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Neuroendocrine and psychological effects of restricted environmental stimulation technique in a flotation tank

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The restricted environmental stimulation technique or REST is a method of relaxation where the level of environmental sensory inputs is kept very low. A particular REST technique called tank flotation, or flotation REST, consists of 1 h sessions in a tank containing water with a high salt content and maintained at 35.5 °C. In this protocol, five normal subjects were studied before and during 2 h after a 60 min flotation REST session and a control session of 60 min in a supine position on a bed. Cortisol, thyreostimulating hormone (TSH), thyroxine (T4), prolactin, melatonin, luteinizing hormone (LH), growth hormone (GH), β-endorphin, vasopressin (ADH), gamma-aminobutyric acid (GABA) and homovanillic acid (HVA) were measured in plasma. HVA, 5-hydroxy-indolacetic acid (5-HIAA) and vanylmandelic acid (VMA) were measured in urine. There were no changes in hormones concentrations that could be attributed to flotation REST. The urinary excretion of VMA was lower after the flotation REST session. The psychological consequences of flotation REST were more easily demonstrated than the neuroendocrine changes that are assumed to reflect the state of relaxation. Flotation REST increased subjective levels of sedation and euphoria.The possible mechanisms by which flotation REST induces relaxation are discussed.

Keywords: Restricted environmental stimulation technique (REST); relaxation; neuroendocrine; flotation.

Introduction

Early studies on sensory deprivation indicated that it induced stress, visual or other hallucinations and unfamiliar experiences or feelings (Bexton, Heron & Scott, 1954; Zuckerman, 1964). Later studies using less disagreeable conditions of sensory deprivation led to the opposite conclusion, that it had relaxing effects and could be therapeutically useful (Suedfeld & Kristeller, 1982). The term restricted environmental stimulation technique or REST was chosen to describe the relaxing effect of environments with low levels of external stimulations. Two techniques have been studied, both called REST.

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The first is chamber REST, where subjects remain on a bed for 12–24 h in a soundproof room. Several studies strongly suggest that chamber REST is useful in the treatment of smoking, alcohol consumption or overeating (reviews by Suedfeld and Kristeller, 1982; Suedfeld, 1990), and for memory improvement after electroconvulsive therapy (Suedfeld, Ramirez, Remick & Fleming, 1987). The second technique of REST is tank flotation, or flotation REST; it consists of an insulated container that is filled with salted water maintained at a temperature of 35.5 °C. In this tank, subjects float on their back in 20–30 cm of water, generally for 1 h. Because of the high salt content, no effort has to be made to avoid touching the bottom of the tank. Lilly reported anecdotally as early as 1954 that flotation REST was a pleasant experience (Lilly, 1977). Unfortunately, Lilly did no research to confirm that flotation REST induces a physiologically or biochemically measurable relaxation state or response, and few controlled studies on the physiological or neuroendocrine effects of flotation REST have been carried out during the last two decades. A decrease in anxiety, hostility and depression self-ratings was observed systematically after flotation REST in nine normal subjects who practised weekly sessions during approximately 6 months. With the exception of one subject, these psychological effects were not cumulative over time (Pudvah & Rzewnicki, 1990). In a study on blood pressure changes after flotation REST, eight normotensive subjects were included in a cross-over evaluation of blood pressure values after a 35 min control or flotation REST session. Systolic and diastolic blood pressure were respectively 20 and 13 mmHg lower at the end of the flotation REST session, while the control session induced insignificant changes (Fine & Turner, unpublished). Stern studied 27 volunteers before and after flotation REST. The EEG theta activity increased after flotation REST and frontal EMG values decreased significantly. Alpha EEG activity and pulse were not influenced (Stern, unpublished). Jacobs taught a simple relaxation technique to 28 volunteers. Later, 14 of them underwent a session in a flotation tank. Their EMG values and systolic and diastolic blood pressure after the session were lower than before the session, by respectively 30%, 7% and 17%. There were essentially no changes in the 14 other subjects who practised relaxation outside a flotation tank (Jacobs, Heilbronner & Stanley, unpublished). Turner and Fine (1983) used a parallel-group protocol with 12 normal subjects. The mean cortisol concentration around noon was decreased from 13.5 to 10.5 μg dl^{-1} after daily flotation REST sessions of 40 min repeated over 4 days. Interestingly, the decrease in cortisol was still present at follow-up 4 days after the end of the sessions. The concentration of ACTH tended to decrease, but changes were not significant. The concentration of LH was unchanged. According to an unpublished version of their report, Fine and Turner also measured the concentration of adrenaline and noradrenaline in the plasma of three of their subjects. These concentrations were lower after

