Effect of short-term restricted environment stimulation on perceived stress

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Abstract stress relief techniques, including the Chamber restricted environment stimulation technique (REST), are becoming increasingly popular in Slovakia. Given this, it is necessary to investigate this method in an experimental setting. According to Urbiš (2012), dark therapy could be a suitable method for people living under constant stress, tension, and difficult living conditions and can also be used as training in coping with stressful situations.

The focus of this study was to assess the relationship between a short-term Chamber REST and perceived stress. Our research sample consisted of 42 participants who participated in a three-hour stay in the laboratory of REST at Comenius University. Participants were psychology students. The selection of the research sample and length of stay was mainly based on the COVID-19 pandemic virus. The average age of the participants was 25 years (SD = 5.63). In terms of gender, 32 women (76.19%) and 10 men (23.81%) participated in the research. 21 respondents (50%) stated that they had some previous experience (not a one-time, but repeated) with relaxation techniques. 20 participants (47.62%) had no prior experience. We measured experienced stress using the Perceived Stress Scale (PSS, Cohen et al., 1983) two days before the stay and one week after, and stress and arousal using The Stress Arousal Checklist (SACL, Mackay et al., 1978) before and after stay.

The results show that the difference in perceived stress decreased significantly right after short-term Chamber REST (p = 0.001; W = 556.00) and even one week after the stay (p = 0,016; W=0,932). There were no significant changes in the SDNN parameter before staying in the dark (M = 65.46, SD = 53.79) and after (M = 73.57, SD = 31.14) Wilk's Lambda = .939, F (1.30) = 1.947, p = .173. No significant changes are also in the rMSSD index before (M = 62.45, SD = 66,42) and after (M = 70.57, SD = 43.80) Wilk's Lambda = .961, F (1,30) =

1.214, p =.790; neither in HF before (M = 3 307.12, SD = 7 524.92) and after (M = 2 384.77, SD = 2 934.18) Wilk's Lambda =.995, F (1,30) =.140, p =.711. There was not a significant effect of gender, Wilk's Lambda =.991, F (1,30) =.283, p =.599 or previous experiences, Wilk's Lambda = 1.000, F (1,30) =.001, p =.980 on SDNN. We also did not observe a significant effect of gender, Wilk's Lambda =.996, F (1,30) =.133, p =.717 or previous experiences, Wilk's Lambda = 1.000, F (1,30) = .014, p = .907 on rMSSD. The same results are in the HF index, with no significant effects of gender, Wilk's Lambda = 0.985, F (1,30) = .469, p = .499 and previous experiences with relaxation methods Wilk's Lambda = 1.000, F (1,30) = .000, p = .994.

According to our expectations, staying in the dark should reduce the level of stress experienced. The results showed the statistical significance of the difference in the stress using PSS and SACL questionnaires scores before and after dark stay. Participants scored lower after their stay in the dark than before, which is in line with our expectations according to other authors (Malůš et al., 2016; Suedfeld & Borrie, 1999) and highlights the potential of Chamber REST to reduce the level of experienced stress. Based on HRV analysis, we conclude that there was a change in measured HRV indexes, however, the changes were not significant. We observed an increase in heart rate variability (SDNN, RMSSD) indicating an increase in parasympathetic tone, compatible with elevated relaxation. Gender factors and previous experience with relaxation methods have no effect.

In conclusion, we found the difference in perceived stress decreased significantly right after short-term Chamber REST and one week after the stay. An increase in heart rate variability (SDNN, RMSSD) after the stay indicated an increase in parasympathetic tone, however, the changes were not significant. There was no effect of factors of gender and previous experience with relaxation methods.

Keywords Chamber REST, Stress, Arousal, Relaxation Response, HRV.

Introduction

The restricted environment stimulation technique (REST) method is becoming increasingly popular not only abroad, but also in Slovakia. The REST technique was developed based on sensory deprivation research (Kupka et al., 2014). The REST presents various methods that use a special environment adapted so that the overall environmental stimulation is significantly reduced (Suedfeld, 1980). If it is a stay in a dark and quiet room, which prevents the supply of stimuli from our environment, we talk about Chamber REST. Based on previous research in the Chamber REST environment, we conclude that this method has a wide range of uses and several benefits, psychological or physiological.

