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Physiological and psychological effects of rapid relaxation devices using sensorial immersion: a pilot study

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Abstract

In developed societies, the number of people diagnosed with chronic stress-related illnesses has risen rapidly in recent years. To meet the increasing demand for relaxation and well-being, several companies have developed relaxation installations to be used within business premises or in public locations. The effects of such devices on physiological and psychological parameters have not been scientifically tested yet.

This pilot study (N=40) evaluates the variations of 4 physiological and 11 psychological parameters on four different groups, three of them using a different rapid (15 minute) sensorial immersion relaxation devices and a control group using no device. The objective of the study was to identify the psychological and psychological parameters of interest and to study the effects of the devices on these parameters. Physiological parameters measured included heart rate, blood pressure, SpO2 and posture. Psychological parameters included an anxiety survey and four numerical scales to evaluate well-being, energy gain, and subjective muscular and nervous relaxation. We also used cognitive tests and *verbatim* reports.

We identified significant physiological and psychological parameters that can be of use for evaluating rapid relaxation devices (particularly mean blood pressure, posture, subjective muscular and nervous relaxation and some of the cognitive test results). Interestingly, the parameters variations differed between groups.

This study paves the way for further analysis of relaxation devices and suggests that rapid sensorial immersion relaxation devices can be of use in stressful environments. Each device could particularly help specific users, depending upon their needs.

Key Words

sensorial immersion relaxation devices, blood pressure, heart rate, attention tests, anxiety, well being

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I INTRODUCTION

Stress is a physiological response to adverse stimuli resulting in the activation of the sympathetic nervous system (Dantzer and Kelley 1989). Chronic stress is the repeated or prolonged activation of the stress response, and often leads to chronic diseases such as asthma, skin diseases, anxiety, depression, cardiovascular dysfunction or even cancer (Salleh 2008, Thayer and Brosschot 2005). In developed societies, the number of people diagnosed with chronic stress-related illnesses has risen rapidly in recent years. To meet the increasing demand for relaxation and well-being interventions, several companies have developed relaxation immersion installations that can be used by businesses or in other public locations (hospitals, transportation, schools, etc.) (Culbert 2017).

Increasing evidence is available regarding the benefits of long-term approaches, such as several weeks of yoga and meditation training on stress reduction (Goyal *et al.* 2014, Pal *et al.* 2014, Pascoe *et al.* 2017, Saeed *et al.* 2019). However, no scientific studies exist for one-off, short duration techniques (Culbert 2017). Therefore, the stress reduction efficiencies of these installations are unknown, as are the physiological and psychological consequences of the use of such devices.

We chose to focus on three of these devices using sensorial immersion that proposed protocols of short duration (inferior to 15 min) and were compatible with a physiological non-invasive and accessible physiological analysis (e.g. EEG, respiratory belt and finger oximeter). The first one, Neural Up® by iCare-Science, an apparatus based on spatialized audition of sound frequencies, which are supposed to reduce stress by acting on the nervous system through the auditory pathway (https://www.neuralup-solutions.com/). Another is Be-Breathe® by Ino-Sens, which consists of a warming armchair modifying the posture with an audio respiratory exercise that prompts the respiratory rhythm of the user. This device is supposed to decrease stress mainly while improving physiological parameters (http://www.ino-sens.com/). The Cobtek laboratory in Nice, France (http://www.innovation-alzheimer.fr/relax/), has also developed a relaxation room, the “Relax room”, which shows a 3D virtual movie of travel to an island, accompanied by music, where the rhythm complements the images. This device, using the visual and auditory systems, is supposed to favor a better attention after the relaxation period by reducing anxiety. We compared these three devices to a control group doing a 15-minute relaxation with no device.

The term “relaxation” covers many aspects including muscular relaxation, nervous relaxation and a global sensation of well-being and state of rest (Norelli *et al.* 2020). It can also be viewed as an emotional state (psychological and physiological) in which emotions and behaviors are interrelated and appraised within a specific context (Scherer 2005). A variety of measures have been used to recognize this emotional state, including self-report, startle response, behavioral response, autonomic measurement, and neurophysiologic measurement (Mauss and Robinson 2009).

This pilot study was conducted to establish effect sizes for appropriately powered future a priori studies and to determine the most relevant parameters to be used for analyzing rapid relaxation devices. We measured before and after the intervention physiological parameters that are known to be modulated in an opposite way by stress and relaxation, such as heart rate, blood pressure, SpO2 and posture. For instance, heart rate is increasing under stress while decreasing during relaxation (Pal *et al.* 2014). Mean blood pressure is a good indicator of stress levels (Zimmerman and Frohlich 1990) and can be decreased by relaxation (Dickinson *et al.* 2008). Breathing deeply can increase the SpO2 (Mengelkoch *et al.* 1994) and it has been shown that muscle relaxation and breathing interventions can have significant therapeutic effects for a variety of problems (Lehrer 2018). Finally, a period of relaxation could improve the straightening of the body posture (Drzał-Grabiec *et al.* 2016).We excluded parameters such as skin conductance, salivary cortisol or alpha-amylase levels as they have been shown to be less reliable for short-term tests due to potential confounding effects (Strahler *et al.* 2017, Tronstad *et al.* 2013). [1]

We measured psychological parameters, by application of a set of stress and anxiety self-evaluation questionnaires (Klainin-Yobas *et al.* 2015).

We also used numeric rating scales to evaluate well-being, energy gain, muscular and nervous relaxation, before and after the intervention (adapted from Griensven *et al.* 2013).

Changes at the physiological level induced by psychosocial stress have been shown to be closely related to cognitive performance (Lupien *et al.* 2009, Sanger *et al.* 2014), as in attention (Cornelisse *et al.* 2011) and memory tasks (Chamberlain *et al.* 2006, Kuhlmann *et al.* 2005): a mild stress is thought to facilitate cognitive performances such as memory tasks, whereas an extreme stress may impair them. On the other hand, practices such as meditation and mindfulness have been shown to improve sustained attention (MacLean *et al.* 2010), cognitive flexibility (Lutz *et al.* 2008, Moore and Malinowski 2009) and inhibition processes (Bailey *et al.* 2019). However, some types of relaxation, by decreasing vigilance, could alter the cognitive performances (Amihai and Kozhevnikov 2014). Therefore, we hypothesized that a period of relaxation could modify memory and attentional performance and thus we included in this study six parameters evaluating sustained attention and short-term memory. We chose to use the Stroop test, which is measuring the aptitude to inhibit automatic response, and gives information on selective attention, cognitive flexibility and processing speed (Stroop 1935), the Sustained Attention to Response Task (SART), a go/no-go task that requires participants to withhold behavioral response to a single, infrequent target, allowing to evaluate the impulsiveness (Smilek 2010) and the Corsi blocks which allows an rapid evaluation of the spatial working memory (Vandierendonck *et al.* 2004).

This pilot investigated the variation of 15 different physiological and psychological parameters, chosen because they cover different aspects of relaxation, on three different rapid relaxation approaches using devices, and a control group using no device. Our objectives were to investigate if 1) some parameters could be more relevant than others to evaluate relaxation state; 2) the use of rapid relaxation devices with sensorial immersion could improve the relaxation of the participant relative to control group with no device; 3) depending on the device employed, some of the parameters could vary differently among groups after the intervention.

II MATERIALS AND METHODS

2.1 Groups of participants

The experiment was conducted with 40 healthy volunteers (who were not paid for the study). The participants were between 24 and 68 years old, with an average of 42.7 ± 11.5 years old, including 28 women and 12 men (Table 1). They were distributed in four groups (10 participants per group) using pseudo-randomization in order to acquire comparable groups in terms of age and sex. There were seven women and three men in each group. All participants declared that there they were not dependent on drugs or alcohol, except four participants smoking occasionally (one in each group). Participants were not taking medication except 3 participants taking medicine for hyper or

[1] Two companion articles will describe respectively 1) the effects induced during the relaxation period on electroencephalograms (EEG), respiratory rate and photoplethysmograms (PPG) and 2) the effect of the relaxation on voice parameters (such as prosody and vocal frequency) and facial emotions extracted from 3-minute videos recorded before and after relaxation. A schema of the repartition of the data presentation in these three articles is shown in Annex 1.
Further studies will analyze electroencephalogram (EEG), PhotoPlethysmoGraph (PPG) and respiration data recorded during the relaxation period, and videos acquired before and after the relaxation interval.

hypothyroidism (which were stabilized). The majority of participants were from Université Côte d'Azur or French research centers (students, teachers, employees, etc.). Both French and English speakers participated and participants could select either English or French language for the surveys. The whole protocol, including the relaxation phase (15 minutes) and the measurements of the parameters (pre and post relaxation), lasted 1 hour. The experiments were performed at room temperature (20-23°C) between 10 am. and 6 pm. on 4 consecutive weeks in April-May 2019.

	G1 - Control	**G2- NeuralUp**	**G3- BeBreathe**	**G4- Relax room**
Age (years)	44.0 ± 13.1	43.2 ± 13.0	42.5 ± 10.6	41.1 ± 10.4
Weight (kg)	65.9 ± 14.8	66.8 ± 10.6	63.4 ± 14.1	69.5 ± 15.2
Height (cm)	167.8 ± 7.2	172.0 ± 10.7	169.1 ± 7.0	168.0 ± 7.8
BMI (kg/cm^2)	23.4 ± 5.2	23.0 ±2.3	22.2 ± 5.4	24.8 ± 5.5

Table 1: Characteristics of the participants in terms of age, weight, height and BMI. Mean ± s.e.m. N=10 per group. One-way ANOVA non-significant between groups for each parameter (p>0.5). BMI: body mass index.

2.2 Relaxation devices

We named the groups as follows: G1 for the control group; G2, Neural Up® device; G3, Be-breathe® chair; and G4, Cobtek "Relax Room" (Figure 1).
G1 was the control group: the participants remained seated in an armchair with their eyes closed. They were equipped with noise-cancelling headphones and asked to breathe calmly throughout the 15-minute session.
G2 tested the Neural Up® device, a solution developed by iCare Sciences, and composed of a patented acoustic technology based on relaxing sound frequencies (Tibetan sounds) that alternate between right and left ears, giving a sensation of spatialized sound around the body. The participants remained seated in an armchair with their eyes closed and were equipped with noise-cancelling headphones. After 2.5-minute rest (baseline), the headphones delivered the Neural Up® sound for 10 minutes, followed by 2.5-minutes additional rest, in order to oblain a whole protocol of 15 minutes.
G3 tested the Ino-Sens Be-Breathe® device, a warming armchair with a back massage and swing, which is synchronized with the respiratory rhythm and communicates audio-respiratory instructions to the participant to inhale for 5 seconds and exhale for 5 seconds. The participants were installed in the Be-Breathe® chair, instructed to breathe with their abdomen and equipped with noise-cancelling headphones and a sleeping mask that covered their eyes. The Be-Breathe® chair was configured for a complex 15-minute sequence including: 1-minute rest, 1-minute audio instructions where the chair reached the horizontal position; 9 minutes of respiration movements driven by the armchair where the participant had a back massage and swing for the last 7 minutes in rhythm with respiration; then 3 minutes of rest in an inclined position and finally coming back to the seated position and resting for 1 minute.
G4 tested the Cobtek laboratory "Relax Room": A relaxation cabin was employed to present a 3D-movie containing virtual images of a realistic universe and then of a fantasy world on an island, with animals (butterfly, turtles) followed by virtual immersion in the water. The movie also presented sounds that began with a fast tempo and slowed down during the island travel phase, and came back to the initial rhythm at the end. The participants remained seated in a chair, equipped

with glasses for 3D vision, in front of a large screen. After 3-minute rest, the 3-D movie was presented for a duration of 9 minutes followed by 3-minute rest.

