



EFFECTS OF FLOTATION REST ON CREATIVE PROBLEM SOLVING AND ORIGINALITY

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Abstract

The purpose of the present study was to explore whether or not flotation restricted environmental stimulation technique (REST) facilitates the creative problem-solving ability and originality. Sample 1 consisted of 40 subjects, 20 men and 20 women, randomly assigned in equal numbers to either a nonREST group (armchair-sitting) or to a floating REST group. Both groups worked on a 'chain puzzle' for 5 min and were then interrupted with 45 min of sitting or floating. The subjects were then given the task of continuing with the creative problem-solving test. Sample 2 consisted of 54 subjects, 27 men and 27 women, randomly assigned in equal numbers to either a nonREST group (armchair-sitting), a dryREST group (lying on a couch in a dark room) or a flotation REST group. The groups then had to fill in a couple of paper-and-pen tests and were given scores on fluency, obvious answers, original answers, elegance and deductive thinking. The results (impaired creative problem-solving ability and higher originality for the floating group) were interpreted as an indication of cognitive function where the primary process still dominates over the secondary process.

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Introduction

The purpose of this investigation is to apply the flotation-isolation technique, a form of sensory deprivation, or, as expressed by the more recent concept, 'restricted environmental stimulation technique' (REST). Earlier experiments conducted with REST often reported negative effects (Zubeck, 1973) such as problems with logical thinking, concentration problems, higher levels of anxiety and even hallucinations. Subsequent research has demonstrated that positive effects may also occur, such as improved relaxation (Jacobs *et al.*, 1984), less anxiety (Fine & Turner, 1982), increased receptivity to information (Aquino, 1982), pain reduction (Turner & Fine, 1984), heart rate reduction (Jacobs *et al.*, 1984) and muscular tension reduction (Stanley & Francis, 1984). Corresponding negative and positive effects are reported for the floating form of REST (e.g. Best & Suedfeld, 1982; Hutchison, 1984; Forgyays & Belinson, 1986; Suedfeld *et al.*, 1987; Suedfeld & Bruno, 1990). Several studies (e.g. Lee & Hewitt, 1987; McAleney *et al.*, 1990; Suedfeld & Bruno, 1990; Wagaman *et*

al., 1991) offer support for the premise that flotation-isolation may reinforce aspects of 'imagery', possibly a prerequisite to the creative process.

Flotation REST has been shown to affect creative performance. For instance, Suedfeld *et al.* (1987) and Forgyays and Forgyays (1992) are two studies directly dedicated to creativity. Unfortunately, both these studies suffer from concomitant methodological problems, as described by the authors. Concerning the study of Suedfeld *et al.* (1987), there were only seven subjects, including two of the authors of the report. The self-report result, however, indicated that subjects experienced 'better' new ideas directly following floating rather than simply after sitting in their offices. Forgyays and Forgyays (1992) lost 25 per cent of their subject population due to a procedural problem in connection with data collection. This proportion of 'missing data' is disconcertingly large in view of the small, though significant, differences obtained (i.e. the floating group succeeded better than the control group) with a divergent test that measured fluency. Another problem with the latter study pertains to the fact that the

authors allowed their subjects to, amongst other things, work with a difficult convergent problem, a so-called 'brain-teaser', during the ongoing isolation. The risk with this procedure is that these subjects, due to this mental activity, were preoccupied with largely irrelevant 'analytical' stimuli, thereby being retained within the secondary process. This situation presupposes a radically different experimental set-up to that ordinarily considered during flotation REST.

The capacity of alcohol intake to alter the balance between the primary and secondary processes (Norlander, 1997) may result in both positive and negative effects for the creative process, as for example heightened originality during intoxication (Hajcak, 1976; Norlander & Gustafson, 1998) or directly after intoxication (Norlander & Gustafson, 1996), improved restitution (Gustafson & Norlander, 1995), decreased deductive ability (Gustafson & Norlander, 1994), less persistent effort (Gustafson & Norlander, 1994), a deterioration in flexibility (Norlander & Gustafson, 1998) and, thereby, a deterioration in problem-solving ability (Hajcak, 1976). Further, a decrease in handicraft-efficiency has been observed (Norlander & Gustafson, 1997). One interesting question in this context would then be whether or not there exists other more suitable techniques, rather than alcohol use, in order to induce the 'shifts of balance', or other combinations, between the primary and secondary processes. These processes may be described as follows: the primary process involves autistic, free-associative and analogical thinking, referring to fantasy, reverie and 'day-dreaming', whereas the secondary process involves the abstract, reality-oriented thought of daily consciousness (Martindale & Dailey, 1996). Several established techniques for inducing 'shifts' (Larsson, 1987a; Larsson & Starrin, 1988; Setterlind, 1990) are available: hypnosis, neuromuscular relaxation, autogenic training, meditation, biofeedback-training, etc. Another effective technique, given the right circumstances, has been found to be long-distance running/jogging (Larsson, 1987b). One problem with the different forms of relaxation exercises remains the complication that those individuals most in need of this training have the most serious problems in relaxing. Consequently, these individuals have problems initiating and/or maintaining the exercises (Maslach, 1988). The 'floating-technique' may have potential as a successful application since it is claimed to produce an immediate and deep relaxation.