flotation REST, but not after control sessions (numerical values were not listed). Later, Turner and Fine (1991) measured cortisol in the plasma of 27 normal volunteers on several occasions over a 2 week baseline period and then during a 3 week experiment with eight flotation REST sessions ($N = 15$ subjects) and eight control sessions ($N = 12$ subjects). There was a 21.6% decrease in cortisol concentrations in the flotation REST group and no changes in the control group. Moreover, the individual variability in cortisol concentrations decreased in the experimental group. Two recently published books on REST (Turner & Fine, 1990a; Suedfeld, Turner & Fine, 1990) contain relevant additional information on the above studies. In three subjects who practised flotation REST twice a week, the urinary cortisol values decreased from baseline by a mean of 18.7% at the end of 10 weeks, and then decreased further over the next 2 weeks of follow-up without REST flotation sessions (Turner & Fine, 1990b). Also, naloxone suppressed the euphoria secondary to flotation REST in four subjects, while placebo did not (Turner % Fine, 1990b). Our short review of results from studies with normal subjects and patients illustrates that flotation REST is a potentially useful method of relaxation, but that more biologically oriented research is warranted.

This study was aimed at collecting further information on neuroendocrine changes after REST, using a cross-over protocol comparing flotation REST to a control session. We measured an extended number of neuroendocrine variables. The choice included compounds classically studied during stress or relaxation, as well as hormones that are not usually considered stress related in humans. These include melatonin, thyroid stimulating hormone (TSH), luteinizing hormone (LH), growth hormone (GH) or vasopressin (ADH), measured because changes in TSH, ADH or LH have been reported during transcendental meditation (TM) (Ahuja, Karmarkar & Reddy, 1981; Jevning, Wells, Wilson, & Guich, 1987; O'Halloran et al., 1985), because melatonin is sedative at pharmacological doses (Lieberman, Waldhauser, Garfield, Lynch, & Wurtman, 1984), and because GH levels might change with stress in neurotic subjects (Miyabo, Hisada, Asato, Mizushima, & Ueno, 1976). Finally, gamma-aminobutyric acid (GABA) was measured because GABA receptor modulation is recognized as a major determinant of anxiety.

Method

Subjects and protocol

Five young healthy males participated. The protocol had been accepted by the ethical committee of the Geneva University Department of Psychiatry, and subjects signed an informed consent form. They were considered healthy on the basis of a medical history and a physical examination. The biological

screening was limited to excluding a positive carrier state for HIV or hepatitis. Cholesterol and triglycerides were measured, since high concentrations of these lipids interfered with the assay of several hormones. Aside from results of the biological screening, the other exclusion criteria were the following: alcoholism or tobacco abuse; a history of convulsions, hallucinations, claustrophobia; haemorrhoids, the presence of any significant superficial wound or a ruptured tympanic membrane (the salt water enters the external ear during flotation REST).

The flotation tank was of the type "Float to Relax" (Denver, Colorado). Its length was 210 cm and width 110 cm; it contained water saturated with magnesium sulfate, 200 kg in approximately 300 l of water that was maintained around 35.5 °C and circulated through cleaning filters. The specific gravity of the solution was 1.15 relative to distilled water. Bacteriological tests indicated that the water was maintained free of germs by the disinfectant. A ventilator brought heated air into the flotation tank. The water heating system and the pumping system were turned off during the flotation REST sessions.

