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Flotation restricted environmental stimulation therapy (REST) as a stress-management tool: A meta-analysis

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Abstract
In this study we investigated the value of flotation Restricted Environmental Stimulation Therapy (REST) as a stress-management tool. We focused on the physiological effects of REST, its influence on well-being, and on performance. Twenty-seven studies published in 25 articles or book chapters were included in a meta-analysis. The total number of participants was 449, with a mean age of 29 years (ranging between 20 and 45). Sixty-four percent was male and 36% was female. The results showed that REST has positive effects on physiology (e.g., lower levels of cortisol, lower blood pressure), well-being, and performance. The pre–post mean effect size and the overall randomized control group effect size were relatively strong. This suggests that despite some limitations of the original studies, flotation REST can be a useful stress management tool in addition to or instead of other stress management tools.

Keywords: *Flotation REST, stress management, well-being*

Secondary prevention is one of the approaches to effectively deal with stress and diminished well-being. It aims at reducing the severity of stress symptoms before they may become harmful (Murphy, 2002). Relaxation techniques are probably the most popular stress-management methods used in secondary prevention. These techniques focus on reducing muscle tension, calming the mind, reducing symptoms of stress, and improving well-being. Popular techniques are progressive muscle relaxation (PMR, Jacobson, 1938), biofeedback, autogenic training, and meditation. Studies have shown that such relaxation techniques are indeed successful in achieving their goals, namely the reduction of stress levels (Lohaus & Klein-Hessling, 2003; Murphy, 2002; van der Klink, Blonk, Schene & van Dijk, 2001).

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A less familiar relaxation technique is flotation Restricted Environmental Stimulation Therapy (REST), introduced by John Lilly (1977). The term REST was coined by Suedfeld (1980) as an alternative to the term sensory deprivation. We will hereby exclusively focus on flotation REST. Flotation REST aims at reducing the level of environmental stimulation to a minimum and achieving a sense of near weightlessness through floating in a salt-water solution. Chamber REST, where a participant lies on a bed for several hours (up to 24 h) in a room that is completely dark and soundproof, is beyond the scope of this article. Although chamber REST has been established as a intervention technique for the reduction or elimination of smoking, alcohol abuse and overeating (Suedfeld & Borrie, 1999), flotation REST has the advantage over chamber REST that it can easily be employed in a clinical or therapeutic setting due to its relative short duration of exposure.

In a typical flotation REST session, participants are lying in a quiet, dark tank filled with water warmed to skin temperature and saturated with Epsom salts (Mg_2SO_4). This solution allows the participant to float supine, with the face and ventral portion of the body above the water line. Due to the density of this salt-water solution, it is impossible to accidentally turn over, and participants may safely sleep or daydream. The tank usually resembles a large box or bathtub with a massive top that can be closed, so it becomes a completely dark and almost soundproof enclosure. An average flotation session takes around 45 min. This comfortable, controlled setting generally brings about an automatic relaxation response. A flotation session can be stopped at any desirable moment.

In this article it is investigated whether flotation REST is an alternative or a supplement to other stress-management instruments. Previous research on REST was integrated using meta-analysis. Although there have been narrative reviews on REST (e.g., Suedfeld, 1980; Suedfeld & Borrie, 1999), up to now, no meta-analysis has been published. Flotation REST research can profit much from a quantitative review; many studies have only small sample sizes (less than ten subjects is no exception) which can lead to problems with meeting statistical assumptions, the estimation of parameters and the influence of outliers, thereby preventing generalization and making error variance a clear threat.

Our research addresses the effects of flotation REST as a stress-management tool with a three-fold focus. First, following positive outcomes with other relaxation techniques (e.g., meditation and biofeedback), several researchers have focused on the extent that REST lowers blood pressure and brings down cortisol levels. Second, REST can be classified as emotion-focused coping, which primarily aims at the reduction or eliminating the symptoms of stress, the ultimate goal is a state of profound muscle relaxation that allows one to release stress and reduce levels of arousal. It is therefore likely that by reducing the heart rate and muscle tension, REST will make people feel better. Wickramasekera (1993) suggested that the sensory restriction during flotation REST and the muscle relaxation that results from floating in salt-water are important mechanisms for reducing sympathetic activity and negative affect. Third, the effect on performance is studied. Especially in situations requiring precise perceptual-motor coordination where high arousal is detrimental for optimal performance, for example, in sports like tennis and target shooting, it is to be expected that using a technique like REST may help to reduce the level of arousal whereby more optimal levels may be attained and performance improved. Other relaxation techniques have also shown to be effective in sports (e.g., biofeedback, DeWitt, 1980).

