

ENHANCEMENT OF SCIENTIFIC CREATIVITY BY FLOTATION REST (RESTRICTED ENVIRONMENTAL STIMULATION TECHNIQUE)

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Abstract

Five psychology faculty members each spent six 90-min sessions sitting alone in their office and six 1-hour sessions floating in a restricted environmental stimulation tank (REST) (warm saline solution, darkness and silence). The order of environments was counterbalanced. During the office sessions and for 30 min after each REST session, subjects dictated ideas concerning their research into a tape recorder. Subsequent self-ratings showed that novel ideas generated after REST were 'better' (more creative) than those developed in office sessions. Interview reports identified experiences compatible with the hypothesis that REST induces a 'twilight state.' Mood ratings showed that REST was associated with trends towards a higher level of vigor and lower levels of tension, anger, depression, fatigue and confusion. These findings support the prediction that REST would facilitate high-level creative behavior and positive affect.

Introduction

Although the study of creative behavior has been burgeoning in psychology during the past 10–15 years, it has been marked by a negative relation between ecological validity and rigor. Experimental studies tend to use unselected subjects, such as university students, rather than individuals of demonstrated creative ability. Measures are artificial and have questionable generality. They assess such behaviors as generating many and/or statistically unusual responses to a question, finding a key concept or word that enables a complex problem to be solved, various verbal and perceptual skills, and showing a high level of responsivity to imagery-related suggestion (see, e.g., Kaltsounis, 1971; Belcher and Rubovits, 1977; Kornfeld, 1984).

Such measures are admittedly objective and quantifiable. But they do not tell us much, or perhaps anything, about the kind of creativity that is important in the world outside the psychology laboratory. For most people, a creative act represents a new advance in some substantive enterprise, contributes to human understanding, enjoyment, appreciation, or welfare, and 'increases the number of islands of the visible in the ocean of the unknown' (Arieti, 1976, p. 5). This kind of creativity is not often measured in experiments; rather, it is the subject matter of a less scientific literature: biographies, autobiographies, philosophical essays, theoretical analyses and ideographic studies.

Unusual is not necessarily creative, and geniuses are hard to enroll in studies. But there is an intermediate level at which many artists, scientists, entrepreneurs, and

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other problem-solvers probably function much of the time. It is this level, specifically the daily creativity of the working scientist, that is the focus of this study.

What conditions affect this kind of creativity? Organizational, sociological and psychological characteristics do so (cf. Taylor and Barron, 1963; Amabile, 1983); so may the level of ambient stimulation, both physical and social. Although there is some evidence in favor of intense stimulation (Osborn, 1953; Berkowitz and Avril, 1969), an absence of distractions and a lowering of arousal may enhance creativity. Techniques that teach the individual to reach these goals—meditation, biofeedback, systematic relaxation, and perhaps hypnosis—have all been reported to have positive effects on creative thinking (McKim, 1974; Martindale, 1975; Gowan, 1978; Nalimov, 1982).

Arieti (1976), in listing some of the conditions that he considers conducive to creativity, includes aloneness. Historically, there is a long list of unquestionably eminent creative individuals whose lives are pervaded with solitude and remoteness. Among these are religious leaders, philosophers and scientists (Suedfeld, 1974): Jesus, the Buddha, Descartes, Rousseau, Thomas Merton, Virginia Woolf . . . all the way to psychology's own Raymond B. Cattell (1972).

Our own major hypothesis is that low stimulation will enhance creative behavior. In its most profound versions, the Restricted Environmental Stimulation Technique (REST) in an experimental chamber or flotation tank offers time out from the usual need to monitor high levels of external stimulation and information, allowing the individual to concentrate on internal processes including thoughts, feelings, memories, etc. Like the techniques mentioned above, but without the need for training, it induces relaxation and lowered arousal. Accustomed sequences and patterns of thought become more flexible and open during the REST experience. Both of these effects should contribute to an enhancement of creativity (Suedfeld, 1980; Fine and Turner, 1985).

REST also incorporates a period of solitude. Arieti implies that the active ingredient in the creativity-related effects of solitude is the lack of external distraction and the opportunity to reduce arousal: 'Aloneness may be viewed as a partial sensory deprivation; to a much smaller degree, it tends to reproduce what experimentally-induced sensory deprivation brings about' (p. 373). If this is so, then a complete REST condition may be even more effective.