The purpose of the present study is to explore whether or not flotation REST facilitates the creative problem-solving ability and originality. The expected ability of this procedure to weaken the secondary process thereby allowing the primary process to remain undisturbed should produce a similar result to that observed under the influence of alcohol, i.e. the creative problem-solving ability (mainly secondary process-oriented) should deteriorate whereas originality (mainly primary process-oriented) should be reinforced. Further, as a control factor, the Logical Deductive Test (secondary process-orientation) should also deteriorate with flotation. The 'cheap necklace problem' (Silveira, 1971; Best, 1995) was applied as a measure of creative problem-solving ability. The type of creativity that different versions of 'chain puzzles' (where the idea is to cut and weld a minimum number of links in order to create different patterns) measure is usually defined as 'adaptive flexibility' (Guilford, 1967). Such tests involve a large amount of 'trial and error': 'Failing in one attempt, E must revise his tactics and attempt another approach. If he is too firmly set on one approach, he is handicapped in doing the test' (Guilford, 1967, p. 152). In order to solve a chain puzzle, a large proportion of logical thought is required; this would not be sufficient if one lacked the ability to view the problem from an alternative perspective, i.e. an 'intuitive leap' (Guilford, 1967). Thus, different versions of chain puzzle creative problem-solving tests offer different estimations regarding the dimensions of ability. As a measure of originality, a technique involving the production, by each subject, of as many associations pertaining to various series of events was assigned. Originality is defined as the 'ability to produce responses that are statistically rare in the population' (Guilford, 1967, p. 154). As a control condition, a deductive test, derived from Holmquist (1974), was applied as a measure of logical-deductive thought.

Method

Experiment 1

Subjects. Forty subjects (20 men and 20 women) were recruited at the University of Örebro. The mean age was 22.03 years (S.D. = 3.23 years, range = 19 to 31), and all were Swedish born. Subjects were randomly assigned in equal numbers (10 men and 10 women) to either 'nonREST' (group 1) or to 'flotationREST' (group 2). There were no (ANOVA)

significant differences ($p > 0.1$) between groups with regard to age, weight or resting pulse (taken at home by the subjects themselves, both in sitting and lying down positions). There were no significant differences (Mann-Whitney U Test) between groups with regard to civil status, consumption of alcohol, breakfast and luncheon habits, amount of training, health status, cultural background, use of tobacco, interest in sports or level of education ($p > 0.07$). There was, however, a significant difference (Mann-Whitney U Test) between groups with regard to their background growing up conditions ($p < 0.01$); subjects in the control group had a more provincial background compared to the floating group.

Design. The control group (group 1) worked on a creative problem for 5 min and then reclined in an armchair for 45 min during which time they were allowed to read magazines which were laid out for them (sitting). Finally they were allowed to continue working on the creative problem either until they had solved the problem or until 30 min (5 min before sitting and 25 min after sitting) had passed. Subjects in the control group had a 'pre-sitting' with the pulse-measuring instrument about 1 week before the designated time for the experiment. No psychological testing was conducted at this point.

The floating group (group 2) worked on the same creative problem as the control group but after 5 min received a 45 min floating session. Then they were allowed to continue the creative problem-solving (chain puzzle) either until a total of 30 min (5 min before floating and 25 min after floating) had passed or until they had completed the task. To allow the subjects to become accustomed to the floating situation and the pulse-measuring instrument, each was called upon to take a floating session about 1 week before the designated time for the experiment. No psychological testing was conducted at this point.