According to Urbiš (2012), sensory deprivation is a fundamental factor that can cause various changes in the body during dark therapy, where the simultaneous action of darkness, silence, and isolation may lead to the intensification of unconscious processes and to the rediscovery and understanding of the various experiences that may have been distorted. Dark therapy thus helps us to sort out ideas, evaluate thought processes, and set priorities, it can also help to manage difficult life situations, crises, and life changes, such as job loss or the death of a loved one. Kupka et al. (2014) state that dark therapy can motivate people to focus more on their inner experiences in the future and to break away from their daily worries and problems.

According to Urbiš (2012), dark therapy could be a suitable method for people living under constant stress, tension, and difficult living conditions. He also considers staying in the dark suitable for patients with fatigue syndrome, patients with precancerous lesions, people with a genetic burden, people at risk of stroke and ischemic heart disease, or people who work in continuous operations. Urbiš adds that dark therapy can also be used as training in coping with stressful situations. According to Phelps (2008), we can also observe a positive effect of dark therapy on the stabilization of circadian rhythms and mood.

Research by Grissom (1966) suggests the beneficial effect of Chamber REST on memory – specifically recalling what has been learned. Kupka et al. (2014) confirm that Chamber REST has a positive effect on cognitive functions, specifically learning and recall. At the same time, it supports the ability to solve problems practically and induces more realistic and elaborate thinking (Norlander et al., 2003). On the contrary, Chamber-REST tends to degrade performance on more complex tasks such as divergent tests or storytelling (Suedfeld, 1969).

Staying in a stimulatingly limited environment can also have a positive effect on our dreams (Kupka & Malůš, 2013). According to Suedfeld and Borrie (1999), the Chamber REST can also be used to treat phobias. Malůš et al. (2015) state from the experience of clients that dark therapy leads to increased attention and alertness. In the dark, there is no division of attention, which means that Chamber REST has a high potential to increase mindfulness.

We also consider it important to mention the negative results mainly associated with the development of the REST methodology in the early days of exploring this method. The

subjects reported disorientation, tearfulness, nightmares, depression, bouts of anger, feelings of hopelessness, and hallucinations (Suedfeld, 1980). Suedfeld, based on his research, concluded that several negative manifestations reported by the participants were mainly due to anxiety about the stay procedure, which was triggered in the participants before they ever entered the sensory-deprived environment. Suedfeld, through his findings and publications, has made a significant contribution to changing negative attitudes towards this method. The turning point came during the 1980s, when the REST technique came to be seen as a useful therapeutic tool with great potential in the field of human behaviour and survival (Suedfeld & Borrie, 1999).

The positive impact of Chamber REST in combination with cognitive behavioural therapy has been demonstrated in patients with obsessive-compulsive disorder (Walker et al., 1994). Both Norlander (2003) and Suedfeld and Borrie (1999) report that this technique produces changes in emotional, cognitive, and psychophysiological domains. REST significantly reduces the effects of external stimuli, so it can be used as a treatment for patients whose problems stem from a temporary inability to cope with or process normal levels of stimuli (Suedfeld & Borrie, 1999).

An explanation for the effects of REST, as well as other relaxation techniques, can be the body's reduced need to process external stimuli. This leads subjects to focus their attention on internal stimuli (Schulz & Kaspar, 1994), which allows them to gain insight into the nature of the self and calm their mental processes (Urbiš, 2012). Staying in the Chamber REST induces a certain relaxation effect compared to being in conditions where sensory stimuli are present (Norlander et al., 2003).