Arieti further identifies inactivity and daydreaming as cultivating creative thought. Both of these are prominent features of the REST environment. Similarly, Schubert (1978) argues that 'free time'—unprogrammed activity time—fosters creative behavior. This is exactly the kind of time available in REST, even though Schubert thinks that REST offers too much of a good thing.

It has been hypothesized that creative thought frequently occurs when the individual is in a hypnagogic or other dreamlike state (Ghiselin, 1952; Vernon, 1970) and that creativity is, in the common shorthand, a right-hemisphere activity (Arieti, 1976). Both the increased incidence of hypnagogic states and the greater role of the non-dominant hemisphere have been advanced theoretically as characterizing the changes that occur during REST (Budzynski, 1976, 1983; Suedfeld, 1980). Hypnotic susceptibility has also been identified both with hypnagogy and with creativity (Budzynski, 1976; Bowers and Bowers, 1979), and has been shown to be reliably increased in REST (Barabasz, 1982).

Last, from a psychoanalytic viewpoint, creativity is allied with primary process

and pre-conscious thinking (e.g., Kris, 1952; Kubie, 1958); more specifically, with (a) the control of the content of primary process, and (b) receptive openness to experience (Suler, 1980). The ability to enjoy and control primary process—regression in the service of the ego—and the ability to look at well-established ideas in new ways have been empirically and theoretically linked to REST (Solomon *et al.*, 1961; Myers *et al.*, 1966; Zubek, 1969; Tetlock and Suedfeld, 1976). Thus, there is a multiplicity of theoretical formulations that predict increased creativity as a result of REST.

Empirical research on this issue is sparse. REST was particularly stressful to subjects who scored high on a creativity scale (Levin and Brody, 1974), and impairs performance on experimental tasks usually associated with divergent thinking such as Alternate Uses or making up a narrative (Fuerst and Zubek, 1968; Suedfeld, 1969; Landon and Suedfeld, 1972). However, the findings are not entirely consistent (Berkowitz and Avril, 1969; Oleson and Zubek, 1970; Suedfeld, 1971). Whether or not REST actually enhances imagery is still in question (Hutchison, 1984; Perry and Perry, 1985; Suedfeld *et al.*, 1985–86). High-level creative performance has not been measured, in spite of suggestions that this be done (e.g., Suedfeld, 1980).

Two studies that have looked at intermediate levels of creativity have somewhat more ecological validity than those employing brief 'objective' tests. Shore (1971) reported on three graduate students in physical chemistry, each of whom underwent six 2-hr chamber REST sessions in the course of six months. Content analysis of their verbalizations led to the conclusion that the environment promoted access to pre-conscious material related to the development and modification of scientific concepts. Unfortunately, there were no control groups or comparison environments, and Shore used monotonous rather than reduced simulation. Recent developments in the field make it clear that the effects of one are not necessarily generalizable to the other (Suedfeld, 1980).

In the other relevant experiment, Taylor (1985) used flotation REST and lying on a couch as the experimental and control conditions respectively, and material related to a chemistry program in which the subjects were enrolled as the test topic. The 10 undergraduate students in the former group learned the material better, did especially well if they used visual imagery, and showed superior performance most clearly on difficult questions that required conceptual synthesis rather than merely rote memorization. The last item is buttressed by another report that undergraduate floaters reported almost twice the intensity and frequency of insight experiences of a control group, with all subjects having had previous training in meditation techniques (Bruno *et al.*, 1985).

Some anecdotal material also exists. The prominent American artist Robert Irwin and several colleagues had repeatedly used an anechoic REST chamber at UCLA, for up to 6–8 hr per session; 'The anechoic chamber was helping us to see . . . the extreme complexity and richness of our sense mechanism and how little of it we use most of the time' (Weschler, 1983, p. 53). A psychologist acquaintance of Irwin's said: 'As I gradually learned about his artistic history . . . I came to understand that [Irwin] had been working with sense deprivation long before he entered that anechoic space. . . . And that . . . brought him a very special kind of knowledge' (p. 59).