Subjects who managed to solve the creative problem before sitting-time or floating-time (five men, one woman) were consequently removed from the experiment, having solved the problem before the experimental manipulation. For group 1 (the non-REST group) this caused a loss of two subjects and from group 2 (the floating group) four subjects. For the statistical analysis there therefore remained a total of 34 subjects, 18 subjects in the control group (eight men and ten women) and 16 in the floating group (seven men and nine women). A personality test measuring creative attitude FS (Holmquist, 1986) was administered to all subjects. Test results

were converted to stanine scores using a norm table (Holmquist, 1986) created from industrial employees. This gave an opportunity to compare the 34 subjects with a larger population ($M = 5.15$; $S.D. = 1.16$). A two-way ANOVA showed no significant differences between groups [$F(1, 30) = 0.58$, $p = 0.45$] or between sexes [$F(1, 30) = 3.56$, $p = 0.07$]. There was no interaction between groups and sexes [$F(1, 30) = 0.03$, $p = 0.87$].

Instruments. (1) A floating tank (Pantarei Flytex-perten, Stockholm) measuring 2400 mm \times 1260 mm \times 950 mm was used. Water depth varied between 200–300 mm due to evaporation, and the volume of water was 1 cubic meter. The floating tank was insulated on the inside so as to maintain a constant temperature and to isolate the subject from sound and sight. The water temperature was maintained at 34.2°C. Ambient (air) temperature was the same as the water temperature to minimize sense sensation. The water was saturated with magnesium sulfate in order to maintain a salt concentration of 1.3 g/cm³.

(2) A pulse-measuring instrument (polar Sport tester) was used throughout the entire duration of the experiment to measure subjects' heart rate. It consisted of an electrode belt fastened over the chest by a wide rubber band and functioned as a radio-transmitter. The receiver was a clock which received and stored the information. Both the receiver and the transmitter were watertight to a depth of 1 atmosphere. To reduce disturbance between the receiver and the transmitter in the salt water, the receiver was fastened to the electrode belt. The information stored in the clock/receiver was then entered into a PC computer. The subjects' pulse was registered every 60 s.

(3) FS—change and stability (Holmquist, 1986). A test measuring attitude to change and stability, and which correlates strongly with several creativity tests, was administered to all subjects at the beginning of the experiment, i.e. before the manipulation.

(4) Silveira's 'cheap necklace problem' (Silveira, 1971; Best, 1995) was administered to test creative problem-solving ability. From four small chains with three links in each chain, the subject is required, by opening and closing the links, to build a circle of chains which costs no more than 15 crowns. To open a link costs 2 crowns and to close a link costs 3 crowns. In order to help the subjects to further visualize the problem, they had the possibility of borrowing a box containing 1 crown coins. The subjects had two separate opportunities to work on the

problem. At the first opportunity they were allowed to work for 5 min only, after which the subject was interrupted. At the second opportunity the subjects were allowed to work, if needed, for 25 min, at the conclusion of which the experiment was terminated.

Procedure. Directly on arrival, subjects were informed that they could terminate the experiment at any time, for any reason. Thereafter, the subjects were instructed to put on the pulse-measuring instrument. Subjects belonging to the floating group were instructed to change into their swimming costumes and a bathrobe before the experiment was started. Then, the subjects were informed of the proceedings for the next 100 min, i.e. first, they were required to solve a problem for 5 min, then sit for 45 min (nonREST group) or float for 45 min (flotation REST group), and finally to solve a further problem within a short time period.

The instructions were then given for the cheap necklace problem as follows: 'In front of you are four small chains each consisting of three links. It costs 2 crowns to open a link and 3 crowns to close a link. All the links are closed at the beginning of the test. Your task is to connect all 12 links into one continuous circle, or if you so wish into a necklace, at a total price of no more than 15 crowns. If you think it may help, you may deduct and add coins from the box while you work with the task.'

After 5 min, the subjects were interrupted from the problem-solving task. Subjects belonging to the nonREST group were instructed to sit in an armchair and read the magazines laid out or any literature they may have brought with them, for a duration of 45 min. Subjects belonging to the flotation REST group were instructed to visit the bathroom and then take a shower. Furthermore, they were instructed to thoroughly dry their faces so as to avoid irritating droplets of water that might disturb their relaxation in the tank. To avoid the possibility that the subjects may be thinking about the creative problem-solving assignment while floating, they were given relaxation instructions according to Benson (Benson, 1975 p. 159–163). The subject was then informed of how to remove the cover and how to climb in and out of the tank. So as not to be disturbed by the water and to further eliminate sounds, wax plugs were inserted into the subjects' ears. Thereafter, the subject entered the tank.