Figure 1: Different relaxation devices used in the study.

2.3 Protocol

We developed a protocol in order to test and compare the effect of the different devices. All procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. The Université Côte d'Azur ethics committee for non-interventional research (CERNI, *Comité d'Ethique pour les Recherches Non Interventionnelles)* approved this protocol (Protocol number : CERNI-2019-5). Briefly, participants were given the information letter and consent form 15 days before the experiments. They gave us back the signed consent mentioning the authorization to be video-recorded before starting the experiment. All the experiences were video-recorded. The different parameters measured are described in Annex 1. Annex 2 presents a protocol showing the order in which we proceeded to the different measurements for each participant.

2.4 Physiological measurements

Immediately before and after each 15-minute relaxation session, we measured the systolic and diastolic blood pressure (to determine the mean arterial blood pressure = 1/3 systolic + 2/3 diastolic) and the cardiac rhythm of the participant using an armband (OMRON® M2). We measured the SpO_2 (partial saturation in oxygen) using a fingertip pulse oximeter (CardioSensys® v1. 0, Sensoria Analytics). Participants were allowed to rest quietly in an armchair 5 minutes before measurement were taken.

Before and after the 15-minute relaxation session, we also evaluated the standing posture of each participant by measuring the height of the eyes using a horizontal laser-pointer on a vertical scale.

2.5 Psychological parameters

The participants completed a preliminary survey on general data such as pre-existing conditions, level of physical exercise, specific diet, addictions (tobacco, alcohol, cannabis or other drugs) and sleeping habits, all of which may influence the data analyses.

Regarding the self-evaluation data collection, the participants used four numeric rating scales from 1 to 10 adapted from pain numeric rating scale (Griensven *et al.* 2013) to indicate their states of: 1) subjective general condition (physical, moral, and emotional), 2) subjective fatigue, 3) subjective muscular tension, and 4) subjective nervous or psychological tension.

They also completed a self-evaluation survey about their stress state and anxiety levels to permit the analysis of the self-perception of the participants, before and after the relaxation session. We used the following two forms:

Perceived Stress Scale (PSS), the most widely used psychological metric for measuring the perception of stress. The 10 questions in the PSS concern feelings and thoughts over the past month. It is a measure of the degree to which the situations in participant's life are appraised as stressful. Items were designed quantify the level of unpredictability, uncontrollability, and overload in the lives of the respondents. The scale also includes a number of direct questions about current levels of stress experienced (Cohen *et al.* 1983).

State-Trait Anxiety Inventory Form Y-1 (STAI-Y-1) or S-Anxiety scale: STAI has been used extensively in research and clinical practice. It comprises separate self-report scales for measuring state and trait anxiety. The S-Anxiety scale consists of twenty statements that evaluate how respondents feel "right now, at this moment". The essential qualities evaluated by the S-Anxiety scale are feelings of apprehension, tension, nervousness, and worry. Scores on the S-Anxiety scale increase in response to physical danger and psychological stress, and decrease as a result of relaxation training (Spielberger 1983).

The questionnaires for the preliminary data (pathologies, physical exercise, diet, etc.) and for self-evaluation about stress (PSS Form) and anxiety (STAI-Y Form) were created using the Google Forms application (in an anonymous way) with versions in English and in French. The participants could select either English or French and responded using a tablet and we verified the registry of their answers on-line. The form responses were stored in .CSV files.

2.6 Subjective perceived duration and Verbatim

The participants were asked to comment on their experience during the relaxation session by giving three words at the end of the experiment. We compiled the words used by the participants of each group and then used a word cloud generator (https://www.jasondavies.com/wordcloud/). In the generated word cloud, word sizes are proportional to their frequency of apparition in the speeches of the 10 participants of each group.

Additionally, after the session, participants were also asked to evaluate the perceived duration of the relaxation experience.

2.7 Attention tests

The participants performed a set of three attention tests, before and after the relaxation session:

Stroop Task: The name of a color (e.g., "blue", "green", or "red") is printed on a computer screen, which is shown to the participant. Sometimes it is printed in the color that corresponds with its name and other times in a color that is different from the name (e.g., the word "red" printed in blue ink) (Wright 2017). The so-called Stroop effect (Stroop 1935) demonstrates that the reaction time to press a button corresponding to the color of the word when the ink mismatches the name of the color takes longer and is more prone to errors than when the ink color and word match. The Stroop effect is reported as the average response time in incompatible trials (for instance the word Green written in red) minus compatible trials (for instance the word Green written in green). This test allows measuring the aptitude to inhibit an automatic reading response and it is used as a tool in the evaluation of executive functions. For Stroop test, we used PsyToolkit library of experiments (https://www.psytoolkit.org/experiment-library/stroop.html) and we created a French version of the test. Each test consisted in 40 trials.

Sustained Attention to Response Task (SART, Smilek *et al.* 2010**):** In this test, a visual mask is presented in the middle of the screen, which is then replaced by a digit (1 to 9). Each digit is presented for 250 ms followed by a 900 ms mask. The digits appearing on the screen were 5 mm high and the screen was placed at 30 cm from the participants. The task requires the participant to press the space bar whenever a digit is presented, as fast as possible, except for the digit '3' (for which no response should be entered). SART is a measure of impulsive responding and sustained attention. We used the open-source application PsychoPy2 (http://www.psychopy.org/) to run a SART code available at GitHub, and we did some adaptations in the code to define the number of digits played (100 trials). For the test applied after the relaxation session, changed the digit '3' to '5' to decrease the bias effect of learning during the post-session test. All the data were stored in .CSV files.

Corsi Block-tapping test: This is a task designed to assess the visual memory span (Kessels *et al.* 2000). 9 blocks "light" up on a computer screen in a sequence (starting with a sequence of 2 blocks and increasing by 1 in each trial). The participant is required to use the mouse to click the same blocks and in the same sequence. If done correctly, the participant progresses to a higher number of blocks; if wrong, he or she gets once more chance; if wrong again, the final score is the number of positions retrieved (the Corsi block span). For Corsi-block test, we used PsyToolkit (https://www.psytoolkit.org/experiment-library/experiment_corsi.html).

2.8 Data analysis

We created a folder for each participant including the experiment guidelines based on the entire protocol. This was strictly followed for each participant and notes were taken of certain measurements and participant answers. The file was anonymous (no name, first name, date of birth or place of birth).

2.9 Statistics

For the statistical analysis, we used Sigmaplot-10.0, GraphPad Prism-6 and InvivoStat-3.7.0.0 software.

Similar to age and sex, body mass index (BMI) can influence physiological parameters measurements such as heart rate (Quer *et al.* 2020) and blood pressure (Khoo *et al.* 2000). In addition, different stress levels between groups at the beginning of the experiment could affect the relaxation process and the physiological and psychological measurements. Therefore, we checked that these parameters were equilibrated between groups at the beginning of the experiment. To compare the baseline characteristics of the participants between groups (in terms of age, body mass index (weight/ height^2), weight and height, and different parameters measured before the relaxation) we used one-way parametric ANOVA. The groups did not differ on these measures at $p>0.3$.

We first evaluated the effects of the relaxation protocols on the different parameters measured using a repeated measures 2-way parametric ANOVA (time x 4 groups). Given the small sample size, this analysis did not reveal differences between groups but revealed a significant time effect for all groups (indicating an effect of the relaxation period) for most parameters (except for SpO2 and some of the attention parameters). As the four groups were independent, and because this study is exploratory in nature, we then compared the values from before and after the relaxation period for each independent group using paired t-tests. We applied a Holm correction for each independent group taking into account all the 15 parameters tested. As we didn't correct for the four groups, some of the effect revealed might be false positive. Only Holm corrected p values are given in the text. Corrected p values inferior to 0.05 were considered significant. We measured effect sizes using Hedges'g formula adapted for small samples, as effect sizes are not affected by sample size:

$$g = \frac{M1 - M2}{SD^{*}\text{pooled}} \times \left(\frac{N-3}{N-2.25}\right) \times \sqrt{\frac{N-2}{N}}$$

The effect was considered as small for $g < 0.2$, medium for $g = 0.5$ and large for $g > 0.7$ (J. Cohen, 1994; Schmidt and Hunter, 1997).
We hypothesized that the magnitude of the relaxation effect would be greater if the stress or anxiety of the participant was high at the beginning of the intervention. To evaluate the possibility of a correlation between the initial stress or anxiety level of the participants and the relaxation effect, we correlated the stress and anxiety survey score before the relaxation with the different parameters that changed following the relaxation session for all participants (value post-minus value pre-relaxation session). For the correlation studies, we used Heatmap built by a Python-3.7.0 script using the "corr()" method, which evaluates the Pearson's correlation between all the sets of variables. The result was graphed using "matplotlib" (Python plot utility source: https://medium.com/@sebastiannorena/finding-correlation-between-many-variables-multidimensional-dataset-with-python-5deb3f39ffb3).
To obtain the correlation graphs, we used Sigmaplot-10.0 linear regression. In each plot, 3 points were detected as outliers by the software and were removed from the plot before the linear regression was computed. For each regression, we calculated the correlation coefficient r as well as the F and p value.

III RESULTS

3.1 Baseline characteristics of the study participants

After pseudo-randomization, we obtained a similar distribution in terms of age, body mass index (weight/ height^2), weight and height in each group, as illustrated in Annex 3. The stress level of the participants at the beginning of the study was comparable between all 4 groups (Annex 3).

3.2 Physiological measurements

We compared the values of physiological measurements made before and after the intervention for each independent group.
The variations in heart rate from before and after intervention did not reach significance in any group (Fig 2A). Similarly, regarding SpO_2, the changes in SpO_2 did not reach significance for any group (Fig 2B).
The mean arterial blood pressure significantly decreased after the relaxation session in G3 (Be-Breathe® chair) ($p<0.01$), with an effect size of -0.32 and the decrease was close to significance in G2 (spatialized sound) ($P=0.078$) with a larger effect size of -0.750 (Fig 2D).
The systolic, diastolic and pulse pressure variations are shown in Figure 3. Overall, these changes did not reach significance, although the mean decreased in all groups, with the major changes observed in G3.
Regarding the posture, we measured a significant increase in the height of the eyes only in G4 (Relax room), with an effect size of 0.272 (Fig 2D). Apart from postural change, G4 showed the fewest changes in physiological parameters following the relaxation session, whereas the largest changes were observed in G3.