The quotes confirm the many positive self-reports of creative persons who had participated in REST sessions (Bernstein, 1976; Lilly, 1977; Hutchison, 1984; Perry

and Perry, 1985). These included artists, scientists, writers, social philosophers, and cross-disciplinary creative thinkers such as Gregory Bateson.

The current study, then, was designed to test the hypothesis that REST will enhance the creative performance of individuals, in an ecologically valid but experimental setting. Subsidiary questions were whether there would be a change in the flow of ideas, regardless of their creative quality (cf. Suedfeld, 1969; Suedfeld *et al.*, 1985–86); and whether paralinguistic factors such as speech rate would show an effect.

Method

Subjects

Subjects were seven full-time faculty members of the Department of Psychology at the University of British Columbia. They included the first two authors of this report. To reduce bias, the data generated by the authors were eliminated from analyses based on self-ratings of ideas (see below); they were retained for other analyses (e.g., mood). Mean creativity results and patterns of results were the same either way.

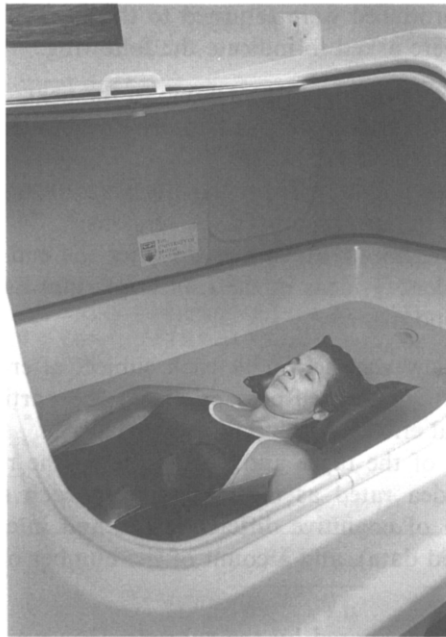
All participants were active researchers, with ongoing research programs and a history of frequent publishing in areas including psychobiology, cognition, perception, social psychology and personality. All but the second author were male. Their academic ranks ranged from University Fellow to Professor, and their ages from the early 30s to the late 40s. Only the first author had previous experience with flotation REST.

Environments

Two environments were used with each subject, in counterbalanced order. One of these (OFFICE) consisted of spending 90 min in one's own office. During this time, the subject was instructed to sit in his or her office chair and speak continuously into a microphone, the topic of speech being any thoughts or material related to scientific work.

The second environment was flotation (REST). This consisted of 60 min floating in a dark, quiet flotation tank (Float to Relax model), with approximately 30 cm of a dense Epsom salts solution in warm water. This enables the subject to float with the face and ventral body surface out of the water, so that breathing is normal. An intercom keeps a monitor in the next room constantly aware of the subject's activities in the tank. Subjects may leave the tank prior to the scheduled end of the session merely by getting up, opening a hatch and stepping out, or they may request the monitor's help. No subject in this study experienced negative reactions that would have made it impossible to complete the float sessions. Subjects were instructed in advance to use their time in the tank thinking about matters relevant to their research (the same instructions as for the OFFICE sessions, except that during REST the subject was instructed not to verbalize these thoughts). At the end of each float session, the subject showered and shampooed rapidly to remove the dried Epsom salts from the body, dressed, and then sat alone in a small office for 30 min with instructions as in the OFFICE phase to speak continuously about research ideas and topics.

Each subject was scheduled to undergo each environment six times, finishing one



series (i.e., OFFICE or REST) before beginning the other. However, scheduling problems resulted in some participants' actually going through fewer than the projected 12 sessions. The range was from 8–12 sessions. Table 1 summarizes the order of events in the two conditions.

TABLE 1
*Research schedule**

REST	OFFICE
Instructions and orientation	Instructions and orientation
Flotation (60 min plus time for pre- and post-showers, dressing)	
POMS	POMS
Dictating ideas (30 min)	Dictating ideas (90 min)
Rate transcribed ideas (1–3 months post-session)	
Interview (After all sessions)	
Identify publications, etc. (12–15 months post-session)	

* Order of REST and OFFICE sessions counterbalanced across subjects

Dependent variables

The Profile of Mood Scales (POMS; McNair, Lorr and Droppleman, 1971) was filled out by each subject immediately prior to the beginning of dictation at each session.