Before the experiment, subjects were asked to undergo at least two habituation flotation REST sessions over a period of 2–3 weeks. Each subject was studied twice from 07:00 to 12:00, once during a flotation REST session and once during a control session. The control session consisted of lying on a bed during 60 min in a quiet room with very dim light (less than 200 Lux). Three subjects started with a flotation REST session and the other two with a control session. They were not informed previously about the nature or the first session. The two sessions were scheduled at least 1 week apart, and they occurred on the same days of the week for each subject. At each session, the subject came to the laboratory around 07:00; he was given a light breakfast consisting of a glass of milk, a piece of bread and an apple. A short indwelling intravenous catheter measuring 3.81 cm/1.07 mm was then implanted (Beckton Dikinson, Bellevue, Switzerland). At 07:30, the subject was asked to lie on a bed. Three blood samples were drawn at 07:30, 07:45 and 08:00, during the pre-control or pre-flotation REST period. At 08:00, a protective surgical waterproof bandage was placed over the catheter (Opsite, Smith and Nephew Medical Limited). From 08:15 to 09:15, the subject spent 60 min either in the flotation tank or lying on the bed, followed by taking a shower. The protective surgical bandage was taken off after the shower. From 09:30 to 11:30, during the post-control or post-flotation REST period, blood samples were drawn every 15 min

Biochemical assays

Table 1 lists the schedule for the assay of the biological variables in plasma. The hormones were measured using commercially available enzy-

Table 1
Protocol for the biochemical assays in blood

	Sampling time (min)											
	0	15	30 session [a]	120	135	150	165	180	195	210	225	240
Cortisol	×	×	×	×	×	×	×	×	×	×	×	×
TSH	×	×	×	×	×	×	×	×	×	×	×	×
Prolactin	×	×	×	×	×	×	×	×	×	×	×	×
LH	×	×	×	×	×	×	×	×	×	×	×	×
GH	×	×	×	×	×	×	×	×	×	×	×	×
Melatonin	×		×	×		×		×				
β-Endorphin		×	×	×		×		×				
ADH			×	×								
T4		×	×	×		×						
GABA	×		×	×		×		×				
HVA		×			×							
Magnesium		×	×	×	×							
Osmolality		×	×	×	×							
Lactate		×	×	×	×							

[a] 60 min in a flotation tank or 60 min on a bed during which no blood samples were taken.

matic or radioactive immunoassays. All assays had intra-assay coefficients of variation in the order of 5–10%. Except for lactate, magnesium and plasma osmolality, all samples from a subject were assayed on the same day to exclude inter-assay variability in the comparison of values from the control and flotation REST sessions. Cortisol (3H-cortisol-CPB-kit, Bio-Mérieux, Paris), TSH (TSH Serozyme, Serono, Geneva), prolactin (PRL Serozyme, Serono), LH (LH Serozyme, Serono), GH (hGH Ter, Serono) were measured more frequently than melatonin (Melatonin [125I], Bio-Science Products, Emmenbrück, Switzerland), thyroxine (T4) (T4 Bio-Science Products), β-endorphin (Allegro β-Endorphin, Nichols Institute, Geneva), ADH (ADH [125I], Bio-Science Products) or GABA (Bohlen & Schoeder, 1982). Plasma osmolality, lactate and magnesium in plasma were measured using routine laboratory tests done by the hospital laboratory. Magnesium in erythrocytes was measured on washed cells using a Perkin–Elmer 2380. Homovanillic acid (HVA), 5-hydroxy-indolacetic acid (5-HIAA), and vanilmandelic acid (VMA) were measured on the urine samples taken after the flotation REST or control sessions, from 09:15 to 11:30. HVA was also measured in plasma. The assay for the monoamines metabolites was by HPLC with electrochemical detection on a Waters system (Schulz & Hugentobler, unpublished).

Psychological measurements

During the 2 weeks before the study, subjects were administered the Minnesota Multiphasic Personality Inventory (Hathaway & McKinley, 1951)

and the Sensation Seeking Scale Form IV or SSS IV (Zuckerman, 1979). The French version of the MMPI was a 566-question paper and pencil test and T-scores were obtained through a computer program (Verlag Hans Huber, Bern). The SSS IV was carefully translated into French by ourselves and responses of the subjects were analyzed using the original scoring method from the English version. Spontaneous reports by the subjects were noted in an informal discussion between 11:30 and 12:00 after each study period. At the time of each blood sampling, the subject answered the French version of the Stanford Sleepiness Scale or SSS (Schulz, Walser, Meyer, Kubl & Garrone, 1983), as well as 10 cm visual analog scales for the dimensions of euphoria/sadness and relaxation/anxiety. Once before and once after the control and the flotation REST sessions, the subjects were asked to answer a French version of von Zerssen's mood questionnaire (Heimann, Bobon-Schrod, Schmocker & Bobon, 1975).