Relaxation techniques, including chamber REST, can be considered a tool to reduce stress reactions (Hoffman et al., 1982; Sandlund & Norlander, 2000). The effect of relaxation techniques, which leads to various physiological and psychological changes, results in what is known as the relaxation response (Benson, 1975). The relaxation response, hereafter referred to as RR, is identified as the physiological counterpart of stress (Esch et al., 2003). On a psychological level, it is manifested by feelings of relaxation and recovery or an increased sense of control in stressful situations, while on a physiological level there is a reduction in sympathetic nervous system activity, a decrease in heart rate and blood pressure or an improvement in sleep quality (Benson, 1977; Hoffman et al., 1982). Ben-Menachem (1977) discusses two factors that are necessary for a relaxation technique to induce RR. A reduction in sensory input and a reduction in bodily movements are needed. Since participants are lying on a bed or sitting in a chair in the absence of sound and light stimuli while in the REST chamber, we assume that both factors could be met and thus a relaxation response can occur. The majority of research investigating the impact of relaxation techniques on reducing subjectively experienced and objectively measurable stress has used long-term interventions (Matousek et al., 2010).

However, there are also emerging studies that suggest that even short-term interventions contribute to stress reduction (Unger et al., 2017). For example, a decrease in cortisol in response to a single session of guided relaxation is reported by Kiran et al. (2005), yoga (West et al., 2004), and meditation (Michaels et al., 1979), with all these studies showing

a reduction in stress following a single intervention compared to control groups. A short, 45-minute stay in the Chamber REST effectively reduced stress and was shown to be an effective relaxation method in research by Norlander et al. (2003).

Based on the above, we consider that there is a presumption of stress reduction following the use of a short stay in a REST chamber as a relaxation technique.

The main objective of our research was to evaluate the relationship between short stay in the dark (Chamber REST) and experienced stress. For this purpose, we decided to choose the Perceived Stress Scale (PSS, Cohen et al., 1983) questionnaire, which will help us to compare the degree of stress experienced by participants 2 days before staying in the dark and a week after staying in a dark room and The Stress Arousal Checklist (SACL, Mackay et al., 1978) administered right before and after the stay.

- H1: The level of stress experienced (measured by PSS-10) one week after staying in the dark will be lower than 2 days before staying in the dark.
- H2: The level of stress measured after the short stay in the dark (measured by the SACL questionnaire) will be lower compared to that measured just before the stay.
- H3: The level of arousal measured after the short stay in the dark (measured by the SACL questionnaire) will be lower compared to that measured just before the stay.

Material and methods

Participants

The research group consisted of N = 42 university students who completed a 3-hour stay in the dark. Participants were psychology students at Comenius University who took part in the research as part of a master's degree course. We decided on the selection of the research sample and length of stay mainly based on the pandemic COVID-19 virus. The average age of the participants was 25 years (SD = 5.63). In terms of gender, 32 women (76.19%) and 10 men (23.81%) participated in the research. Participants were also asked about their previous (not a one-time, but repeated) experience with meditation, autogenous training, breathing exercises, biofeedback, staying in the dark, or other similar relaxation techniques. 21 respondents (50%) stated that they had some previous experience with one of these relaxation techniques. 20 participants (47.62%) had no prior experience with these techniques.

Procedure

The research took place in the period from October 2020 to December 2020 on the premises of the Faculty of Arts of Comenius University, on working days either in the morning or in the afternoon. Due to the government regulations associated with the COVID-19 virus, the research had to be interrupted. All participants received detailed instructions in advance, allowing them to participate in our research without major problems.

The stay itself had to be shortened from the original 24 hours to only 3 hours due to the adverse conditions caused by the COVID-19 virus. Each participant completed a 3-hour

stay in a newly built laboratory of restricted environmental stimulation. The restricted environmental stimulation laboratory consisted of a dark room and an atrium, in which the participants completed questionnaires before and after their stay in the dark. The dark room was a simply furnished attic room with a bed, armchair, and table, as well as access to the bathroom. The only window in this room was dimmed and adjusted so that no light could penetrate through it. Participants had a blanket and a small snack available in the dark room, they could bring a notebook and pen, or a musical instrument to reduce time, as well as their food and drinks. An SOS device was also available in the dark room, which participants could use in case of any complications. Mobile phones were only allowed under the conditions that they were used as an alarm clock announcing the expiration of a 3-hour interval. However, if the participants decided to use a mobile phone instead of an alarm clock, they first had to wrap it carefully in a blanket so that no light penetrated through it. The laboratory premises were regularly disinfected, and all necessary hygiene and safety measures were supervised.