Our central research question, therefore, is to what extent flotation REST can be a useful stress-management tool. Using meta-analysis, we will focus first on its physiological effects, then on the influence on well-being, and finally we will study its effects on performance.

Method

Search and inclusion criteria

First, a computerized search into the two databases Medline and Psycinfo (1980–2002) was used to identify appropriate studies for the present meta-analysis. The following search terms were used: 'REST' and 'Restricted Environmental Stimulation'. Second, the studies cited in the review article of Suedfeld and Borrie (1999) were checked. Third, conference proceedings of the International Conference on REST and Self-regulation were scanned for unpublished studies. There were two main criteria for studies to be included into the meta-analysis: (1) They had to examine the effects of flotation REST, and (2) the outcomes had to be either physiological measures directly related to activation (e.g., blood pressure, level of cortisol, and level of adrenaline), psychological measures of well-being (e.g., negative or positive affectivity), or performance outcomes of activities involving a physiological component (e.g., archery, basketball). There were no qualitative criteria on the basis of which studies could be excluded. Any study that reported the necessary information to calculate an effect size was included.

Statistical analysis

The statistical analyses were conducted according to the guidelines provided by Lipsey and Wilson (2001). Their book provides formulas to calculate Cohen's d directly from means and standard deviations and indirectly from several other statistics (e.g., F, t, r, and p). Cohen's d represents the standardized mean difference between either the pre-intervention mean and post-intervention mean or the experimental group mean and the control group mean. For studies that used multiple outcomes variables, the effect sizes were averaged into one Cohen's d. The MS Excel Effect Size Computation Program developed by Wilson (see Lipsey & Wilson, 2001) was used to compute effect sizes.

In calculating the mean effect size across studies, the standard error of the effect size should be taken into account (Hedges & Olkin, 1985). Smaller samples give larger standard errors, and a larger standard error leads to a less precise effect size. To deal with varying sample sizes, the recommended weight given to each study is the inverse of its squared standard error value (for an elaborate explanation see Lipsey & Wilson, 2001).

The mean effect sizes of the studies in a meta-analysis usually show variance. A homogeneity analysis is employed to determine whether the variance of effect sizes among the studies is larger than could be expected from chance alone. In a homogeneous distribution, the effect sizes are spread around the mean, the deviation being not larger than could be expected from the sampling error alone. The homogeneity test used in this study is based on the Q-statistic, which has a chi-square distribution. Additional analyses into possible moderating effects are only warranted when the value of Q reaches significance.

Results

Description of studies

Twenty-seven studies published between 1983 and 2002 in 25 articles or book chapters met the required criteria. Fifteen studies were published in peer-reviewed journals; the remaining 12 were published in books based on papers presented at one of the yearly conferences on REST. Ten studies included physiological measures (e.g., cortisol or adrenaline levels, and blood pressure levels). Ten studies included measures of well-being

Table I. Effect sizes by study and outcome measure.

Outcome measure	N_{exp}	N_c	$d_{pre-post}$	$d_{exp\ c}$
Physiological				
Fine & Turner (1985)	6		1.13	
Fine & Turner (1987)	4		1.22	
Jacobs, Heilbronner & Stanley (1985)	14		0.88	
McGrady, Turner, Fine & Higgins (1987)	6	11	1.29	0.67
Ruzyla-Smith & Barabasz (1993)	22		0.43	
Schulz & Kaspar (1994)	5	5	1.00	0.25
Turner & Fine (1983)	5	5	0.21	0.46
Turner & Fine (1990)	15	12	0.73	0.84
Turner, Fine, Ewy, Sershon & Freundlich (1989)	21		1.24	
Turner, Gerard, Hyland, Nieland & Fine (1993)	10	9	2.02	0.46
Well-being				
Barabasz, Barabasz, Dyer & Rather (1990)	15	15	0.90	0.91
Kjellgren, Sundequist, Norlander & Archer (2001)	20	17	0.53	0.84
Kuola, Kemp, Keane & Belden (1987, 1)	80		1.14	
Kuola et al. (1987, 2)	54		1.40	
Mereday, Lehman & Borrie (1990)	6		0.89	
Pudvah & Rzewnicki (1990)	5		1.39	
Suedfeld, Ballard & Murphy (1983)	27		1.58	
Suedfeld & Eich (1995, 1)	16	16		1.21
Suedfeld & Eich (1995, 2)	12	12		0.76
Wallbaum, Rzewnicki, Steele & Suedfeld (1991)	4	5	1.37	0.74
Performance				
Atkinson (1993)	15	15	0.98	0.66
McAleney, Barabasz & Barabasz (1990)	10	10	0.44	1.01
Melchiori & Barabasz (1990)	10	10	0.47	0.00
Norlander, Bergman & Archer (2001)	20	20		0.44
Suedfeld & Bruno (1990)	10	10	1.20	1.78
Suedfeld, Collier & Hartnett (1993)	10	10	0.43	0.54
Wagaman, Barabasz & Barabasz (1991)	11	11	0.80	0.68