Statistics

Results were compared using Wilcoxon matched-pairs signed-ranks tests. In a few instances, the associations between variables were illustrated with Pearson's coefficients of correlation. Because of the small number of subjects, no further statistical analyses were carried out.

Results

Biochemical results

Table 2 indicates the mean values of plasma variables before and after the control and the flotation REST session, together with the lowest and highest values or range. Differences between subjects were important and stable over time from one session to the next. Thus, interindividual differences were greater than intraindividual changes attributable to the experimental conditions. For several variables, the mean baseline values between 07:30 and 08:00 were unstable from day to day. Higher baseline values before the control session were found for cortisol, prolactin and TSH, while the values of melatonin and HVA were higher before the flotation REST session. These differences were not statistically significant. With cortisol, prolactin and TSH, the mean concentrations between 09:30 and 11:30 tended to correlate positively with the values of the hormones between 07:30 and 08:00. This tendency was significant for TSH: Pearson's coefficients of correlation between pre-control and post-control and pre-flotation REST and post-flotation REST periods were, respectively, $r = 0.94$ and $r = 0.98$ ($N = 5$ pairs, $P < 0.05$ and 0.01). Table 2 shows that cortisol, TSH, prolactin, melatonin

Table 2
Mean values and changes in biochemical variables

		Pre-control (range)	Post-control (range)	Percentage change	Pre-REST (range)	Post-REST (range)	Percentage change
Cortisol	(ng ml^{-1})	154.9 (118.9–189.3)	92.7 (39.2–152.0)	−40.2 *	135.6 (99.1–152.5)	84.3 (34.2–124.5)	−37.8 **
TSH	(μU ml^{-1})	2.01 (0.90–3.13)	1.63 (0.70–2.20)	−18.9 **	2.01 (1.03–3.10)	1.51 (0.79–2.04)	−24.9 *
Prolactin	(μU ml^{-1})	232 (123–421)	151 (82–197)	−35.0	216 (132–393)	146 (94–215)	−32.4
LH	(mU ml^{-1})	2.81 (1.97–3.50)	3.05 (2.10–3.99)	+8.5	3.53 (2.50–4.67)	3.45 (2.71–4.26)	−2.3
GH	(ng ml^{-1})	0.36 (0.19–0.57)	1.12 (0.30–2.03)	+211	0.50 (0.13–0.90)	1.30 (0.17–1.22)	+160
Melatonin	(pg ml^{-1})	22.8 (9.9–36.9)	19.0 (14.0–23.0)	−16.7	30.9 (19.1–65.2)	17.2 (13.4–23.8)	−44.3
β-Endorphin	(pg ml^{-1})	22.1 (10.7–38.9)	24.4 (9.3–46.4)	+10.5	28.1 (12.4–52.8)	26.2 (15.4–47.7)	−7.5
ADH	(pg ml^{-1})	2.97 (1.05–6.68)	3.4 (0.78–11.77)	+14.5	2.86 (1.29–5.42)	3.63 (0.81–7.11)	+26.9
T4	(ng ml^{-1})	49.1 (31.4–68.1)	51.8 (36.6–68.5)	+5.5	47.2 (33.7–72.5)	51.0 (39.0–69.9)	+8.1
GABA	(μmol l^{-1})	0.171 (0.07–0.215)	0.201 (0.143–0.26)	+17.5	0.185 (0.11–0.294)	0.187 (0.145–0.289)	+1.1
HVA	(ng ml^{-1})	10.48 (7.2–13.7)	7.02 (4.6–9.10)	−33.0 *	17.48 (6.8–29.3)	13.62 (5.3–21.0)	−22.1
Magnesium	(mmol l^{-1})	0.81 (0.76–0.88)	0.87 (0.85–0.89)	+7.4	0.80 (0.72–0.9)	0.82 (0.78–0.89)	+2.7
Osmolality	(mmol kg^{-1})	292.2 (282–298)	290.8 (283–296)	−0.5	295.3 (294–298)	294.8 (293–298)	−0.2
Lactate	(mmol l^{-1})	1.82 (1.30–2.47)	1.24 (0.71–1.53)	−32.0	1.58 (0.65–2.88)	1.19 (0.59–1.67)	−25.0