After 45 min sitting (in the armchair) or floating (in the tank) subjects were allowed to leave the armchair or tank, respectively, and were given the

task of continuing with Silveira's cheap necklace problem. The time to solve the problem was noted. If the subject had not solved the problem within 25 min (after the break) the experiment was terminated. A manipulation check after completion of the experiment was conducted to control whether or not the subject had consciously thought about the experiment while sitting or floating. Subjects were asked if they had considered the problem and, if so, how many times, and the answer was written down.

Experiment 2

Subjects. Fifty-four subjects (27 men and 27 women) were recruited at the University of Örebro. The mean age was 23.24 years (S.D. = 3.50 years, range = 19 to 33), and all were Swedish born. Subjects were randomly assigned in equal numbers (nine men and nine women) to either a 'nonREST' group (group 1), a 'dryREST' group (group 2) and a 'flotationREST' group (group 3). There were no significant differences (one-way ANOVA) between groups with regard to age, height or weight ($p > 0.18$), but there was a significant group difference with regard to how many academic terms the subjects had attended at the university [$F(2,53) = 6.62$, $p < 0.01$]. A *post hoc* test (Scheffé's) showed that group 3 ($M = 4.61$, S.D. = 2.12) differed from both group 2 ($M = 2.22$, S.D. = 2.65) and group 1 ($M = 2.17$, S.D. = 2.09). There were no significant differences (Kruskal-Wallis) between groups with regard to consumption of alcohol, breakfast and luncheon habits, amount of training, health status, cultural background, growing up conditions, use of tobacco, interest in sports or education ($p > 0.26$), but there was a significant difference with regard to civil status ($p = 0.02$) where group 3 (mean rank = 20.5) differed from group 2 (mean rank = 31) and group 1 (mean rank = 31). Group 3 consisted of more singles compared to the other two groups. A test was administered to all subjects to provide more background information. The test measured prevailing attitude to creativity with respect to change and stability, namely the FS (change and stability) test (Holmquist, 1986). A two-way ANOVA indicated no differences between groups ($p = 0.51$) and no differences between sexes ($p = 0.42$). The FS scoring results were transformed into stanine following a norm from industrial employees, both workers and officials (Holmquist, 1986), thereby making possible a comparison to a broader population ($M = 4.7$, S.D. = 1.59).

Design. The flotation REST group (group 3) received a 45 min floating session, after which

they were instructed to conclude three psychological paper-and-pen tests. To accustom the subjects to the floating situation they were instructed to partake of four floating sessions before the designated time for the experiment.

The dry REST group (group 2) received exactly the same treatment as group 3 before and during the experiment, but instead of floating they spent 45 min resting on a couch in a light- and sound-proofed chamber. The nonREST group (group 1) received exactly the same treatment as group 3 before and during the experiment, but instead of floating they sat in an armchair for 45 min and were allowed to read magazines which were laid out for them (sitting).

Instruments. (1) A floating tank (Pantarei Flytexperten, Stockholm) with measurements $2400 \times 1260 \times 950$ mm was used. Water depth varied between 200–300 mm according to evaporation, and the volume of water was 1 cubic meter. The floating tank was insulated on the inside so as to maintain a constant temperature and to isolate the subject from sound and sight (see above). Water and air temperature were maintained at 34.2°C , as for experiment 1. Magnesium sulfate saturation was maintained at a concentration of 1.3 g/cm^3 , as above.

(2) The FS change and stability test (Holmquist, 1986) used to measure attitude to change and stability, and correlates strongly with several creativity tests, was administered to all subjects at the beginning of the experiment, i.e. before the flotation manipulation.

(3) The Syllogisms I test (Holmquist, 1974) measures logical and deductive thinking ability. It consists of 21 items demanding a quantitative type of deduction reasoning (e.g. Tom is taller than John. John is smaller than Bill. Is John taller than Tom?) Time was limited to 5.5 min and the number of correct answers were registered.

(4) The FREGO test (Holmquist, 1973) is a questionnaire which has been constructed for measuring the variable 'preconscious activity'. It is a translation from the North American Preconscious Activity Scale (Holland & Barid, 1968). The reasoning behind the test is that high 'preconscious' activity stimulates new and unusual associations. The FREGO test consisted of 36 items to which the subject assigned 'yes' or 'no' answers to statements (e.g. I would rather be a politician than a scientist).