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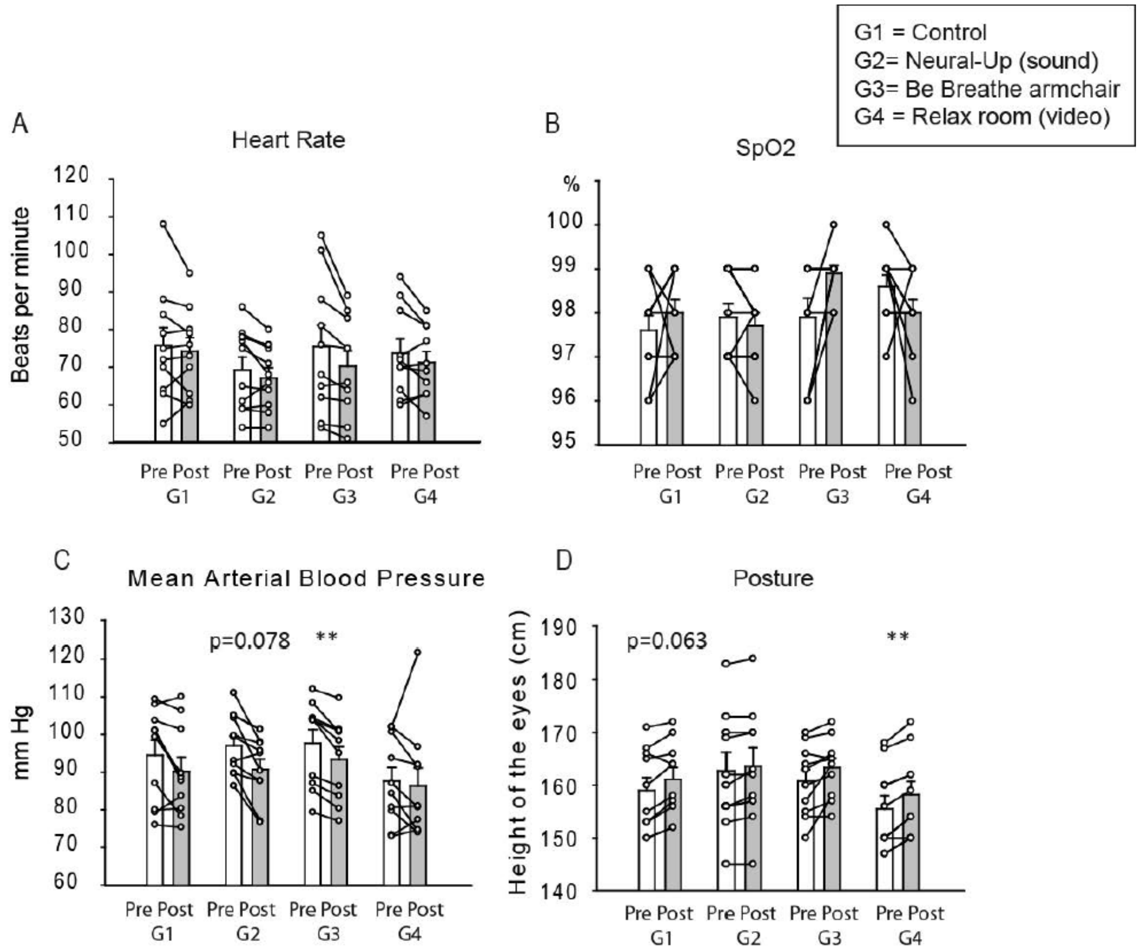

Figure 2: Physiological measurements before and after relaxation period for each group.
A) Heart rate; B) SpO2; C) Mean arterial blood pressure (2/3 diastolic + 1/3 systolic blood pressure); D) Posture (evaluated by the height of the eyes).

Dots represent the values pre- and post- intervention of a single participant, linked by a line. Bars represent the mean +/- s.e.m. (standard error of the mean) for the whole group (n=10), pre- (white bars) and post- (grey bars) intervention. One- way ANOVA revealed no significant difference between groups pre-intervention (white bars). Repeated measure 2- way ANOVA revealed no effect between groups but a significant time effect for heart rate, mean arterial blood pressure and posture. * $p<0.05$, ** $p<0.01$, paired t-test between pre- and post- values for each group adjusted for multiple comparisons by Holm/Bonferroni correction. P values close to significance are indicated on top of the bars.

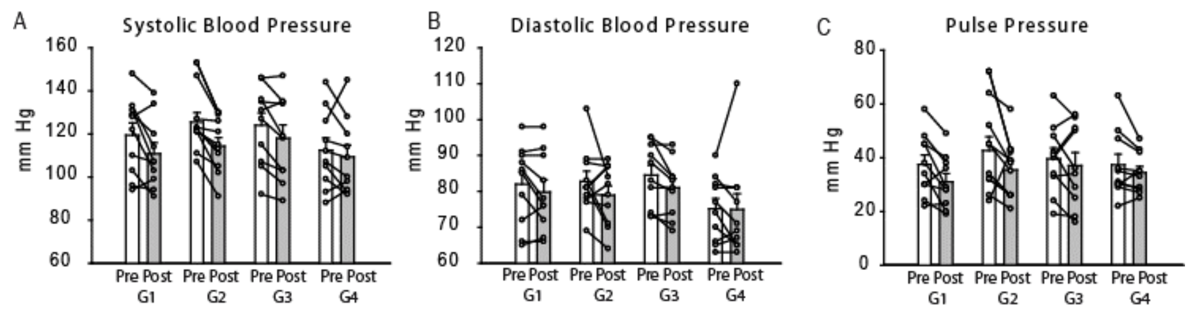

Figure 3: Blood pressure parameters. A) Systolic blood pressure B) Diastolic blood pressure C) Pulse pressure (Diastolic minus systolic). Dots represent the values pre- and post- intervention of a single participant, linked by a line. Bars represent the mean +/- s.e.m. (standard error of the mean) for the whole group (n=10), pre- (white bars) and post- (grey bars) intervention.

3.3 Self evaluations

The data obtained in evaluations using scales of well-being or energy gain did not show significant differences among groups between pre- and post-relaxation across all groups (Fig 4A and B). However, we observed a significant increase in subjective muscular relaxation in G3 (with an effect size of 0.736) and a significant increase in subjective nervous relaxation in G1 and G2 with effect sizes of respectively 1.166 and 0.778).

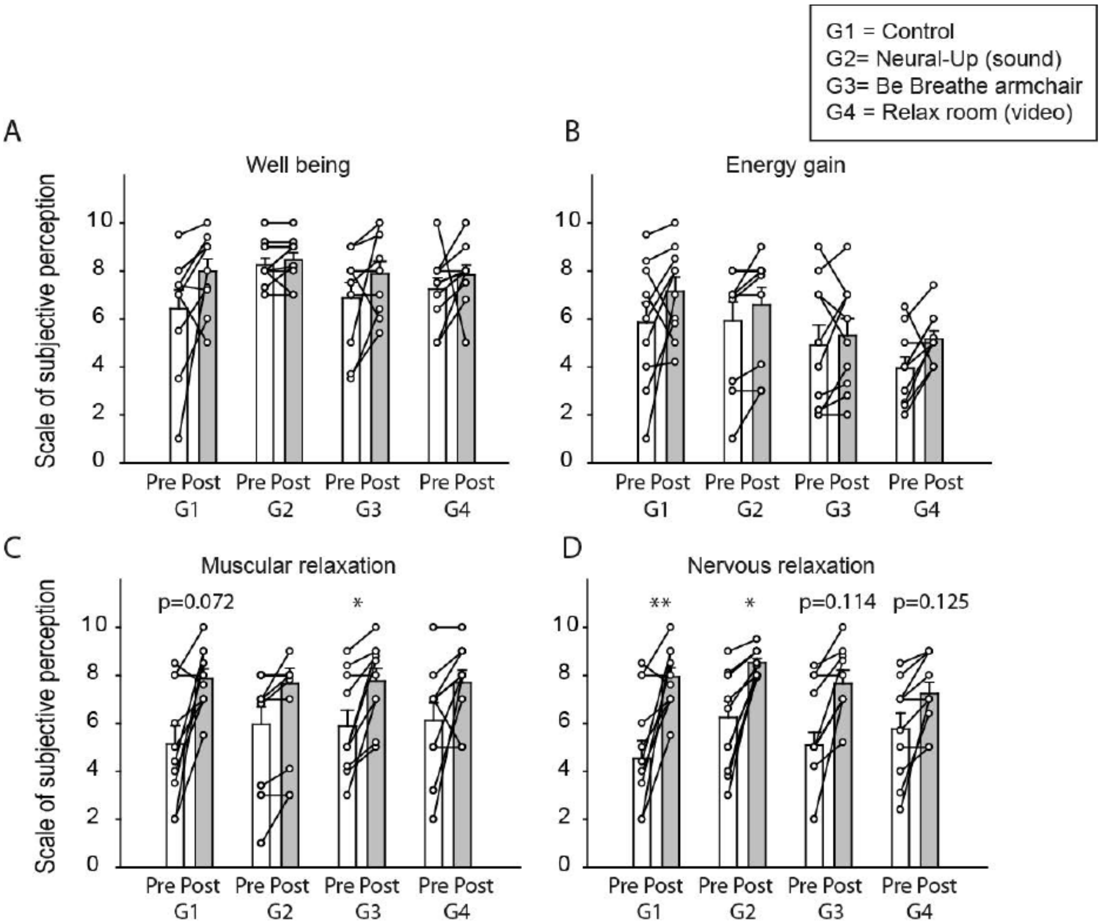

Figure 4: Self-evaluation before (pre) and after (post) the relaxation, measured using scales from 1 to 10 for: A) well-being, B) perception of gain of energy, C) subjective muscular relaxation state and D) subjective nervous relaxation state.

Dots represent the values pre- and post- intervention of a single participant, linked by a line. Bars represent the mean +/- s.e.m. for the whole group (n=10) before (white bars) and after (grey bars) intervention. One- way ANOVA revealed no significant difference between groups pre-intervention (white bars). Repeated measure 2- way ANOVA revealed no effect between groups but a significant effect of time for all four self-evaluation parameters. * p<0.05, ** p<0.01 paired t-test between pre and post values for each group adjusted for multiple comparisons by Holm/Bonferroni correction. P values close to significance are indicated on top of the bars.

3.4 Self-reported anxiety

We observed no significant effect of relaxation on anxiety levels (measured by STAI-Y form) in any group. However, decrease in anxiety levels were close to significance for G1 (control group, p=0.092, effect size of -0.754) and G4 ("Relax Room", p=0.148 , effect size of -0.685).

3.5 Estimation of the relaxation duration

As illustrated Fig 5B, participants in G3 estimated the duration of the relaxation significantly much shorter than the objective duration (15 min), whereas the other groups kept a good notion of time.

3.6 Verbatim

We compiled the words used by the participants to describe their relaxation session experience. The results, presented in Figure 5C, show that expressions meaning "relaxed", "pleasant", and "nice" are frequently used by all participants, regardless of their group. However, there were some minor differences between groups, for instance the appearance of "short" for G3, in agreement with the result of Figure 5B, "packing" for G2 or "travel" for G4, corresponding to the diversity of the sensorial stimulus of each device.