The number of samples in the pre-control and pre-flotation REST periods (0–30 min) as well as the post-control and post-flotation REST periods (120–240 min) are indicated in Table 1. Mean values ($N = 5$) are shown, with the lowest and highest individual values (range).
No significant differences were observed between the post-control and post-flotation REST periods. Within the control and also the flotation REST sessions, there were changes between pre- and post- periods, indicated as percentage changes (* $P < 0.05$ and ** $P < 0.01$, Wilcoxon test).

and HVA decreased during the morning of the flotation REST as well as of the control sessions. This decrease was significant for cortisol and TSH ($P < 0.05$ in both cases), but not for prolactin. GH and ADH increased after both sessions, but these increases were not significant. The increase in GH was due to the presence of secretion pulses in two subjects during the post-flotation REST and less so during the post-control sessions, while GH

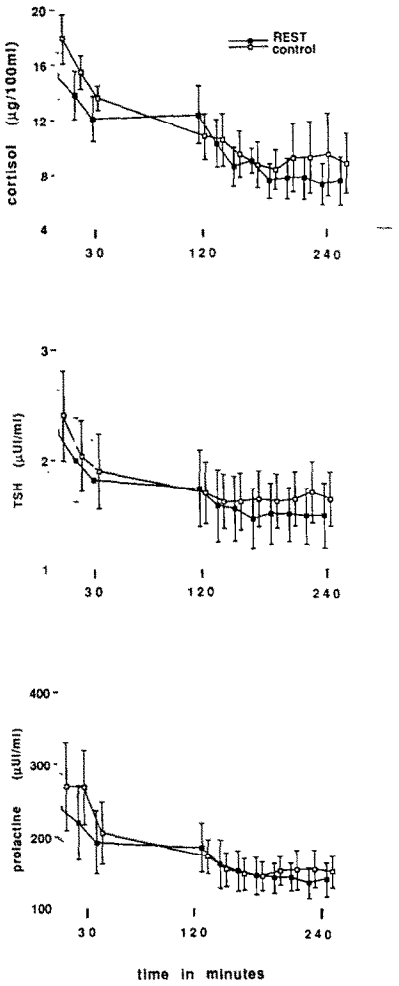

Fig 1. The influence of flotation REST on hormones concentrations. From 30 to 120 min the subjects spent 60 min in the flotation tank or lying on a bed. No samples were drawn during this period. Mean values and SD are shown ($N = 5$). Differences between tank flotation and control session are not significant.

remained unchanged throughout the sampling time in the other three subjects. When comparing the post-flotation REST with the post-control periods for individual compounds, no differences reached significance. However, cortisol and TSH tended to decrease more after REST. The mean concentration of these hormones was lower 2 h after flotation REST than after the control session. The differences (Fig. 1) were -12.6 ng ml^{-1} for cortisol and -0.2 μU ml^{-1} for TSH. The interindividual differences in the urinary excretion of monoamines metabolites during the 3 h after the control or the flotation REST session had a range of 4–5, i.e. some subjects excreted 4–5 times more metabolites than others. These interindividual differences were stable over time from the first to second session (Pearson's correlation coefficient, $P < 0.05$) for HVA and VMA, but not for 5-HIAA. The urinary excretion of monoamines was lower in the post-flotation REST versus the post-control period. These differences were not significant for 5-HIAA (3.98 versus 4.94 μmol) and HVA (6.13 versus 6.90 μmol). A statistically significant lower VMA excretion was observed in the post-flotation REST compared with the post-control period (3.94 versus 6.23 μmol; $P < 0.05$).

Psychological results

All subjects' answers to the personality questionnaires were within values that could be expected from normal educated subjects. Subject No. 1 had T-scores of 70 on the MMPI Pd scale (psychopathic deviate) and Mf scale (masculinity–femininity). All other subjects' T-scores were within 41–67. On the SSS IV, all subjects scored slightly higher on BS (boredom susceptibility) than the mean values quoted for students from the United States (Zuckerman, 1979). Overall, the subjects reported being relaxed during both the control and the flotation REST session. After the REST session, two subjects

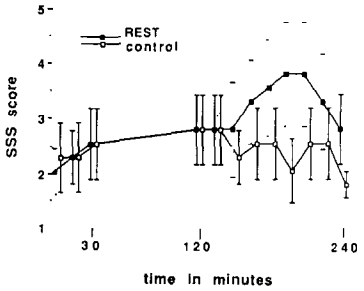

Fig. 2. Ratings of sedation after flotation REST. Higher values on the SSS questionnaire indicate greater sedation. Mean values and SD are shown ($N = 5$). The area under the curve from 120 min onwards was significantly greater after tank flotation ($P < 0.05$).