Since our research was part of a larger project, all participants completed several questionnaires and measurements at different times. For our analysis, we use only a subset of them. Two days before the stay, the participants received the PSS questionnaire, which they filled out. Just before and after the stay, they completed the SACL questionnaire and their HRV was measured. One week after staying in the dark room, participants completed the PSS questionnaire for the second time.

Methods

In our research, we decided to choose a quantitative approach and we used 2 questionnaires and HRV measurement to obtain data from participants.

We measured the experienced stress using the Perceived Stress Scale (PSS) questionnaire by Cohen et al. (1983). It consists of 10 items that have been designed to reflect the extent to which respondents consider their lives unpredictable, uncontrollable, and overburdened. An example of one of his items is the question: "How often have you felt nervous and stressed in the last week?". Each of the items is rated on a 5-point scale from 0 = never to 4 = very often. This is the most widely used questionnaire focused on the degree of stress experienced, which proved its validity and reliability (Lee, 2012) and the internal consistency of its Slovak translation (α = 0.87) was also examined (Ráczová et al., 2018).

SACL is a short checklist of 20 mood adjectives by Mackay et al. (1978). There are two scales which assess the experience of stress (5 negative and positive adjectives) and arousal (activation, 5 negative and positive adjectives). Current moods are rated on a 4-point scale, which is adjusted to measure the direction of the scale (stress + or stress -; arousal + or arousal -). The scale points are: definitely yes, slightly yes, not sure or do not understand, and definitely not. The scale is dichotomous. The reliability coefficients (Cronbach alpha) for both scales are given to vary between 0.74 and 0.90 (Cox & Mackay, 1985; Watts et al., 1983). We translated the questionnaire from English into Slovak using back-translation.

Among the psychophysiological variables, we focused on heart rate variability (HRV): heart rate variability is used to analyse the activity of sympathetic nerves inner-

vating the heart. It is based on a mathematical analysis of spontaneous fluctuations in heart rate (Mravec, 2011). We used the Bittium Faros 360 sensor to record HRV. We took the measurements twice – just before and after the stay, seated, in a chair in the atrium, without disturbance for 6 minutes. The first measurement was taken at least 20 minutes after arrival and settling in, the second measurement was taken at least 20 minutes after adaptation to light.

Data collection and statistical analysis

We used online questionnaires, which the research participants filled in via Microsoft Forms, to collect data from the participants. We subsequently analysed the obtained data using the statistical programs SPSS and JASP, in which we used parametric and non-parametric methods. The differences in PSS and SACL-20 scores before and after stay were compared using the Wilcoxon signed-rank test. As part of the design, we controlled the effect of gender and experience with relaxation methods on HRV, which is a good index for the parasympathetic system. We had chosen a combination of High Frequency (HF – power in ms^2), Standard deviation of all NN intervals (SDNN), and Root mean square of the successive differences (rMSSD) indexes to track the time-domain analysis and frequency--domain analysis. We analysed 5-minute segments with Kubios HRV Premium software. For the analysis, we used Two-way repeated measures ANOVA with Greenhouse-Geisser correction with covariates gender and experience with relaxation methods. 7 participants were excluded from our sample due to missing data on psychophysiological measures.

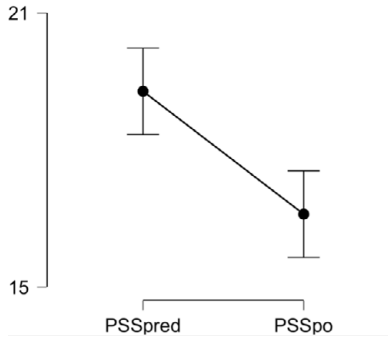
Ethical aspects

All participants were informed in advance about the course, purpose, and duration of the research. They participated in the research voluntarily and had the right to withdraw from it at any time. Before completing the questionnaires, they gave their informed consent to the processing of the data, and their anonymity was maintained throughout the process. The research was approved by the ethics committee.