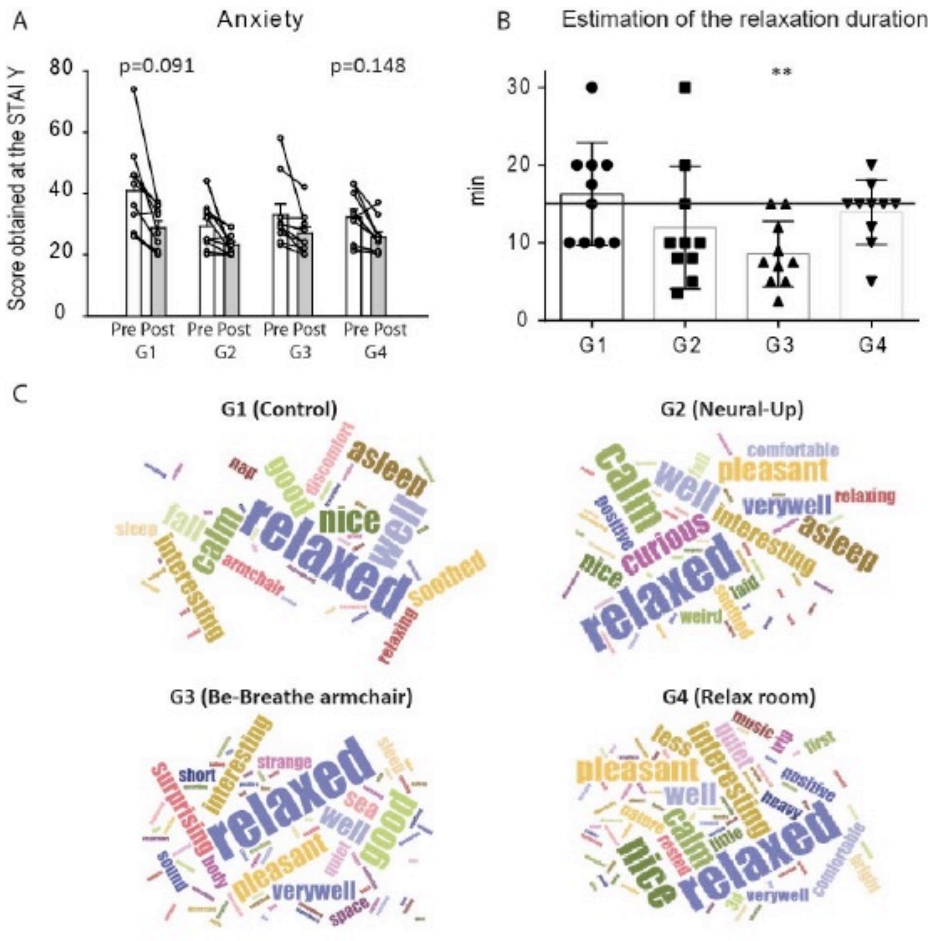

Figure 5: Anxiety, duration estimation and verbatim reports.

A) Anxiety evaluated using the STAI-Y state survey. Dots represent the values pre- and post-intervention of a single participant, linked by a line. Bars represent the mean +/- s.e.m. for the whole group (n=10) before (white bars) and after (grey bars) intervention. One- way ANOVA revealed no significant difference between groups pre-intervention (white bars). Repeated measure 2- way

ANOVA revealed no effect between groups but a significant time effect. P values close to significance of paired t-test between pre and post values for each group adjusted for multiple comparisons by Holm/Bonferroni correction are indicate on top.
B) Subjective estimated duration of the relaxation time at the end of the experiment. ** $p<0.001$, Fisher test compared to control (G1) after one-way ANOVA.
C) Compilation of the words used by the participants at the end of their relaxation experience. French words were translated into English. Words expressed by the participants are represented in a word cloud in which the largest size of one word represents the more frequent apparition of the word in the speech of the participants within each group.

3.7 Attention tests

The Stroop effect was unchanged after the relaxation session (Fig 6A). However, we did observe a significantly reduced reaction time in the Stroop test (related to processing speed) in G1, G2 and G4 with effect sizes of respectively -0.740, -0.718 and -0.480 (Fig. 7B). In addition, the Stroop test accuracy improvement after the relaxation session was close to significance in G4 ($p=0.096$) with an effect size of 0.735 (Fig 6C). Independent of the group, the relaxation sessions did not modify the average number of Corsi blocks memorized by the participants (Fig 6D). Finally, in the SART test, the target accuracy was significantly improved for G4 with an effect size of 0.797 (Fig 6E) while the non-target accuracy was unchanged for all groups.

Table 2 summarizes the results obtained from Pre and Post relaxation analyses, allowing a clear comparison of the changes in variables within each group and giving an overview of the effects sizes observed for each parameter tested. Table 2 also presents the Holm-adjusted p-values for the 15 variables revealed by paired t-tests. All 4 groups showed improvements in different aspects regarding physiological and self-reported effects, including the control group (G1). We observed dominant physiological changes in G3 (with a reduction of mean blood pressure) while cognitive effects were notable for G4.

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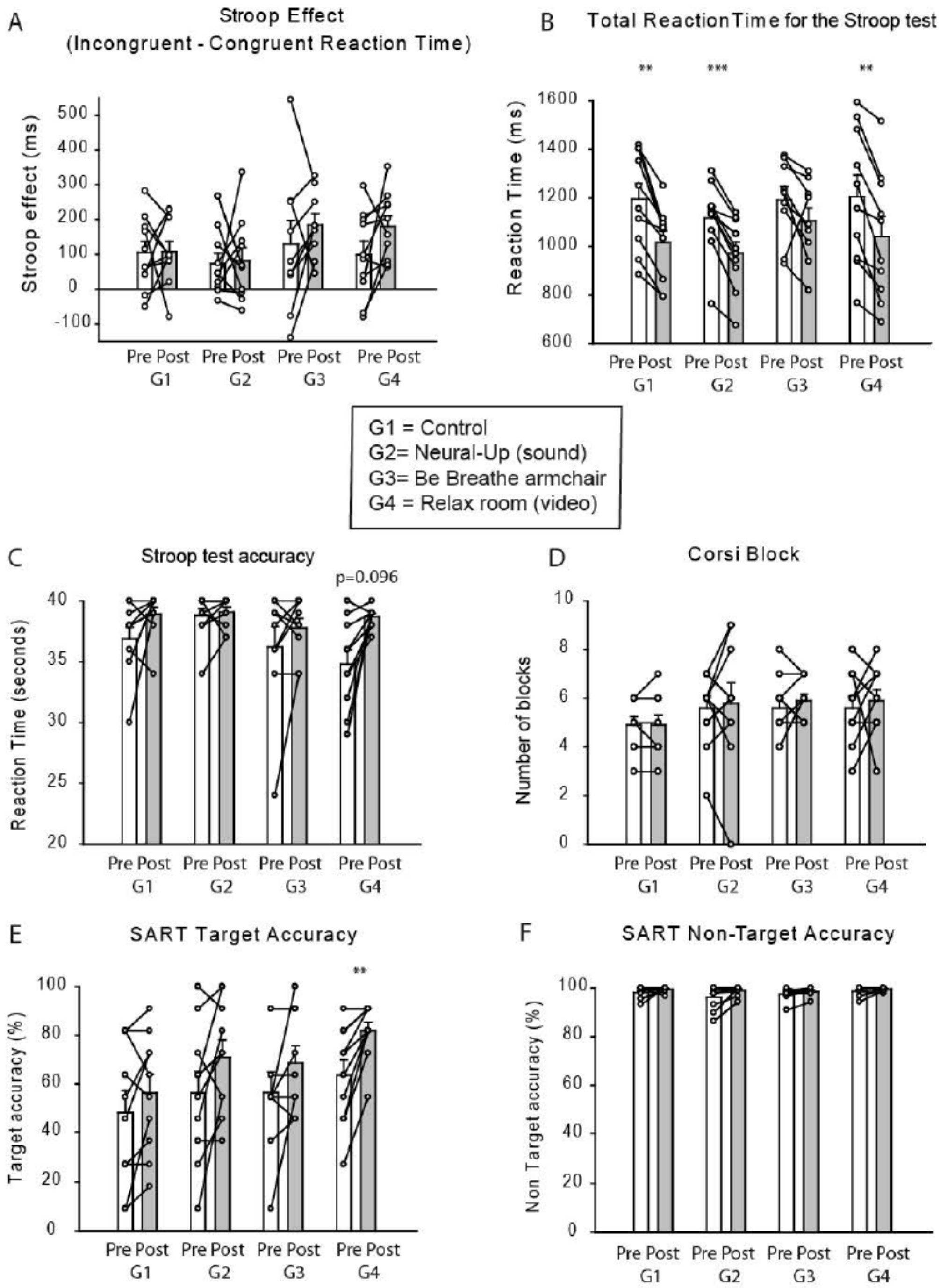

Figure 6: Attention tests. Results obtained with the attention tests before (Pre) and after (Post) relaxation for the four groups. A) Stroop effect (mean reaction time of congruent minus incongruent presentation). B) Reaction time for the Stroop test (including both congruent and non-congruent presentations). C) Stroop test accuracy (number of correct answers for 40 trials) D) Number of Corsi Bloks memorized. E) SART target accuracy (% of good responses). F) SART non-target accuracy (% of good responses).

Dots represent the values pre- and post-intervention of a single participant, linked by a line. Bars represent the mean +/- s.e.m. for the whole group (n=10) before (white bars) and after (grey bars) intervention. One-way ANOVA revealed no significant difference between groups pre-intervention (white bars). Repeated measure 2- way ANOVA revealed no effect between groups but a significant time effect. ** p<0.01, *** p<0.001, paired t test between pre and post values for each group adjusted for multiple comparisons by Holm/Bonferroni correction. P values close to significance are indicated on top of the bars.

Parameter type	Parameters	Group	G1 (Control)	G2 (Neural Up)	G3 (Be-Breathe)	G4 (Relax room)
Physiological effects	**Posture (cm)**	Pre	159.0 ± 7.8	162.7 ± 11.1	160.8 ± 6.7	155.5 ±7.9
		Post	161.1 ± 7.1	163.6 ±11.1	163.3 ±5.7	158.2 ± 8.0
		Effect size	0.226	0.065	0.325	0.272
		P value	0.064	0.224	0.271	0.001 **
	Heart rate (bpm)	Pre	75.8 ± 15.1	69.3 ± 10.9	75.5 ±18.1	73.8 ± 11.8
		Post	74.3 ± 11.3	67.2 ± 8.4	70.3 ± 13.14	71.3 ± 9.3
		Effect size	-0.417	-0.176	-0.269	-0.191
		P value	1	0.737	0.271	0.839
	SPO2 (%)	Pre	97.6 ± 1.1	97.9 ± 1.0	97.9 ± 1.4	98.6 ± 0.8
		Post	98.0 ± 0.9	97.7 ± 1.0	98.9 ± 0.6	98.0 ± 0.9
		Effect size	0.323	-0.161	**0.807**	-0.484
		P value	1	1	0.418	0.967
	Mean PB (mm Hg)	Pre	94.5 ± 12.6	97.0 ± 8.1	97.7 ± 11.4	87.9 ± 11.4
		Post	90.1 ± 12.0	90.7 ± 8.6	93.3 ± 10.8	86.4 ± 14.9
		Effect size	-0.288	-0.605	-0.322	-0.092
		P value	0.555	0.078	0.004 **	1
Self-reported effects	**Anxiety**	Pre	40.9 ±14.9	29.3 ± 7.5	33.0 ± 11.1	32.2 ± 8.3
		Post	28.8 ± 7.1	23.2 ± 3.7	27.0 ± 6.7	25.8 ± 5.4
		Effect size	**-0.754**	**-0.750**	-0.512	-0.685
		P value	0.092	0.315	0.418	0.148
	Well-Being	Pre	6.4 ± 2.5	8.3 ± 0.9	6.9 ± 2.1	7.2 ± 1.5
		Post	8.0 ± 1.6	8.5 ± 1.0	7.9 ± 1.7	7.8 ± 1.3
		Effect size	0.590	0.176	0.126	0.345
		P value	0.562	1	0.864	1
	Energy gain	Pre	5.9 ± 2.6	5.9 ± 2.5	4.9 ± 2.7	3.9 ± 1.5
		Post	7.2 ± 1.9	6.6 ± 2.3	5.3 ± 2.3	5.2 ± 1.1
		Effect size	0.453	0.239	0.133	0.732
		P value	0.897	0.315	1	0.269
	Subjective Muscle Relaxation	Pre	5.1 ± 2.4	6.0 ± 2.3	5.9 ± 2.1	6.1 ± 2.3
		Post	7.9 ± 1.3	7.7 ± 2.0	7.8 ± 1.7	7.7 ± 1.6
		Effect size	**0.960**	0.600	**0.736**	0.605
		P value	0.072	0.315	0.042 *	0.427
	Subjective Nervous relaxation	Pre	4.5 ± 2.4	6.3 ± 2.1	5.1 ± 1.7	5.8 ± 2.1
		Post	7.9 ± 1.2	8.5 ± 0 .6	7.7 ± 1.8	7.2 ± 1.5
		Effect size	**1.166**	**0.778**	**1.008**	0.530
		P value	0.002 **	0.036 *	0.114	0.125
Cognitive effects	**Stroop Reaction time (ms)**	Pre	1195.8 ± 199.4	1116.6 ±150.0	1191.6 ± 164.3	1205.6 ± 280.4
		Post	1017.2 ± 150.4	972.0 ±147.0	1104.8 ± 163.8	1040.4 ± 232.6
		Effect size	**-0.740**	**-0.718**	-0.424	-0.480
		P value	0.004 **	0.0003 ***	0.864	0.008 **
	Stroop Accuracy	Pre	36.9 ± 3.0	39.8 ± 1.9	36.2 ± 5.0	34.8 ± 3.7
		Post	38.9 ± 1.9	39.1 ± 1.3	37.8 ± 2.4	37.8 ± .8
		Effect size	0.608	-0.359	0.331	**0.735**
		P value	0.788	1	1	0.096
	Stroop effect	Pre	104.8 ± 104.4	73.2 ± 93.7	129.2 ± 205.2	98.9 ± 124.8
		Post	107.0 ± 96.3	81.4 ± 120.3	185.3 ± 95.4	180.3 ± 97.2
		Effect size	0.018	0.062	0.286	0.563
		P value	1	1	1	0.574
	Corsi span	Pre	4.9 ± 1.1	5.6 ± 1.6	5.6 ± 1.3	5.6 ± 1.5
		Post	4.9 ± 1.3	5.8 ± 2.7	5.9 ± 0.9	5.9 ± 1.4
		Effect size	0.000	0.080	0.226	0.167