(e.g., positive affectivity, optimism, anxiety, and depression). Seven studies included performance measures (e.g., archery performance and flight performance).

The quality of the designs and of the reported data varied. Seventeen studies used a randomized control group design. Ten other studies reported only pre- and post-data. In order to retain as much of the information in the original studies as possible, both the pre–post effect sizes and the randomized control group effect sizes are reported. The pre–post effect size compares the mean on a particular dependent variable before and after the floating sessions. The randomized control group effect size, then compares the mean on the dependent variable of the experimental group with that of the control group. The control conditions differed among the studies. Persons were either asked to participate in a relaxation exercise ($n = 5$), to sit alone on a couch in silence ($n = 7$), to do a biofeedback exercise ($n = 2$), or were free to do what they wanted without any explicit instruction ($n = 3$). As can be seen from Table I, the number of participants in the studies varied considerably, ranging from 4 to 80. The total number of participants was 449, with a mean age of 29 years (ranging between 20 and 45). Sixty-four percent was male, 36% female. There was also a considerable range in the time frame of the studies, about half the studies (13 to be exact) focused on the effects of one session, other studies asked the participants to return for more sessions (up to once week) within a time period ranging from 2 to 28 weeks.

Table II. Effect size and confidence intervals for pre–post measurement.

Outcome measure	No. of studies	No. of participants	$d_{pre-post}$	95% Confidence interval
All measures	24	421	1.02	0.91–1.12
Physiology	10	119	1.01	0.79–1.23
Well-being	8	226	1.09	0.95–1.22
Performance	6	76	0.72	0.44–1.00

Table III. Effect size and confidence intervals for studies with a randomized control group design.

Outcome measure	No. of studies	No. of participants	$d_{exp-control}$	95% Confidence interval
All measures	17	387	0.73	0.52–0.94
Physiology	5	83	0.59	0.15–1.04
Well-being	5	132	0.92	0.56–1.28
Performance	7	172	0.65	0.34–0.96

Table II shows an overall pre–post mean effect size of 1.02. The homogeneity analysis shows a significant effect ($Q_{(23)} = 50.92$, $p < 0.001$). The differences in mean effect size between the three outcome measures approach significance ($Q_{(2)} = 5.54$, $p = 0.06$). The mean effect size for the physiological measures ($d = 1.02$; $Q_{(9)} = 15.12$, $p = 0.09$) and the well-being measures ($d = 1.09$; $Q_{(7)} = 26.03$, $p < 0.001$) are similar. The homogeneity analysis indicates a heterogeneous distribution for the studies using well-being measures. The mean effect size for performance is lower than the mean effect size for the other two measures, although still large ($d = 0.76$; $Q_{(5)} = 4.23$, $p = 0.52$); the distribution appears to be homogeneous.

Given the heterogeneous distribution of the effect sizes using the well-being measures, it was investigated whether the time frame of the study was of any influence on the degree in which changes in well-being took place. It was hypothesized that participants who had used flotation REST for a longer period of time would show a greater improvement in well-being. This was confirmed by the outcomes of the analysis ($Q_{(1)} = 7.59$, $p = 0.005$). The mean effect size of short-term studies (with a time frame of three weeks or shorter) was 0.87 (95% confidence interval: 0.67–1.08); for the long-term studies (with a time frame of six months) the mean effect size was 1.25 (95% confidence interval: 1.07–1.42).