Results

The average score obtained in the PSS questionnaire distributed 2 days before staying in the dark was 19.29 (SD = 6.22). One week after staying in the dark, we measured a lower average score of 16.60 (SD = 6.18). Using the Wilcoxon signed-rank test, we found that the difference between pre-dark and post-dark scores was significant ($p = 0.016$; $W = 0.932$). 95% CI [1.5; 4.5].

Figure 1
Average values of the score achieved in the PSS questionnaire before and after the stay in the dark



The average score of stress factor obtained in the SACL questionnaire distributed before the stay was 4.22 (SD = 3.41) and for the arousal factor 5,97 (SD = 3.52). Right after the stay, we measured a lower average score in the stress factor .81 (SD = 1.88) and arousal factor 5.36 (SD = 3.44). Using the Wilcoxon signed-rank test, we found that the difference in pre-dark and post-dark scores in stress factor was significant (p = 0.001; W = 556.00). 95% CI [3.0; 5.5] and arousal factor was not significant (p = 0.391; W = 430.00). 95% CI [-1.0; 2.5].

Figure 2
Average values of the stress and arousal score in the SACL-20 questionnaire before and after the stay

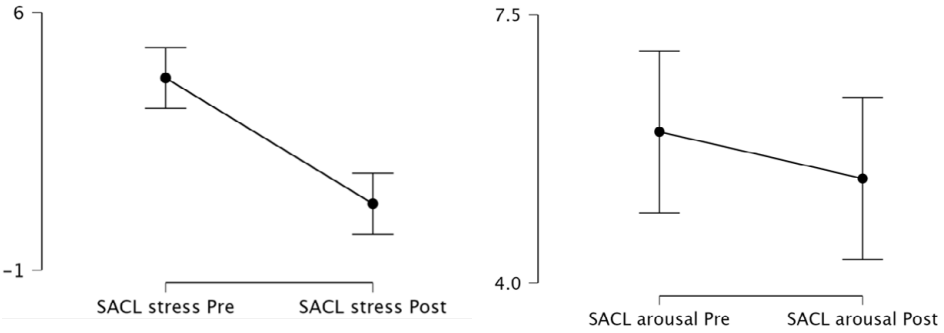


Table 1
Descriptive statistics of HRV indexes results measured before and after the stay in the dark

	Pre M(SD)	Post M(SD)	N
SDNN (ms)	65.46 (53.79)	73,57 (31.14)	35
rMSSD (ms)	62.45 (43.48)	70,57 (43.80)	35
HF (ms^2)	3307.12 (7524.92)	2384,77 (2934.18)	35

There were no significant changes in the SDNN parameter before staying in the dark (M = 65.46, SD = 53.79) and after (M = 73.57, SD = 31.14) Wilk's Lambda =.939, F (1.30) = 1.947, p = .173. No significant changes are also in the rMSSD index before (M = 62.45, SD = 66,42)

and after (M = 70.57, SD = 43.80) Wilk's Lambda = .961, F (1,30) = 1.214, p = .790; neither in HF before (M = 3 307.12, SD = 7 524.92) and after (M = 2 384.77, SD = 2 934.18) Wilk's Lambda =.995, F (1,30) = .140, p = .711.

There was not a significant effect of gender, Wilk's Lambda = .991, F (1,30) = .283, p = .599 or previous experiences, Wilk's Lambda = 1.000, F (1,30) = .001, p = .980 on SDNN. We also did not observe a significant effect of gender, Wilk's Lambda =.996, F (1,30) = .133, p = .717 or previous experiences, Wilk's Lambda = 1.000, F (1,30) =.014, p =.907 on rMSSD. The same results are in the HF index, with no significant effects of gender, Wilk's Lambda = 0.985, F (1,30) = .469, p = .499 and previous experiences with relaxation methods Wilk's Lambda = 1.000, F (1,30) = .000, p = .994.

