally generated imaginal activity (subjects' spontaneous imaging) and that such activity can be reactivated, at will, sometime after the REST experience despite the intrusion of normal levels of stimulation. The present study confirms that performance-enhancing imagery can occur during dry-REST without the necessity of guiding the im-

agery which has been reported to interfere or attenuate the general reduction in stimuli so important to the REST environment.

This study shows that the positive effects of dry-REST on rifle marksmanship go significantly beyond those produced by relaxation using hypnosis. Barabasz (1982) hypothesized that subjects learn to develop imaginative involvements during dry-REST, a dissociative process, as a defensive maneuver to cope with reduced stimulation. Consistent with Hilgard (1974), Barabasz (1982, p. 163) concluded that "these skills, once learned, may account for the maintenance of this talent over time." We now speculate that enhancement of performance after dry-REST might reflect a coalescing effect perhaps in the precipitation of a new ego state (Watkins & Watkins, 1986) which the subject can then call upon as needed when situations require such skills. Tests of these notions should be undertaken. This investigation is also unique as a controlled study which demonstrates the effectiveness of dry flotation REST compared with hypnosis. The technique further simplifies and makes more economic the use of REST in a wider variety of settings with athletes.

Further research is currently being completed on the effects of REST on marksmanship which compares both wet- and dry-float methods and conditions of guided-imagery versus nonimagery. Work is designed to estimate the optimal number and spacing of the dry-REST sessions (Bauman, Barabasz, & Barabasz, in preparation). Attempts to identify the underlying mechanisms of REST are also underway using electroencephalographic topographic mapping and evoked potentials.

REFERENCES

BARABASZ, A. (1982) Restricted environmental stimulation and the enhancement of hypnotizability: pain, EEG alpha, skin conductance and temperature responses. *International Journal of Clinical and Experimental Hypnosis*, 30, 147-166.

BARABASZ, A. (1990) Effects of sensory deprivation on EEG theta and skin conductance. Paper presented at the Fifth International Congress of Psychophysiology, Budapest, Hungary, July 9-13.

BARABASZ, A. (1993) Enhancement of human performance skills. Paper presented at the Fifth International Conference on REST, Seattle, WA, February 26-28.

BARABASZ, A., & BARABASZ, M. (1992) Research designs and considerations. In E. Fromm & M. Nash (Eds.), *Contemporary hypnosis research* New York: Guilford. Pp. 173-200.

BARABASZ, A., BARABASZ, M., DYER, R., & RATHER, N. (1993) Effects of chamber REST, flotation REST and relaxation on transient mood states. In A. Barabasz & M. Barabasz (Eds.), *Clinical and experimental restricted environmental stimulation: new developments and perspectives*. New York: Springer-Verlag. Pp. 113-120.

BARABASZ, A., BARABASZ, M., & O'NEILL, M. (1991) Effects of experimental context, demand characteristics and situational cues: new data. *Perceptual and Motor Skills*, 73, 775-786.

BARABASZ, M., BARABASZ, A., & MULLIN, C. S. (1983) Effects of brief Antarctic isolation on absorption and hypnotic susceptibility. *International Journal of Clinical and Experimental Hypnosis*, 31, 235-238.

BAUMAN, J., BARABASZ, A., & BARABASZ, M. (in preparation) The effects of wet and dry flotation restricted environmental stimulation technique (REST) on marksmanship.

CRAWFORD, H. (1993) Psychophysiological comparisons of REST and hypnosis: implications for future research. In A. Barabasz & M. Barabasz (Eds.), *Clinical and experimental re-*

stricted environmental stimulation: new developments and perspectives. New York: Springer-Verlag. Pp. 175-186.

HALL, E., & HARDY, C. (1991) Ready, aim, fire . . . relaxation strategies for enhancing pistol marksmanship. *Perceptual and Motor Skills*, 72, 775-786.

HILGARD, J. R. (1974) Imaginative involvement: some characteristics of the highly hypnotizable and nonhypnotizable. *International Journal of Clinical and Experimental Hypnosis*, 22, 133-156.

JACOBS, G. D., HEILBRONNER, R. L., & STANLEY, J. M. (1984) The effects of short term flotation REST on relaxation: a controlled study. *Health Psychology*, 3, 99-102.

LEE, A., & HEWITT, J. (1987) Using visual imagery in a flotation tank to improve gymnastic performance and reduce physical symptoms. *International Journal of Sport Psychology*, 18, 223-230.

MCALENEY, P., BARABASZ, A., & BARABASZ, M. (1990) Effects of flotation restricted environmental stimulation on intercollegiate tennis performance. *Perceptual and Motor Skills*, 71, 1023-1028.

MILLER, M., BARABASZ, A., & BARABASZ, M. (1991) Effects of active alert and relaxation hypnotic inductions on cold pressor pain. *Journal of Abnormal Psychology*, 100, 223-226.

MORGAN, A., & HILGARD, J. R. (1975) Stanford Hypnotic Clinical Scale. In E. R. Hilgard & J. R. Hilgard (Eds.), *Hypnosis in the relief of pain*. Los Altos, CA: Kaufmann. Pp. 209-221.

REYHER, J. (1964) Brain mechanisms, intrapsychic processes and behavior: a theory of hypnosis and psychopathology. *American Journal of Clinical Hypnosis*, 7, 107-119.

SANDERS, R. S., & REYHER, J. (1969) Sensory deprivation and the enhancement of hypnotic susceptibility. *Journal of Abnormal Psychology*, 74, 375-381.

SUEDFELD, P., & BRUNO, T. (1990) Flotation REST and imagery in the improvement of athletic performance. *Journal of Sport and Exercise Psychology*, 12, 82-85.

TURNER, J. W., JR., & FINE, T. H. (1982) Use of a restricted environmental stimulation technique (REST) for induction of relaxation: effects on plasma cortisol, ACTH and LH. Paper presented at the meeting of the Society of Behavioral Medicine.

U.S. ARMY. (1980) *The United States Army pistol marksmanship guide*. Washington, DC: U.S. Government Printing Office.

WAGAMAN, J., & BARABASZ, A. (1990) Effects of flotation REST on collegiate athletic performance: basketball. Paper presented at the Fourth International Conference on Restricted Environmental Stimulation, Washington, DC, March 22-23.

WAGAMAN, J., BARABASZ, A., & BARABASZ, M. (1991) Flotation REST and imagery in the improvement of collegiate basketball performance. *Perceptual and Motor Skills*, 72, 119-122.

WATKINS, J. G., & WATKINS, H. H. (1986) Ego states as altered states of consciousness. In B. B. Wolman & M Ullman (Eds.), *Handbook of states of consciousness*. New York: Van Nostrand Reinhold Pp. 133-158.

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