All material generated by subjects in each session was tape-recorded and transcribed. Transcriptions which bore a date but did not indicate the condition in

which they had been produced were returned to the subjects 1–3 months after the session. The subjects were asked to indicate the following:

- (1) Mark the changes from one idea or topic to the next.
- (2) Indicate whether each idea or topic had been new to them, or something they had previously thought about.
- (3) Mark each idea on a 1–10 scale for 'quality' (creativeness). These ratings were made 1–3 months after the completion of the sessions.
- (4) As a last measure, about 12–15 months after the end of participation, each subject was asked to identify ideas in the transcripts that had led to new research publications, grant proposals, etc.

A post-REST interview was held with each subject after the completion of all sessions, with emphasis on the self-perceptions of the participant concerning the cognitive and emotional effects of the REST experience.

Subsequent analyses of the tapes and transcripts by the research team included blind scoring of the idea rated as most creative in each session for integrative complexity, a function of cognitive differentiation and integration (Baker-Brown *et al.*, 1986, unpublished data), and a count of the number of words spoken.

Scoring

As noted, all material was scored by the subjects. However, not all of the scores were used in subsequent analyses. For each environment, the first session was discarded as essentially an orientation to the environment and the task. There is evidence (e.g., Forgays and Bellinson, 1986) that the first session has different affective and physiological effects from later ones, so that it is appropriate to ignore it in multi-session studies.

Although all 90 min of the OFFICE session were scored, only the first 30 min were counted, so that the same period of time was considered in two situations. In choosing a segment of the OFFICE session as a basis for comparison, two factors were crucial: the flow of speech (and ideas) trailed off rapidly after the first 30 min in the OFFICE to a very low level in the last 30 min (in many cases, there were practically no ideas produced during the latter), so that using the initial period made for a more rigorous test of the hypothesis; and the rates of speech, hesitations, and total output were essentially identical between the first portion of the OFFICE tapes and the REST tapes, leaving the content as a relatively uncontaminated dependent measure. This issue is further considered in the discussion section.

Results

Because of the unequal number of sessions experienced by the participants, the data analysis was based on four sessions in each of the two environments. As indicated previously, the first session in each condition was discarded; for those subjects who had five sessions remaining, the last session was ignored as well. All subjects had completed at least four sessions in each environment.

Table 2 presents the results for each subject on the creativity ratings of new ideas; Table 3 shows group mean results in the major categories of dependent variables. These were analyzed by ANOVA (condition \times session) for repeated measures. The difference in the mean quality (creativeness) of new ideas was significant, with REST

TABLE 2
Individual creativity ratings

Subject	Mean (best) New Ideas	
	REST	OFFICE
1	5.92 (8.00)	5.00 (5.25)
2	5.45 (7.00)	5.38 (7.00)
3	6.20 (8.50)	5.56 (7.50)
4	5.71 (7.75)	4.03 (4.50)
5	6.25 (7.00)	4.20 (5.75)
6*	3.65 (4.75)	3.13 (5.00)
7*	4.05 (6.50)	3.84 (7.00)

* Subjects 6 and 7 were the first two authors

TABLE 3
Mean results on ideas (5 subjects)

Measure	REST		OFFICE	
	\bar{x}	S.D	\bar{x}	S.D
Number of old ideas	4.35	4.38	4.60	4.07
Number of new ideas	5.90	2.77	4.65	3.47
Proportion of new ideas	0.66	0.28	0.52	0.30
Quality of old ideas	5.03	2.51	5.17	2.24
Quality of new ideas	5.91	1.01	4.83	1.43
Best old idea	6.60	2.11	6.70	2.18
Best new idea	7.65	1.31	6.00	1.91

leading to higher ratings, $F(1,4) = 8.97$, $P < 0.05$. The same was true for the most creative new idea, $F(1,4) = 7.67$, $P = 0.05$. Session number was a significant main effect on only one measure: the most creative old idea recalled decreased with repeated sessions, $F(3,16) = 4.32$, $P < 0.05$. There were no significant main or interaction effects in the total number of ideas generated, the number of old or new ideas, or the proportion of old to new ideas (see Table 3).