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		P value	1	1	1	1
	Sart target accuracy	Pre	48.2 ± 29.1	56.4 ± 28.0	56.7 ± 25.2	63.6 ± 20.1
		Post	56.4 ± 24.2	70.9 ± 22.6	68.7 ± 20.9	81.8 ± 11.3
		Effect size	0.251	0.452	0.415	**0.797**
		P value	0.897	0.370	0.864	0.009 **
	Sart non Target accuracy	Pre	98.1 ± 2.5	96.1 ± 4.8	97.3 ± 2.7	98.6 ± 2.1
		Post	99.3 ± 1.1	99.0 ± 2.0	98.5 ± 1.8	99.4 ± 0.8
		Effect size	0.485	0.610	0.425	0.410
		P value	1	0.315	0.864	0.967

Table 2: Changes in parameters for each group.

Mean values ± standard deviation Pre and Post relaxation are indicated for each group as well as Hedges'g effect sizes (in blue, large effect sizes (with an absolute value > 0.7) indicated in bold) and P values of paired t test, adjusted for multiple comparisons (Holm/Bonferroni correction). P<0.15 in red, * p<0.05, ** p<0.01, *** p<0.001. N=10 per group.

3.8 Impact of the anxiety state of the participant at the beginning of the relaxation

We hypothesized that the magnitude of the relaxation effect would be greater if the stress or anxiety of the participant was high at the beginning of the intervention. To evaluate the possibility of a correlation between the initial stress or anxiety level of the participants and the relaxation effect, we correlated the stress and anxiety survey score before the relaxation with the different parameters that changed following the relaxation session for all participants (value post-minus value pre-relaxation session).

The results were then presented as a heat map (Figure 8), which revealed a good correlation between well-being, muscular and nervous relaxation subjective data with the initial anxiety level. However, it can be seen that the initial stress level did not correlate well with the subjective data.

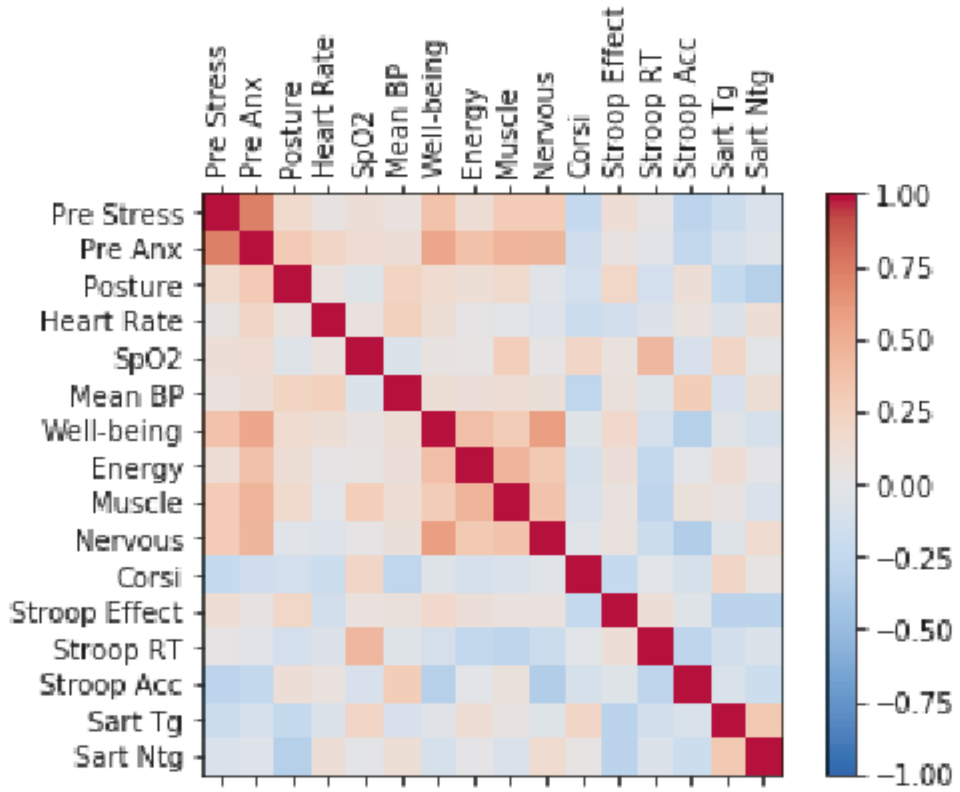

Figure 7: Heat map representing the level of correlation between the parameters analyzed for all participants in the four groups.

Pre Stress: Stress before the relaxation evaluated with the PSS; Pre Anx: Anxiety before the relaxation evaluated with the STAI state survey; Posture: Delta Post-Pre relaxation of height of the eyes to evaluate the posture; Heart Rate: Delta Post-Pre relaxation of heart rate; SpO2: Delta Post-Pre relaxation of SpO2; Mean BP: Delta Post-Pre relaxation of mean arterial blood pressure; Well-being: Delta Post-Pre relaxation of subjective evaluation with scales; Energy: Delta Post-Pre relaxation of subjective evaluation of energy gain with scales; Muscle: Delta Post-Pre relaxation of subjective evaluation of muscular relaxation with scales; Nervous: Delta Post-Pre relaxation of subjective evaluation of nervous relaxation with scales; Corsi: Delta Post-Pre relaxation of score obtained with the Corsi attention test; Stroop Effect: Delta Post-Pre relaxation of score obtained for the Stroop Effect; Stroop RT: Delta Post-Pre relaxation of reaction time obtained with the Stroop test; Stroop Acc: Delta Post-Pre relaxation of the Stroop test accuracy; SART Tg: Delta Post-Pre relaxation of scores obtained in the SART test for the target digit and SART NTg: Delta Post-Pre relaxation of scores obtained in the SART test for the non-target digit.

Figure 8 depicts correlations between initial anxiety levels (before relaxation) and the variation observed in well-being, subjective muscular and nervous relaxation between the values recorded pre- and post-relaxation (values post minus pre). Correlation coefficients were r= 0.43 for well-being, r=0.37 for muscular, and r=0.44 for nervous relaxation, meaning that there was a slight tendency for the relaxation to be more efficient for the participants who were the most anxious just before the relaxation. Although the correlations were small, they were significant.

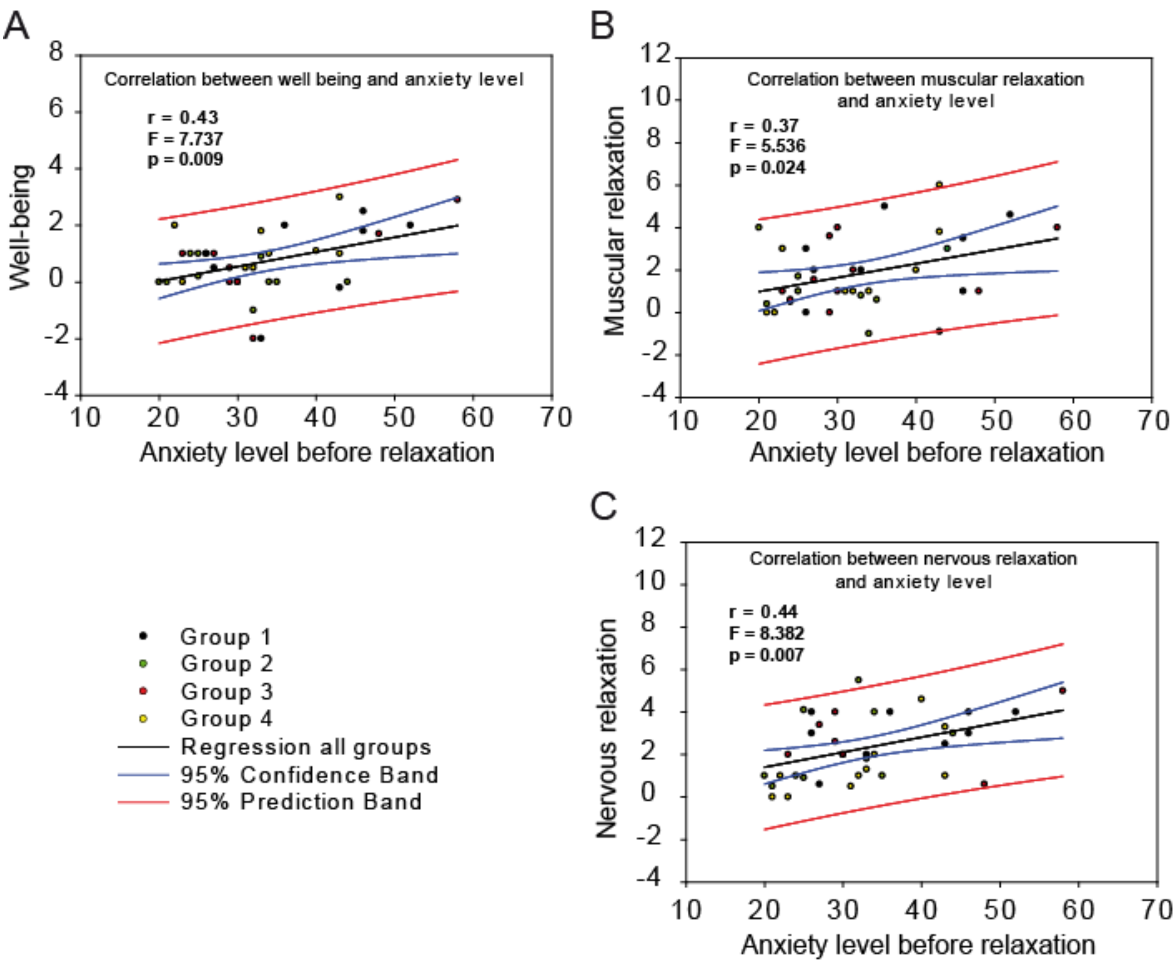

Figure 8: Linear correlation plots showing the relation between anxiety level before the relaxation (in abscissa) and A) the subjective well-being variation (Post minus Pre relaxation value); B) the subjective muscular relaxation variation (Post minus Pre relaxation value); and C) the subjective nervous relaxation variation (Post minus Pre relaxation value). Each dot represents a participant with a color code indicating the group. Correlation coefficients (r), F and p values are indicated in each box.