(5) Finally, each subject was asked to produce as many consequences as possible to six dramatic

events, all with some connection to the Nordic situation (e.g. 'What would happen if there suddenly was a new ice age in North Europe?'). Time was limited to 2 min per item, giving a total of 12 min. The fluency score was obtained through a simple summation of all the responses, excluding all iterations. A panel of judges (consisting of two high school teachers) was formed to assess responses as being either obvious or original on the basis of quality. In addition, each judge was required to determine from the responses of each subject that which was considered most elegant and to adjudge this on a ten-point scale. In the event of a lack of any response being considered elegant, the subject was assigned no points. 'Obvious' was defined as a high frequency response, 'original' as a rare response in large populations and 'elegance' as 'an object/enterprise achieves elegance when two or more apparently opposing components are combined to one harmonious unit. The greater the initial opposition between the components involved the more elegant the solution or 'end-point' is experienced' (Norlander, 1997, p. 9).

Procedure. Directly on arrival at the laboratory the subject was informed that they could terminate the experiment at any time, for any reason. If the subject belonged to the floating group s/he was instructed to change into her/his swimming costume and a bathrobe before the experiment was started. The subject then completed the FS test and filled out a questionnaire about their background. If the subject belonged to the nonREST group s/he was instructed to sit in an armchair and read the magazines laid out, or any literature they had brought with them, for a duration of 45 min. If the subject belonged to the dry REST group s/he was given relaxation instructions according to Benson (1975 p. 159–163) and the instruction to practise these exercises while relaxing on the pallet. Each subject was given wax ear plugs to place in her/his ears. After this, the door was closed and the subject left alone in the darkened chamber. Finally, if the subject belonged to the flotation REST group s/he was instructed to visit the bathroom and then take a shower. Furthermore s/he was instructed to thoroughly dry her/his face so as to avoid irritating droplets of water that might have disturbed relaxation in the tank. Thereafter the subject was given relaxation instructions according to Benson (1975 p. 159–163) and the instruction to practise these exercises during floating. So as not to be disturbed by the water and to further eliminate

TABLE 1
Means and standard deviations (s.d.) of test time
for group (nonREST, floating) and gender (men, women)
conditions

	Group 1 NonREST		Group 2 Floating	
	Men	Women	Men	Women
Test time				
Mean	20.26	21.60	29.93	24.85
S.D.	10.69	10.26	0.19	7.53

sounds, wax plugs were inserted into the subject's ears. The subject then entered the tank.

After 45 min of nonREST, dry REST or flotation REST, the subject had to complete the FREGO and Syllogisms I tests and the six-item dramatic events test. The order of these tests was randomized.

Results

First sample

Test time. A two-way ANOVA showed a significant difference between groups [$F(1, 30) = 4.75$, $p = 0.04$], with the floating group using more of the available test time ($M = 27.07$, $S.D. = 6.08$) than the control group ($M = 21.00$, $S.D. = 10.16$). There were no differences between sexes ($p > 0.53$), neither was there any interaction between group and sex ($p = 0.28$, for means and standard deviations, see Table 1).

Hits and misses. The number of correct reported solutions within the given test time (hits) was noted, as well as the number of incorrect solutions (misses). Results showed that group 1 (control group), had nine hits and nine misses. Group 2 (floating group) had 6 hits and 10 misses. A Mann-Whitney U Test showed no significant differences between groups ($p = 0.47$) or between sexes ($p = 0.47$).

Pulse measurements. During the entire experiment pulses were registered from subjects both in the control and floating groups. To simplify further statistical analysis the registered pulse values were reduced to the following eight categories: (1)–(4) mean pulse rate, standard deviation for pulse rate values, highest pulse rate value, and lowest pulse rate value, respectively, for (1) sitting and floating, (2) during sitting and floating, (3) during sitting/floating, (4) during sitting respective floating, (5)–(8) mean pulse rate, standard deviation for the mean pulse rate, highest pulse rate value, and lowest pulse rate value when the cheap necklace problem was resumed. A MANOVA (Pillais) with