Among the other measures, there was no difference in integrative complexity as a function of environments or previous experience (OFFICE $\bar{x} = 2.63$, REST $\bar{x} = 2.66$). Speech rate did not differ significantly as a function either of environmental condition or session number.

The POMS showed no significant effect for condition. However, ratings immediately after REST showed consistently lower levels than OFFICE on a number of subscales (see Table 4). REST was without exception associated with less negative and more positive mood states.

Post-float interviews were held with each subject after the taping session was completed. The comments were compatible with Budzynski's suggestion that a twilight state is induced in REST (1976). Major features were:

(a) Loosening of the reality-based framework: unawareness of, and removal of 'the self' from, the body; disorientation in space and time; detachment from the environment;

TABLE 4
Mean scores on the Profile of Mood Scales
 (7 subjects)

Subscale	REST	OFFICE
Tension	0.55	0.97
Anger	0.25	0.37
Depression	0.08	0.21
Fatigue	0.24	0.76
Confusion	0.80	0.85
Vigor	1.54	1.25

(b) Suspensions of critical thinking: open-mindedness, thoughts flow freely without intrusion or reflection; 'everything is equally valid'; 'don't have to put everything together'; following chains of random or remote associations; difficulty in thinking linearly; not evaluating thoughts;

(c) Vivid, free imagery: illusions of movement, waves, current moving downstream, increased tactile sensitivity, images of tank and self; kaleidoscope of images and short dreams, excitement; and

(d) 'Experiencing a nonverbal state': no verbal component of experience; 'perceptual mode of just experiencing things'.

One of the seven participants consistently differed from the others in that he did not report such experiences. He continued to think linearly, and indeed mentioned that he found it difficult to change topics of thought. Unlike the other six, much of whose post-float material dealt with theoretical and meta-experimental ideas, he tended to center on details of methodology and apparatus. These results again emphasize the role of individual differences in the response to REST (cf. Zubek, 1969; Forgays and Belinson, 1986).

Six of the subjects responded 12–15 months later to an inquiry concerning papers, articles, grant proposals, etc., that emanated from the ideas developed during the experiment. Although the number was surprisingly high, even for a group of active and productive researchers (over 30 items in progress, submitted, or published), it was difficult to estimate any differences as a function of environment because of the mixture of ideas that went into most papers.

Discussion

The major hypothesis was supported: new ideas generated during REST were rated as more creative than those originating in OFFICE sessions. This was true for both the mean creativity ratings and for the idea rated as the single best one in each session.

The Profile of Mood Scales shows that REST was associated with lower levels of negative moods and a higher level of vigor than the OFFICE condition. This is completely compatible with previous findings (e.g., Suedfeld *et al.*, 1983; Bruno *et al.*, 1985; O'Leary and Heilbronner, 1985). On the other hand, the contrast between the two environments in this regard was not so drastic as to provide a sufficient explanation for their differential effects on creativity.

The limitations of the study include the small sample size, its restriction to

academic psychologists, the use of self-ratings of creativity as a major measure, and differences in procedure between the two conditions besides the crucial office vs. floating distinction (one anonymous reviewer suggested that the post-REST shower might have been a crucial factor).

On the other hand, obtaining significant differences with so small a sample is encouraging, and we wanted to use people whose careers require creative behavior, engaging in that form of behavior, for ecological validity. Subject expectancy was in most cases contrary to our own hypotheses (and to the outcome); in interviews after REST, five of the seven participants judged that floating had either decreased or not affected their level of creativity. Retroactive bias was reduced by the long interval between the sessions and the ratings. Third-party expert ratings of the ideas would be helpful, and were suggested, but several of the subjects demurred. In future studies, the collecting of such assessments should be included in the initial consent form. The ancillary procedural differences, generally dictated by the nature of the environments (e.g., a brief shower is required to remove crusted Epsom salts after a float) seem to us relatively minor.

Perhaps a greater concern is the time involved in the two conditions. It seems important to use the same total length for the OFFICE and REST sessions. Since 1-hr flotation sessions are both modal and are known to be acceptable to almost all subjects, this duration was selected and was to be followed by 30 min to record ideas. We would have preferred an identical procedure for the OFFICE condition, but subjects were reluctant to sit in the office and think for 60 min without saying or writing anything, using the telephone, looking at their books and journals, getting a cup of coffee, etc. For this reason, it was decided to have the entire 90-min session devoted to thinking and speaking into the tape recorder.