Discussion

In the first hypothesis, we predicted that subjectively experienced levels of stress would be lower one week after attending a 3-hour stay at Chamber Rest than 2 days before attending the stay. According to Suedfeld (1980), isolation and low stimulation relieve participants from stressful stimulus overload. Turner & Fine (1983) report that participants subjectively identify the REST technique as inducing deep relaxation. The induced relaxation response is manifested on a psychological level by an increased sense of control in stressful situations (Esch et al., 2003). According to our expectations, staying in the dark should reduce the level of stress experienced. The results showed the statistical significance of the difference in the stress using PSS and SACL questionnaires scores before and after dark stay. Participants scored lower after their stay in the dark than before, which is in line with our expectations and highlights the potential of Chamber REST to reduce the level of stress experienced by several authors (Kupka et al., 2012, Malůš et al., 2015; Suedfeld & Borrie, 1999). Similar results were reported by Borrie (1991), who used the Flotation REST technique. Participants reported feeling calmer and less reactivity to stressful events over a period of several days during the intervention.

Based on HRV analysis, we conclude that there was a change in measured HRV indexes, but gender factors and previous experience with relaxation methods have no effect. We observed an increase in heart rate variability (SDNN, RMSSD) indicating an increase in parasympathetic tone, compatible with elevated relaxation, however, the changes were not significant. Similar but significant results were shown by the study of Malůš et al. (2015) that proved an increase in the parameter "high coherence" in heart action. A limitation of our study in the HRV analysis, as an indicator of parasympathetic system activity, is our inability to control participants' activity in the laboratory, as they were free to move around, and we have no record of their activity in a given stay.

We consider one of the biggest limitations of our research to be the fact that the research took place during the COVID-19 pandemic and had to be interrupted for some time. Due to the spread of the virus, it was more difficult to monitor the progress of the research. It was possible to control the participants only remotely, which complicated the whole situation in case of ambiguities and possible questions from the participants. We also believe that the pandemic may have had an adverse effect on some participants,

which may have distorted their responses to the questionnaires and thus affected the overall results.

We also perceive the research sample as one of the limits of our research, as it consisted of only 42 participants. In the future, it would be beneficial to carry out it with a larger research sample, which would also be more evenly distributed in terms of gender, since there was a large disparity between men and women in our research. The use of a self-assessment questionnaire to measure experienced stress may also be a limitation for several reasons. Participants may not be able to adequately assess their own experiences in terms of introspection skills. Indication of more socially acceptable responses may also occur. Also limiting was the fact that the research sample consisted only of psychology students at Comenius University. The number of university responsibilities and the approaching probationary period could have a negative impact on students. On the other hand, students' motivation could be higher as well as interest in the issue. However, greater sample heterogeneity and random selection of participants would help to more relevant results.

In the future, we propose to focus on the measurement of salivary cortisol. Studies show that relaxation techniques can reduce cortisol after a single intervention, for example one-time guided relaxation (Kiran et al., 2005), yoga (West et al., 2004), meditation (Michaels et al., 1979), progressive muscle relaxation (Pawlow & Jones, 2002, 2005), stress management training (Chan et al., 2006; Storch et al., 2007). In all these studies, there was a reduction in cortisol levels following a single intervention compared to control groups.

Van Dierendonck & Te Nijenhuis (2005) conducted a meta-analysis in which they evaluated the impact of Flotation REST as a stress management tool. Of the 27 studies, 13 studies examined the effect of a single stay and 10 studies that assessed physiological variables, including cortisol levels. The results of the meta-analysis suggest that there is a reduction in cortisol levels after completing the Flotation REST stay. Suedfeld & Borrie (1999) argue that psychophysiological measurements demonstrating positive changes in variables related to stress, whether compared before and after the REST intervention or during repeated REST interventions, are in the majority.

In conclusion, we found the difference in perceived stress decreased significantly right after short-term Chamber REST ($p = 0.001$; $W = 556.00$) and one week after stay ($p = 0{,}016$; $W = 0{,}932$). An increase in heart rate variability (SDNN, RMSSD) after the stay indicated an increase in parasympathetic tone, however, the changes were not significant. There was no effect of factors of gender and previous experience with relaxation methods.

There are several dark therapy providers in Slovakia, but it is also important to consider whether they are professional facilities with professional staff. Research of dark therapy requires an experimental environment that provides relevant data from which scientifically based conclusions can later be drawn. The Laboratory of Restricted Environmental Stimulation at Comenius University has been designed to meet all the necessary criteria.

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