the eight categories as dependent variables and group and sex as the independent variables showed no significant differences for the eight categories with regard to group ($p > 0.09$), sex ($p = 0.5$), or the interaction between groups or sex ($p = 0.78$). There was a significant difference (Wilcoxon Matched-Pairs) between the pulse while sitting/floating and the pulse when the problem had been resumed ($p = 0.02$). Further analysis (Wilcoxon Matched-Pairs) showed no difference for group 1 ($p = 0.81$), but there was a difference for group 2 ($p < 0.01$). The pulse mean for group 1 during sitting was 67.79 ($S.D. = 8.81$) and for group 2 during floating was 66.44 ($S.D. = 10.26$). The pulse mean during the resumed work in group 1 was 69.34 ($S.D. = 9.44$) and in group 2 it was 73.68 ($S.D. = 9.44$).

Correlation analysis (Pearson's r) showed a negative correlation ($r = -0.50$, $p = 0.008$) between test time and the subjects' standard deviation for mean pulse rate during the resumed work on the problem, indicating that the less time used, the higher the standard deviation. Further analysis (Pearson's r) showed a stronger negative correlation between test time and the standard deviation for the mean pulse rate during work in group 1 ($r = -0.72$, $p = 0.005$), but no significant correlation for group 2 ($r = -0.38$, $p = 0.33$).

Manipulation control. Subjects were instructed to report how often during floating/sitting they had consciously thought about the necklace problem. Of the subjects in the control group ten reported that they had not thought about the problem whatsoever, while eight reported having once thought about the problem. Of the subjects in the floating group, six reported not having thought about the problem, while ten reported having once thought about the problem. A Mann-Whitney U Test showed no differences between groups ($p > 0.29$) regarding the amount of conscious thought on the problem during floating/sitting.

Second sample

Interjudge reliabilities. With regard to fluency, obvious, original and elegance, the correlation statistics (Pearsons' r) showed significant ($p < 0.05$) values between the scores given by the two judges: fluency ($r = 0.99$, $p < 0.01$), obvious ($r = 0.85$, $p < 0.01$), original ($r = 0.40$, $p < 0.01$), elegance ($r = 0.57$, $p < 0.01$). With this background analysis it was determined as meaningful to summate the judges scoring on the four variables for further statistical analysis.

Dependent variables. A Pillais' MANOVA (3×2 factorial design) was performed with group and sex as independent variables and the scores from the FREGO and Syllogisms I tests together with the averaged scores from the two judges on 'fluency', 'obvious' 'original' and 'elegance' as dependent variables. The analysis showed no interaction between group and sex ($p = 0.5$) and no significant difference with regard to sex ($p = 0.61$), but there was a significant group difference ($p = 0.04$). An ANCOVA controlling for the differences in the number of terms the subjects had attended at the university yielded no other significant indications. Described below are the results for each dependent variable from the univariate F -tests with regard to group and sex (there was no interaction effect between group and sex, for means and standard deviations, see Table 2). (1) Fluency. Univariate F -tests showed no significant difference between groups ($p = 0.63$) and no difference with regard to sex ($p = 0.86$). (2) Obvious. Univariate F -tests showed no significant difference between groups ($p = 0.92$) and no difference with regard to sex ($p = 0.96$). (3) Original. Univariate F -tests showed a significant difference between groups [$F(2,48) = 4.11, p = 0.02$] but no difference with regard to sex ($p = 0.33$). A *post hoc* test (Scheffé's) showed that group 3 ($M =$

8.53, S.D. = 3.48) had higher scores on originality compared to group 1 ($M = 5.64, S.D. = 2.98$) but not to group 2 ($M = 7.33, S.D. = 2.57$). (4) Elegance. Univariate F -tests showed no significant difference between groups ($p = 0.48$) and no difference with regard to sex ($p = 0.70$). (5) FREGO. Univariate F -tests showed no significant difference between groups ($p = 0.92$) and no difference with regard to sex ($p = 0.84$). (6) Syllogisms I. Univariate F -tests showed no significant difference between groups [$F(2,48) = 2.43, p = 0.09$] and no difference with regard to sex ($p = 0.86$). Even though there was no significant group difference, a slight tendency towards a trend could be observed: group 1 ($M = 14.67, S.D. = 5.60$), group 2 ($M = 13, S.D. = 4.86$) and group 3 ($M = 11, S.D. = 4.43$).