The original intention was to use the last 30 min of the OFFICE material as the comparison to the last 30 min (i.e., the recording portion) of the REST session. However, the transcripts made it obvious that most of the ideas were generated in the *first* 30 min of OFFICE dictation, with practically none in the last 30. The planned comparison would have been extremely biased in favor of REST as facilitating the production of ideas, and it was therefore decided to use the most productive portion of the OFFICE sessions in order to make a more conservative test of the REST effect.

The two periods actually compared were, then, a half-hour session immediately following an hour of REST and a half-hour session immediately following the daily activities of the participant. The latter obviously varied; that is, the 30 min of OFFICE dictation used in the analysis followed a variety of normal activities of a working academic. In future research, requiring an hour of relatively quiet time before each OFFICE taping session should be considered.

Although there were no relations between integrative complexity and other measures, the findings do tell us something about the cognitive functioning of our colleagues. The mean level of complexity was quite high. It was comparable to that of 18 eminent individuals from various walks of life (Suedfeld and Piedrahita, 1984), and of eminent diplomats of the nineteenth and twentieth centuries (Wallace and Suedfeld, 1986, unpublished data). It was lower, on the other hand, than the complexity of presidential addresses delivered to the American Psychological Association (Suedfeld, 1985).

The creativity findings add a new step to previous analyses of the cognitive effects

of REST. These had shown performance to vary as a function of task complexity, so that measures of rote learning and memory tended to indicate improvement as a consequence of REST whereas measures of originality (e.g., the Alternate Uses Test) showed deterioration (Suedfeld, 1969). It now appears that extending the complexity dimension to high-level creative (as distinct from the merely statistically unusual) productions results in a reversal of that trend. The curvilinear function between task complexity and performance in chamber REST is reversed in our current data and in those of Taylor (1985), who also used flotation REST. Future research will have to establish whether this reversal is related to the use of the tank, the use of creative subjects performing actual creative activities, or both.

The data confirm a long history of self-reports concerning the role of solitude and reduced ambient stimulation in enhancing creative thought. On the other hand, the brevity, dispersion and small number of experiences in this kind of environment in the current study are very different from the long durations of self-sought stimulus reduction noted in the biographies and autobiographies of creative individuals. It is interesting that such a minor intervention, in the artificial context of an experiment, could still produce the effect.

Although the OFFICE and REST environments had much in common (e.g., solitude, reduced physical activity and external stimulation), REST led to more creative ideas, more positive mood, and in interviews was evaluated as more pleasant. Indeed, we had some difficulty in persuading some subjects to complete the set of six OFFICE sessions, with practically no equivalent problem for REST.

The study pushes back the boundaries of the useful and beneficial applications of REST. Most studies on this topic have dealt with the use of the technique in clinical and health psychology (Adams, 1980; Suedfeld, 1980; Suedfeld and Kristeller, 1982) or with the ability of REST to induce states of deep relaxation (Fine and Turner, 1985). Aside from a few studies concerned with the improvement of memory (Grissom, 1966; Suedfeld, 1969; Taylor, 1985), most reports on positive cognitive applications have been anecdotal (Hutchison, 1984).

Clearly, further research is necessary at this point to remedy the problems noted earlier. A larger sample of naive subjects should be studied, using individuals from a range of creative fields (e.g., music, graphic arts, literature, natural sciences), and with evaluators who are blind as to the conditions under which responses were generated. The use of chamber as well as flotation REST, and in the latter technique, of more and/or longer sessions, should be tested.

The data generated in this study are limited. But in combination with the firm theoretical base, previous research results and massive autobiographical literature summarized in the introduction, they suggest that the potential utility of flotation REST in creativity enhancement may be quite impressive. The exact place of REST in creative productivity—e.g., to which stage of creativity (cf. Wallas, 1926) the experience contributes—should be investigated. Given the ease and economy of the technique, it could be widely adopted as a useful tool by individuals engaged in a wide variety of creative occupations or avocations.

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