IV CONCLUSION AND REFERENCES

4.1 Discussion

This pilot study compared the variations in physiological and psychological parameters, before and after a relaxation session using three commercial devices and a control group where participants relaxed without the use of any device. For this study, we chose to measure a series of 15 parameters that we expected to change with the relaxation state of the participants, such as blood pressure (Dickinson *et al.* 2008), heart rate (Pal *et al.* 2014), anxiety (Klainin-Yobas *et al.* 2015) and 6 cognitive parameters (Lupien *et al.* 2009).

These technologies are under-evaluated and protocols to estimate their efficacy are needed. Our study allowed determining a set of parameters that seems to be appropriate for measuring rapid relaxation effects and establishing effect sizes for appropriated powered future *a priori* studies. Among the variables that changed the most, we observed the physiological parameters mean blood pressure (particularly in G3, a group where the participants breathed deeply). Among the self-reported effects, we noted large variations on values obtained on the subjective muscular and nervous relaxation numerical scales, which showed large effect sizes and significance in most groups (Table 2).

We also observed decreases on subjective measurements of anxiety after relaxation close to significance for G1 and G4 (Fig 5A). The effect of relaxation could depend on the initial anxiety level of the participants. Correlation studies showed that the perceived magnitude of subjective muscular and nervous relaxation (using scales) was proportional to the participants' level of anxiety before the relaxation intervention, independently of the group. Therefore, a rapid relaxation session is likely to be particularly efficient when people are anxious; conversely, there might be a ceiling effect in parameter improvements for rapid relaxation if the participants were initially relaxed. In our protocol, we did not purposefully stress a participant before the relaxation period. However, it is possible that the initial attention tests may have induced stress in some participants (Mejia-Mejia *et al.* 2018).

Regarding the cognitive parameters, Stroop and SART attention tests parameters showed important differences in parameters that were particularly obvious in G4, a dispositive that is indeed supposed to help improving attention. The reaction time in the Stroop test improved after the relaxation session in all groups. This effect might be due to an increase in processing speed after the relaxation session. However, it could also be due to a learning effect.

At the opposite, some variables did not change much. Among physiological effects, posture showed little changes (although we got significant result in G4, the effect size was low). Surprisingly, the heart rate remained quite stable although it has been described to vary with stress (Pal *et al.*, 2014). 15 minutes might not be enough to observe significant variations on heart rate and heart rate variability parameters will probably tell us more information on relaxing effects (von Rosenberg *et al.* 2017). Among self-reported effects, well-being and energy gain numerical scales self-reports showed only small variations. This could be because after the relaxation session, the participants often felt a sensation of being asleep, which can seem opposite of energy gain and well-being. Among cognitive parameters, the number of Corsi blocks memorized also did not change after relaxation for any group, thus, short-term memory did not improve with greater relaxation in this study. Interestingly, while certain metrics in attention tests improved after relaxation, others were unchanged : the Stroop effect (the difference between the reaction time to congruent *vs.* incongruent stimuli) did not vary after the relaxation session for any group, suggesting that the cognitive flexibility was not affected by rapid relaxation.

In this study, we also tried to compare the different relaxation devices compared to a group using no device by studying the variations obtained on the different parameters tested. We are aware of the limitations of this study. Given the low sample size, the statistical analysis was a concern. All groups were equivalent for all parameters tested at the beginning of the relaxation as revealed by one- way ANOVA. Repeated measure two- way ANOVA did not reveal any difference between groups. However, there was a time effect for almost all the parameters tested, meaning that the relaxation period induced significant changes. As groups were independent, we used paired t- tests to compare the effects within each group over the 15 parameters tested, while using a stringent Holm/Bonferroni correction. This statistical approach has some limitations: Holm–Bonferroni correction could induce false negative due to its rigor. On the other hand, due to the lack of multiple corrections across groups, this method is also likely to induce false positive.

This analysis revealed that the relaxation treatments were more efficient at modifying certain parameters in some groups compared to others. This approach has the advantage of allowing a comparison between the effects of the different devices. The use of effect size, that are supposed to be unaffected by sample size (Huberty and Morris 1989) allowed us to obtain an estimation of the variation range of the parameters. Due to the sample of participants used in the study (students and teachers from the University), the generalizability of this study with larger sample size may pose problems for replication with other populations. The low sample of participants also prevented a true random allocation. However, this pilot study allows us to make some assumptions on the efficacy of each device.

Interestingly, in G1 (control), where the participants were simply seated in an armchair and told to relax and breathe calmly (G1), we observed an increase in subjective muscular and nervous relaxation (Fig 4C-D) and a decrease in the Stroop test reaction time (Fig 6B). In addition, the participants used words like “relaxed, pleasant, good, etc.” to describe their experience (Fig. 6C). We can thus deduce that rapid relaxation, even without devices, can help people to achieve a sense of well-being in our “time-poor” society.

In G2, where the participants were listening to spatialized Tibetan sounds, we observed a very similar profile as compared to G1.

The most significant variation we found in G3 concerned the physiological parameters, especially blood pressure (Fig 2). This result is not very surprising as the device used by G3 prompts the participants to breathe deeply and slowly, leading them to the state of “cardiac coherence”, which is known to promote the activation of the parasympathetic system (McCraty and Zayas, 2014; Tiller *et al.* 1996). The G3 participants were the only ones to lose the sense of time, estimating that the duration of their relaxation session to be much shorter than it actually was (Fig 5B). The participants of G3 also felt, on average, a significant increase in subjective muscular relaxation (Fig 4C).

Interestingly, for G4 after relaxation, we found an improvement in participants’ posture with no other physiological parameter changes. We also found an improvement in some of the assessed cognitive tasks. In the go/no-go SART (in which the participants have to press a key after every number presented on the screen except for a specific chosen number, the target), the target accuracy (non-response to a selected number) was improved for G4. Similarly, the Stroop reaction time significantly decreased (Table 2). Overall, G4 seemed to show improvement in attention. The “Relax Room” (G4) was conceived to encourage people to relax before they perform tests (specifically, tests to reveal the presence of Alzheimer’s disease). The direction of the effect we observed in this pilot study is congruent with expected effect of this device on attention.

From this study, we can thus conclude that as little as 15 minutes of relaxation positively impacts physiological and psychological parameters. The use of a relaxation device may improve some aspects of relaxation. The spatialized sounds in Neural Up® (G2) improved the subjective nervous relaxation and the Stroop reaction time after relaxation. The Be-breathe® chair (G3) encouraged deeper, slower respiration, producing improved physiological changes, offering a real “disconnection” as evidenced by the participants’ loss of the awareness of passing time, with no significant impact on the subsequent attention test results. The “Relax Room” (G4) enhanced the performance in attention tests and the improved participants’ posture with no other physiological parameter changes.

Using a device can be particularly helpful for people who are not used to practicing relaxation. However, for people who are used to practicing relaxation or meditation regularly, the protocol followed by G1 could be sufficient to rapidly reach a state of relaxation. Even for untrained people, it has been shown that respiration in cardiac coherence could help to decrease stress (Mejia-Mejia *et al.* 2018).

While the majority of studies on relaxation are currently based on subjective measurements only, our study, which also includes objective criteria such as physiological measurements in the evaluations, has provided a more detailed analysis. Indeed, our study shows that for all groups, there is no clear correlation between the effects of relaxation according to subjective analyses (when a participant self-evaluates) and physiological parameters such as blood pressure (Table 2). This means that the participants may perceive themselves to be more relaxed despite the absence of a corresponding change in their physical parameters (for instance blood pressure). Furthermore, for G4, we observed an improvement in the attention test performance, but no significant changes in blood pressure parameters.

Our study illustrates that there are many different aspects of relaxation and that different relaxation devices can target one or more of these aspects.

4.2 Conclusion

In conclusion, this pilot study identified several parameters allowing the evaluation of different aspects of relaxation when using sensorial immersion rapid relaxation devices. Such technologies could be helpful in stressful environments, and could improve some aspects of relaxation compared with relaxation with no device.

Future studies could help identifying the most suitable relaxation device for each user, according to its specific needs. The ability to choose the device that would maximize the relaxation for each individual would represent a great advance and would provide better health and well-being in a shorter time. The quantification of relaxation parameters used in this study may contribute to assessing in the future the degree of relaxation for each participant, in order to improve existing relaxation devices. A further study with a larger cohort will allow directing participants with a given stress profile to the device that best suits their needs.

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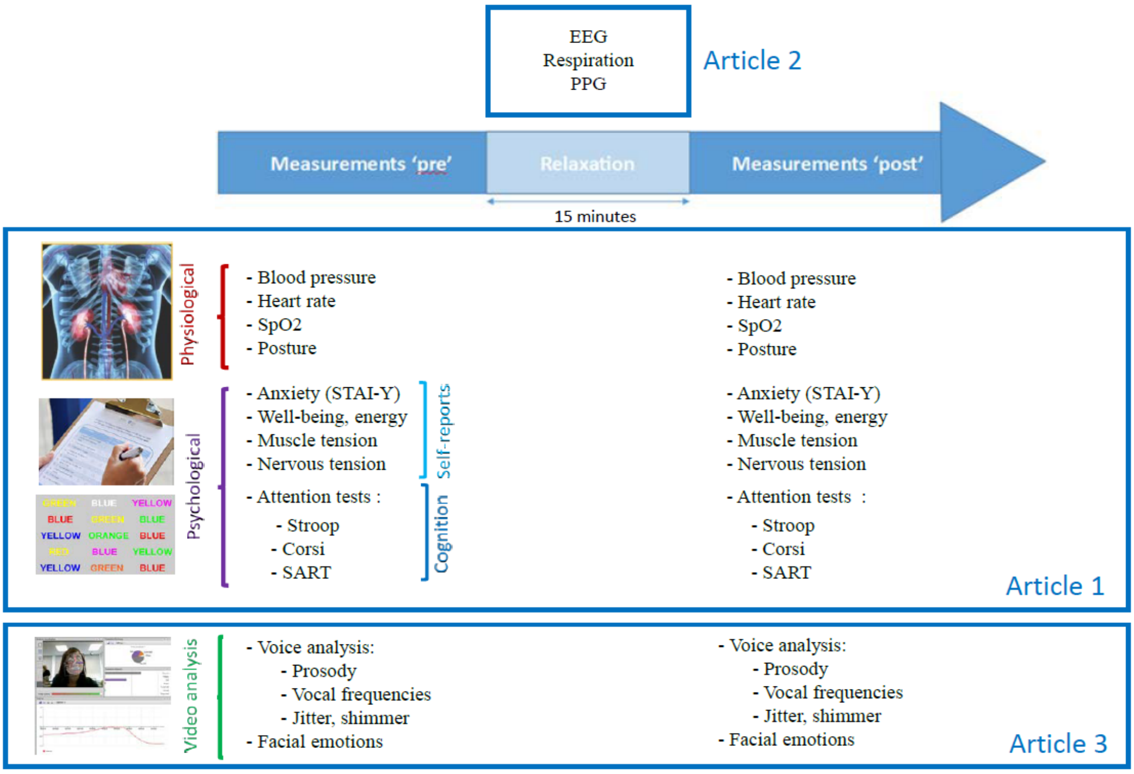
A Annex 1: Repartition of the different data of this pilot study presented in the three companion articles of this issue.