For studies with a randomized control group design, Table III shows an overall effect size of 0.73. The homogeneity analysis shows that the distribution of the effect sizes around the mean effect size is homogeneous ($Q_{(16)} = 11.53$, $p = 0.78$). Although the differences in mean effect size between the three outcome measures are not significant ($Q_{(2)} = 2.87$, $p = 0.23$), we do report them in Table III in order to give a complete overview of the scores. The mean effect size of the physiological measures is 0.59 ($Q_{(4)} = 0.81$, $p = 0.94$), for the well-being measures the mean effect size is 0.92 ($Q_{(4)} = 0.09$, $p = 0.99$), and for the performance measures the mean effect size is 0.65 ($Q_{(4)} = 7.76$, $p = 0.26$).

Discussion

The central aim of this study was to investigate the extent to which flotation REST could be useful as a stress-management tool. The results showed that REST has positive effects on outcomes relating to physiology, well-being, and performance. The overall pre–post mean effect size was 1.02. The overall randomized control group effect-size was 0.73. Flotation REST appeared to be more effective compared to other stress reduction techniques, such as relaxation exercises, biofeedback or sitting comfortably on a couch. In the meta-analysis of van der Klink et al. (2001), relaxation techniques (which did not include REST) showed a mean effect size of 0.35. This indicates that REST can be considered a technique with impact similar to that of other, more popular, stress management techniques. Compared to other studies on stress and coping (Lipsey & Wilson, 1993), the effects of flotation REST could even be considered high. Their distribution of mean effect sizes among 300 meta-analyses of psychological, educational, and other behavioral interventions, shows that an effect size of 0.73 belongs to the top 25% of effect sizes.

The enhanced effects of REST on well-being found in the long-term studies suggest that the effects of REST become stronger through repeated exposure. It may indicate that participants learned to profit more from their sessions, and that its effects were better integrated. As such, it becomes plausible that the beneficial effects remained after persons ended their REST sessions. Regretfully, no study has yet been conducted with a follow-up weeks (or months) after the last session. Nevertheless, given the lack of standardization of the frequency and duration of the sessions, this long-term effect is noteworthy. Regretfully, the available data does not allow for an exact advice on how many sessions of REST to recommend. We can, however, conclude that more sessions, taken over a longer period of time, are likely to give a better result.

Regretfully, there are two limitations to this meta-analysis that preclude making strong generalizations. The most important limitation of this meta-analysis is the generally small sample sizes of the studies included, which results in a rather high error variance; that could explain why we failed to find any differential effects between various conditions. Missing data and/or outliers are likely to have a huge effect. With small sample sizes, if a few people who do not respond well to REST drop out of the study, the remaining effect size will be quite high. Due to their specific character, REST studies are likely to evoke self-selection bias. It is less likely that such processes explain the effect sizes found in the randomized control-group studies. Nevertheless, one might argue that within these studies, resentful demoralization exists within the control groups. However, the correlation between number of people in a study and effect size was 0.07 (n.s.) with pre–post effect size and 0.22 (n.s.) with randomized control-group effect size, suggesting that the effects of the predominantly small group sizes is limited. A second limitation is the influence of sample bias ('file-drawer problem'). It may be that studies that revealed no significant effect have never been published, nor have been presented at conferences. The number of additional studies with a zero effect that are needed to significantly reduce the effect size can be calculated. For example, in order for the pre–post mean effect size to be reduced to 0.50*SD* (which is still a moderate effect size), it would take 25 studies with a zero effect. For the mean effect in the randomized control group effect to be reduced to 0.50*SD*, it would still take eight studies with a zero effect. We can therefore conclude that sample bias is not likely to undermine our conclusions.

The findings from our study suggest that flotation REST might be a valuable alternative to other stress-management techniques. It has relaxing, mood-, and performance-enhancing effects that seem to be more profound than those of other relaxation techniques. Especially in the field of burnout and chronic fatigue, REST could have practical use. Emotional demands are important causes for burnout, as are difficulties in letting go of the daily troubles and recharging after a day's work (Schaufeli & Buunk, 2002). Higher cortisol levels have been related to higher levels of exhaustion (Melamed et al., 1999). Our results show that REST is most effective particularly in those areas. REST is a technique that deserves more research that takes into account the limitations of previous studies by using larger samples with a randomized design comparing REST to its key elements (sensory deprivation and muscle relaxation), with participants who are neutral towards it effectiveness.

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