Discussion

The present study produced three main results:

- (1) subjects in the floating group in the first experiment used more test time (latency) than the nonREST group;
- (2) the shorter the test time latency by the sub-

TABLE 2
Effects of nonREST, dry REST or flotation REST (see methods) on estimates (mean, s.d.) of fluency, obvious, original, elegance, FREGO and Syllogisms for men and women

Type of scores	Group 1 NonREST		Group 2 DryREST		Group 3 Floating	
	Men	Women	Men	Women	Men	Women
Fluency						
Mean	29.95	30.44	32.37	31.90	33.78	32.39
S.D.	10.57	5.88	7.09	7.50	11.64	10.18
Obvious						
Mean	23.95	25.25	25.75	25.10	25.00	24.04
S.D.	8.26	4.17	6.77	7.02	9.18	6.29
Original						
Mean	6.00	5.19	8.06	6.75	8.72	8.33
S.D.	3.21	2.80	2.98	2.16	2.79	4.23
Elegance						
Mean	1.30	0.44	0.94	2.45	1.44	1.44
S.D.	2.35	1.24	1.74	1.99	2.51	2.17
FREGO						
Mean	25.90	24.50	24.75	24.90	24.44	26.56
S.D.	2.96	5.07	5.63	5.26	3.97	6.88
Syllogisms						
Mean	14.00	15.50	13.38	12.70	11.78	10.22
S.D.	6.65	4.24	5.58	4.50	4.89	4.06

jects in the first experiment required for the creative problem-solving test, the greater the heart rate variability;

(3) in the second experiment, subjects in the floating group were scored as more original in comparison with the dry REST and nonREST control groups.

The finding that results of the floating group from the first experiment were not as high as the control group on the creative problem-solving test seems to indicate that a residual floating effect must be considered, even after the subject has left the immersion tank. This effect may possibly be characterized by cognitive functioning wherein the primary process still dominates over the secondary process and where the ability of making shifts between the two processes appears impaired/retarded. One support for this suspicion is provided by the second main result of this study which coincides with certain other experiments, e.g. Bowers and Keeling (1971) who found that subjects scoring high on creative tests had greater variance of heart rate compared to those who produced low results. With support of Lacey (1967), Bowers and Keeling concluded that the greater heart rate variability observed in the more creative subjects indicated that they had rapid cognitive shifts between reality-oriented cognition and more imaginal innerdirected ideation. Following a comprehensive perusal through studies with physiological correlates of creativity, Suler (1980) drew the conclusion that 'Creative people should possess an above average ability for shifting between states of low arousal associated with primary process and higher states of arousal characterized by secondary process' (p. 158). It is within reason to suggest that adaptive flexibility, which may be measured with different forms of chain puzzles, demands a higher propensity to cognitive shifts. It seems relevant that the control group, i.e. that producing the best results on the test, provided the highest correlation between shortest test time and greater variance in heart rate.

A third support for the notion of a primary process-dominated floating effect directly after the actual floating is indicated by the third main result in this study, i.e. the subjects in the floating group of the second experiment were scored as more original compared to the dry REST and nonREST groups. To reiterate, it seems as if originality may be connected to the primary process in much the same manner as problem-solving may be connected to the secondary process. On the other hand, the second experiment poses a complex result insofar

as deductive ability (secondary process-oriented) was not influenced negatively by the floating procedure, even though one may discern a weak, non-significant trend. One possible explanation focuses upon the facilitation of visual imagination through floating. A more abstractly constructed deductive test may have provided a more explicit deterioration. In general, it appears that the balance/combination between primary and secondary processes during a creative problem-solving test or an originality test may be influenced by flotation REST in much the same way as was that obtained for alcohol intoxication (Norlander, 1997).

An important aspect for future studies concerning flotation REST and tests of creativity pertains to the more stringent control of expectancy factors. In this regard, it may be argued that both positive and negative expectations of floating may have some impact upon the results. In none of the three studies directly concerned with floating and creativity, i.e. Suedfeld *et al.* (1987), Forgays and Forgays (1992) and the present study, has sufficient consideration been made for the putative role of expectancy factors.

Generally, flotation REST experiments maintain only one control group, i.e. an armchair group or a couch group. In the present circumstance we have developed a double-control group design (the DCG-design) maintaining both a NONREST and a DRY REST condition. This type of design resembles the condition which has been considered in terms of 'double-placebo' and/or 'balanced-placebo' designs now often applied in studies on the effects of alcohol and other drugs on states of consciousness (*cf.* Marlatt *et al.*, 1973).

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Notes

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