B Annex 2: Protocol

Research project on the effects of rapid relaxation induced with several devices of sensorial immersion

File identifications

File number : ___________________________________

***Identification of the subject* :** ___________________________________

***Investigator* :** ___________________________________

***Date and time* :**

Start – ___________________________________

Free and informed content:

Information form given	
Consent form signed	

Evaluation pre-session

Preliminary questionnary

Birth date				
Gender	*Man*		*Woman*	
Weight	Kg			
Height	cm			
Langage	*French*	*English*		
Pathologies ?				
Practice of physical exercices ?				
Specific diet ?				
Addictions (tobacco, alcohol …)?				

1- Subjective stress evaluation

Perceived Stress Scale survey in 10 item.

Investigator **:**

Note below the Perceived Stress Scale score

A1 =

2- Subjective anxiety evaluation

STAI form Y1

Investigator **:**

Please indicate below the STAI-state score

A2=

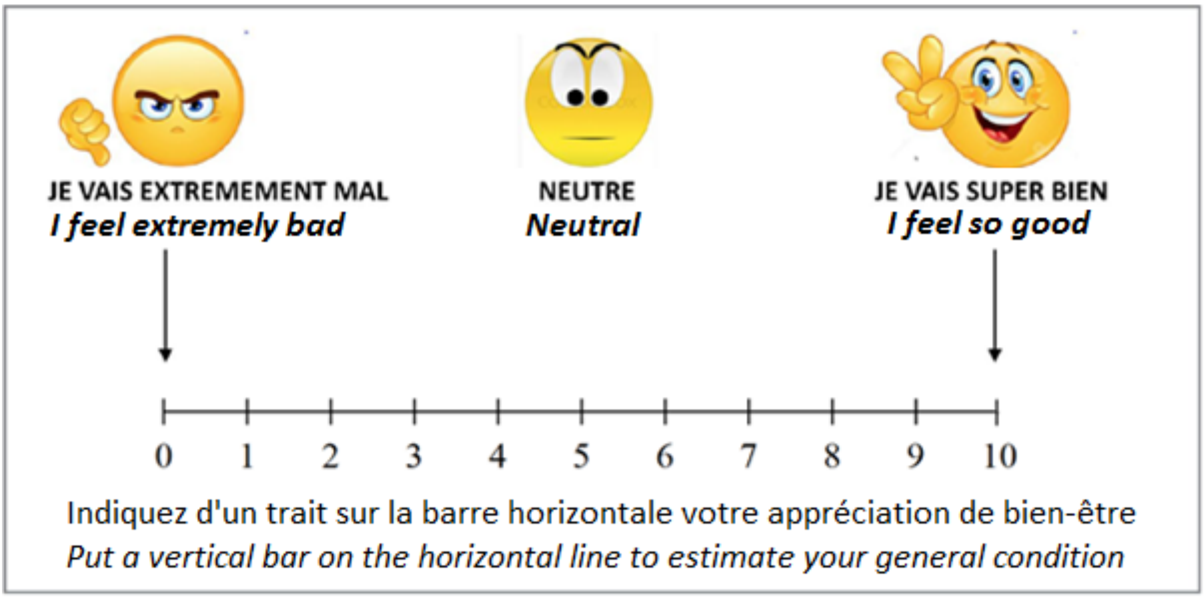
3- Profile photo at 1m from the wall and posture evaluation

Height H1 of the eyes on a vertical graduate scale (in meter)

H1 =

4- Subjective well-being evaluation

- *Right now, please indicate at which level you estimate your condition (physical, moral, emotional as a whole, as you feel it).*



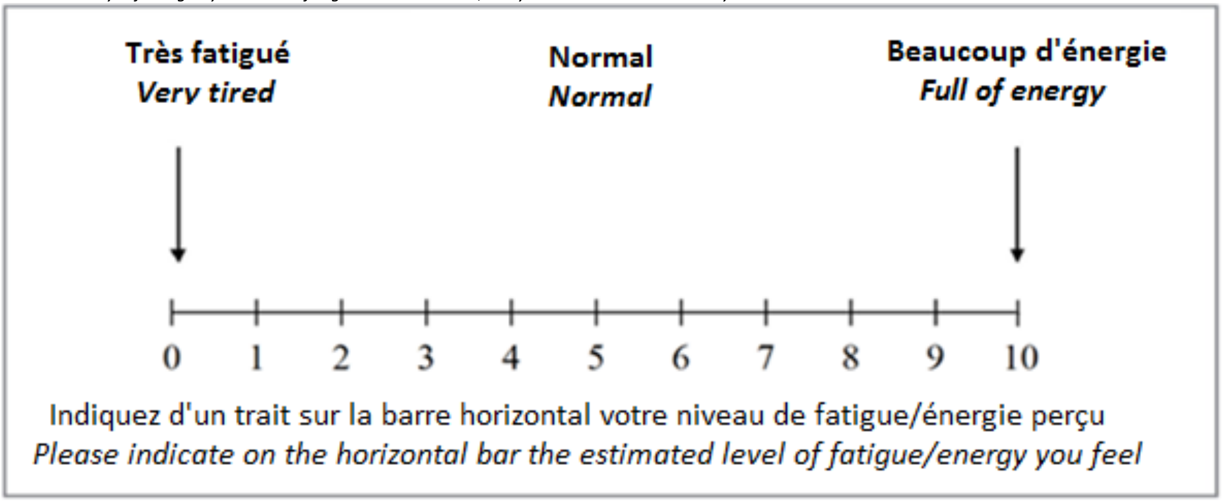
I*nvestigator* :

Please write the A1 score below

A3 =

5- Subjective energy gain evaluation

- *By referring to your state o fatigue at this moment, can you indicate at which level you estimate it on this linear scale?*



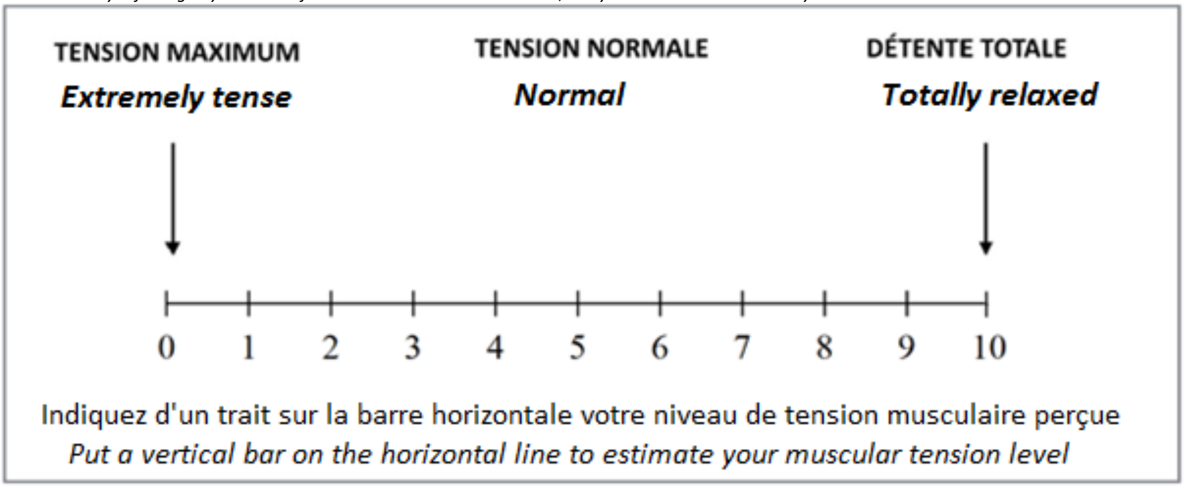
Investigator **:**

Note below the estimated level of fatigue/energy

A4=

6- Muscular tension subjective evaluation

- *By referring to your state of muscular tension at this moment, can you indicate at which level you estimate it on this linear scale?*



Investigator **:**

- *Please indicate below the A3 score*

A5 =

7- Nervous tension subjective evaluation

- *By referring to your state of nervous tension at this moment, can you indicate at which level you estimate it on this linear scale?*

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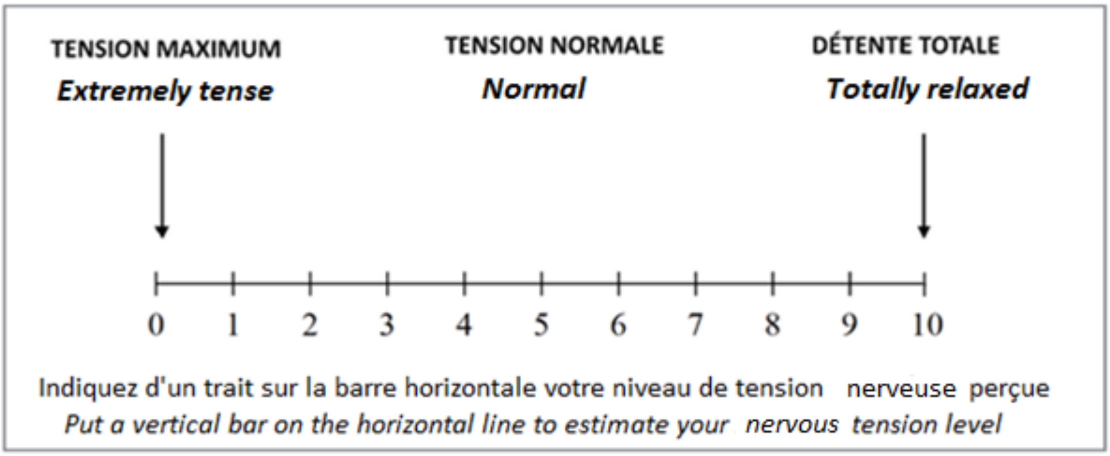


Investigator **:**

- *Please write the A6 score below*
- **A6=**

8- Video acquisition 3 minutes:

- Tell us a good experience you had recently
- Tell us a bad experience you had recently
- What are your motivations to participate ?