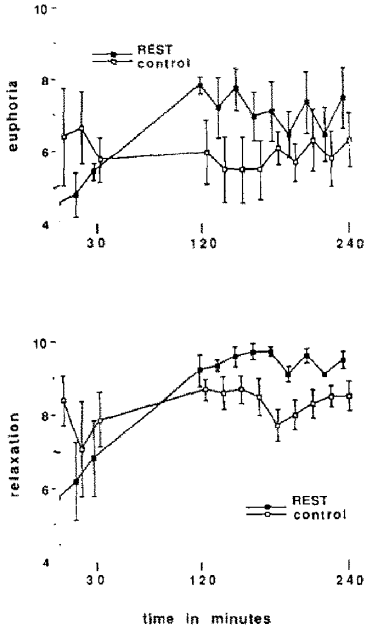

Fig. 3. Ratings of euphoria and relaxation after flotation REST Relaxation and euphoria were evaluated with 10 cm visual analogue scales. Mean values and SD are shown ($N = 5$). The area under the curve from 120 min onwards was significantly greater after tank flotation for relaxation ($P < 0.05$), but not for euphoria.

spontaneously described a state of wellbeing comparable with that after having made a physical effort such as jogging. There was more sedation after flotation REST according to the SSS (Fig 2.) and a tendency towards higher ratings in euphoria and relaxation on the visual analog scales (Fig. 3). According to von Zerssen's questionnaire, euphoria also tended to be greater after flotation REST than after the control session ($P = 0.1$). No relation was found between these psychological effects of REST and MMPI and Sensation Seeking Scale variables.

Discussion

Biochemical results

This cross-over study was designed to demonstrate acute neuroendocrine changes induced by flotation REST. The number of subjects was chosen on

the basis of the magnitude of changes described in previous studies of TM, i.e. of the order of a one-third increase or decrease in the concentrations of hormones and neurotransmitters (Gallois, Forzy & Dhont, 1984; Jevning, Wilson, & Davidson, 1978; Jevning et al., 1987; Wallace, Benson, & Wilson, 1971). No such changes that could be attributed to flotation REST were observed in our five subjects, except for a 37% lower mean value of urinary VMA. The change in VMA accords with the hypothesis that relaxation is accompanied by decreased catecholaminergic activity, but our results with 5-HIAA do not confirm the hypothesis of increased serotonergic activity (cf. TM results of Bujatti & Riederer, 1976). The decrease in lactate can be attributed to muscle relaxation, but it was no greater after flotation REST than after the control session. Osmolality and magnesium in plasma or in erythrocytes did not change. This excludes the remote possibility that the psychological effects of flotation REST were mediated through cutaneous absorption of magnesium in the flotation tank. Our negative neuroendocrine results were unexpected in view of previous studies demonstrating acute psychophysiologic (Gallois, 1984; Wallace, 1970) and neuroendocrine changes (see references above) during diverse relaxation methods, in particular TM. However, biochemical markers of relaxation are difficult to elicit. For example, no biochemical changes were observed in several TM studies (Cooper et al., 1985; Michaels, Parra, McCann & Vander, 1979).

In this cross-over protocol, we found no important acute neuroendocrine changes attributable to a single flotation REST session. This does not exclude small or subject-specific changes, for which the risk of a Type II error is high. Other technical issues can be considered in discussing our negative results. The first issue is sample size. Indeed, a larger number of subjects would have been necessary to describe small changes, but this was not our initial aim. Second, the short sampling time might have obscured the demonstration of changes, since cortisol and TSH disappear from plasma with half-lives on the order of 1 h. However, the short sampling time did not prevent other authors (see above) from observing changes in the concentration of hormones during TM. Because of the shorter half-life of prolactin and GH (around 30 min) as well as that of melatonin (a few minutes), the demonstration of changes in concentrations should have been easy, had they existed. The study took place in the morning, when the concentration of many hormones decreases physiologically, but this could not have confounded the potential effects of flotation REST. Also, four of the five subjects had done only two flotation REST sessions before the study. This lack of long-term training might have played a role, since the profile of neuroendocrine changes in the only trained subject (No. 1) showed a clear decrease in TSH and cortisol after flotation REST compared to the control session. The last technical issue is that the control session was quiet and non-stressing.

Psychological results

The five subjects described relaxation after flotation REST, in line with the reported advantage of this method that it needs no long and active training. Sedation (SSS) was increased in the five subjects after flotation REST (Fig. 2), and this was expected on the basis of preliminary discussions with people who practice flotation REST frequently. The visual analogue scales showed a tendency towards relaxation and euphoria (Fig. 3), and the answers to von Zerssen's questionnaire were also in the direction of euphoria. These findings coincide with previous descriptions of flotation REST effects (Pudvah and Rzewnicki, 1990). None of the five subjects described changes in visual perception during flotation REST, although such changes have been mentioned in previous case reports (Lilly, 1977). It is unclear whether these manifestations were true hallucinations, i.e. that the percept was interpreted as real. In fact, they were most often considered interesting experiences by subjects; for example, the physicist Feynman (1985) had hallucinations during several 2 h sessions of flotation REST, but was unable to repeat his interesting experience later, while sitting comfortably in a chair.

The mechanism of REST

A frequently quoted explanation for the effects of REST, as well as those of other relaxation techniques, is the reduced need to process external stimuli, leading subjects to focus their attention towards internal stimuli. This certainly occurs during flotation REST. Nevertheless, exploring further the mechanism of flotation REST is interesting, because its effects seem to occur after limited training, suggesting that biological factors may be as important as psychological ones. Relaxation during and after flotation REST could be through sedation and decreased CNS arousal, or it could be mediated through muscle relaxation and the interpretation by the subjects that they are not stressed, because their muscle tone is low. The role of weightlessness or relative weightlessness is rarely quoted, but it could also be very important. Indeed, the proprioceptive systems controlling motor functions and body position probably become less active during flotation REST. As a consequence, more oxygen and glucose could be available to other brain areas and this redistribution of CNS activities may explain how relaxation and even euphoria might occur. Also, because of a lower level of external and internal sensory-motor stressors during flotation REST, neuronal inputs from the brainstem to the corticotropin releasing factor (CRF) cells of the paraventricular nucleus (Palkovits, 1989) might become hypoactive. No evidence of a reduced hypophyseal activity was found here, but blood was sampled in quiet and non-stressing conditions. This does not exclude the possibility of a reduced responsivity of the hypothalamo–pituitary axis to stressors after flotation REST, a possibility that we intend to explore.

Another hypothesis that deserves mention is that flotation REST has some of the beneficial consequences of sleep. Indeed, there are similarities between flotation REST and sleep; both conditions share the characteristics of isolation from the environment, muscular relaxation and sensory deprivation or desafferentation. Moreover, flotation REST can induce visual experiences that are reported by some subjects as similar to the content of dreams (Lilly, 1977). Although relaxation states are usually considered quite different from sleeping, flotation REST might induce a state that is physiologically equivalent to sleep. According to Crick and Mitchison (1983), one of the major functions of sleep is to store in memory or to discard whatever spurious information of thoughts are circling in our brains. One subject reported that spontaneous and irrelevant thoughts were considerably decreased, and that his ability to concentrate improved during the hours after the flotation REST sessions.

The possible resemblance between sleep and flotation REST was explored further in a preliminary study in which two subjects wore portable EEG electrodes (Medilog 9000, Oxford Instruments) during a control session and a flotation REST session when no blood samples were taken. The data have limitations, because we could not completely prevent humidity from reaching the electrodes while the subjects were in the flotation tank. Nevertheless, we observed neither slow wave sleep nor eye movements indicative of paradoxical sleep during flotation REST. Short episodes of stage I and stage II sleep were noted during the flotation REST and the control sessions. Based on these data, we suggest that flotation REST is not accompanied by slow wave sleep, the type of sleep that is usually considered most restorative. Yet, despite the absence of electroencephalographic or endocrine changes typical of slow wave sleep, flotation REST might share some of the clinical consequences of sleep. Whether this is specific of REST or common to other relaxation techniques remains to be established.

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