9- Attention tests :

- Stroop test
- Corsi blocks test
- Sart test

10- Results of physiological evaluations

- *Note below the SPO2 and the values of blood pressure measured at T0 (to be indicated) :*

Time T0	:	
SPO2	%	BMP
Blood pressure measurements ***(Systolic)*** ***(Diastolic)***	mmHg mmHg	

Check-list pré-session

Informations for Control group

Subject comfortably installed in the armchair, eyes closed if possible, with headphones

Informations for Be -Breathe

- Amrchair with following parameters :

Position	Zero Gravity	
Swing	Activated	
Press	50%	
Respiratiry system	Inspi 5 s. / Expi 5 s. (0,10 Hz)	

Informations for CobteK

Position	Installed in the armchair	
3D Glasses	positioned	

Audio/visual system	ready	
Olfaction	No	

Informations for Neural Up

Position	Installed in the armchair	
Audio cask	On	
Software	Ready	

Note which installation was used during the session

Installation of the subject

- *Check the following points:*

The subject went to the restroom before the session	
Glass of water available to the subject	
Subject well installed on the armchair	
Ungraded shirt collar and beld (if needed)	
Legs uncrossed, head resting and jaws released	
Hands affixed to the armrests	
Headban and noise reduction headphones installed	

Installation of measurement sensors

- *The investigators checks the setting up of measurement sensors :*

Respiration belt	Belt (/ ! \ signal)	
Tensiometre	Armband	
SPO2 et PPG captor	Finger oximetre	
EEG	Frontal Muse cask (/ ! \ calibrage)	

	Staring	***Stop***
PPG siftware		
Respiration software		
EEG software		

Evaluation post-session

1- *Note here the first reaction of the participants, the 3 firs words describing his or her experience:*

2- *Results of physiological evaluations*

- *Note below the SPO2 and the values of blood pressure measured at T0 (to be indicated) :*

Time T0	:	
SPO2	%	BMP
Blood pressure measurements **(systolique/*systolic*)** **(diastolique/*diastolic*)**	mmHg mmHg	

3- *Profile photo at 1m from the wall and posture evaluations*

Height H'1 of the eyes on a vertical graduate scale (in meter)
H'1 =

4- *Please answer the following questions*

Did you feel your body sensation during the whole experience?
Yes/No
Did you keep the notion of space surrounding you during the experience
Yes/No
How long do you think the experience lasted?

______________**minutes**

5- *Video acquisition 3 minutes:*

- Tell us what you liked
- Tell us what you disliked
- How do you feel now Choose 3 words to describe your experience

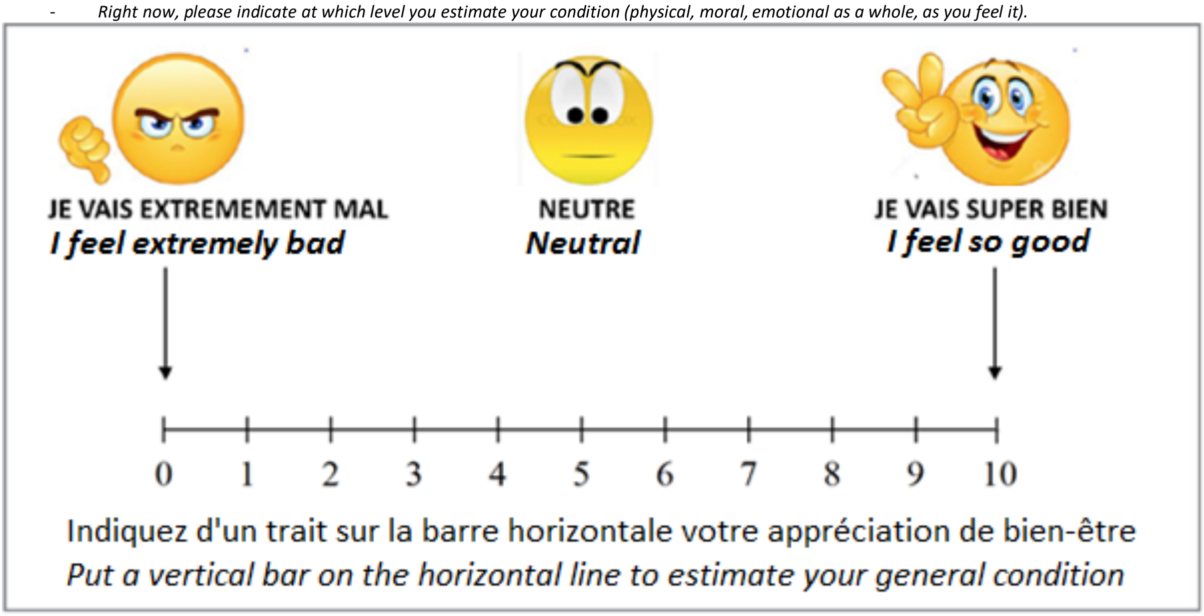
6- *Subjective anxiety evaluation*

STAI form Y1
Investigator **:**

Please indicate below the STAI-state score
B2=

7- *Subjective well being evaluation*

- *Right now, please indicate at which level you estimate your condition (physical, moral, emotional as a whole, as you feel it).*

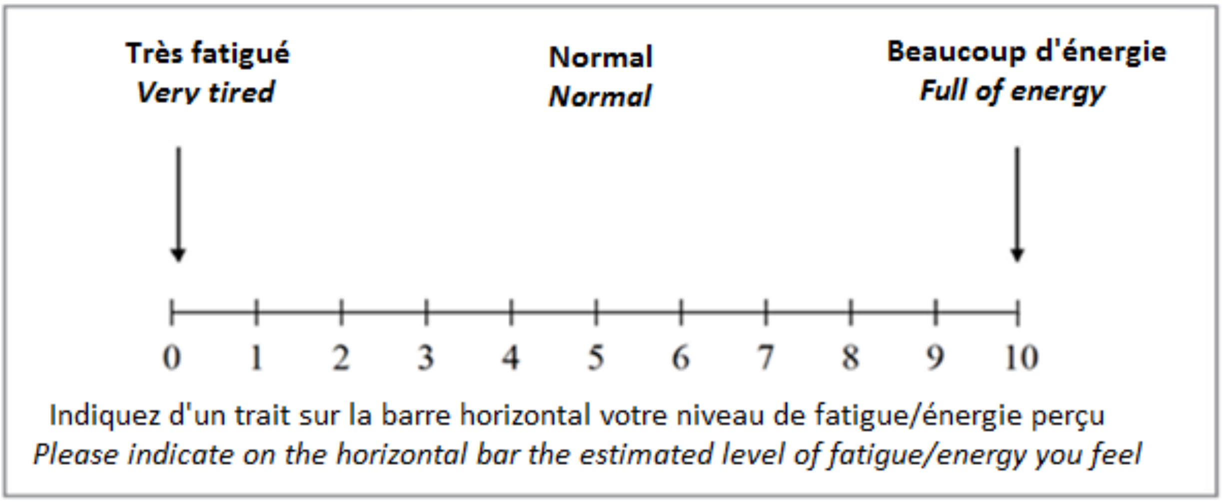


Investigator **:**

Please write the B1 score below
B3 =

8- *Subjective energy gain evaluation*

- *By referring to your state o fatigue at this moment, can you indicate at which level you estimate it on this linear scale?*



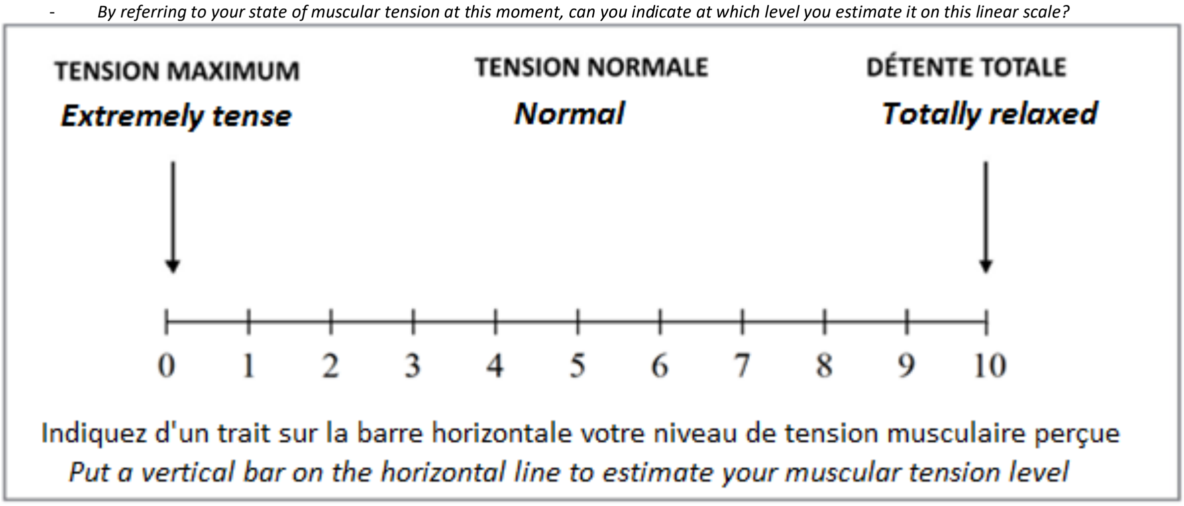
Investigator **:**

Note below the estimated level of fatigue/energy

B4=

9- Muscular tension subjective evaluation

- *By referring to your state of muscular tension at this moment, can you indicate at which level you estimate it on this linear scale?*



Investigator **:**

- *Please indicate below the B3 score*

B5 =

10- Nervous, psychological tension subjective evaluation

- *By referring to your state of nervous, pschological tension at this moment, can you indicate at which level you estimate it on this linear scale?*

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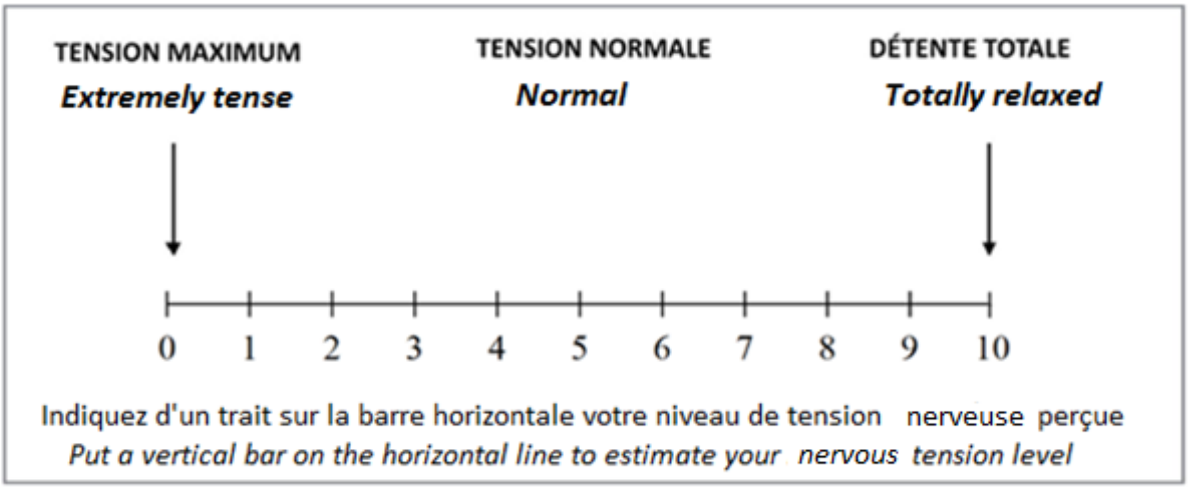

Investigateur/*investigator* :

- *Please write the score B4 below :*

B6 =

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11- ***Attention tests :***

- Stroop test
- Corsi blocks test
- Sart test

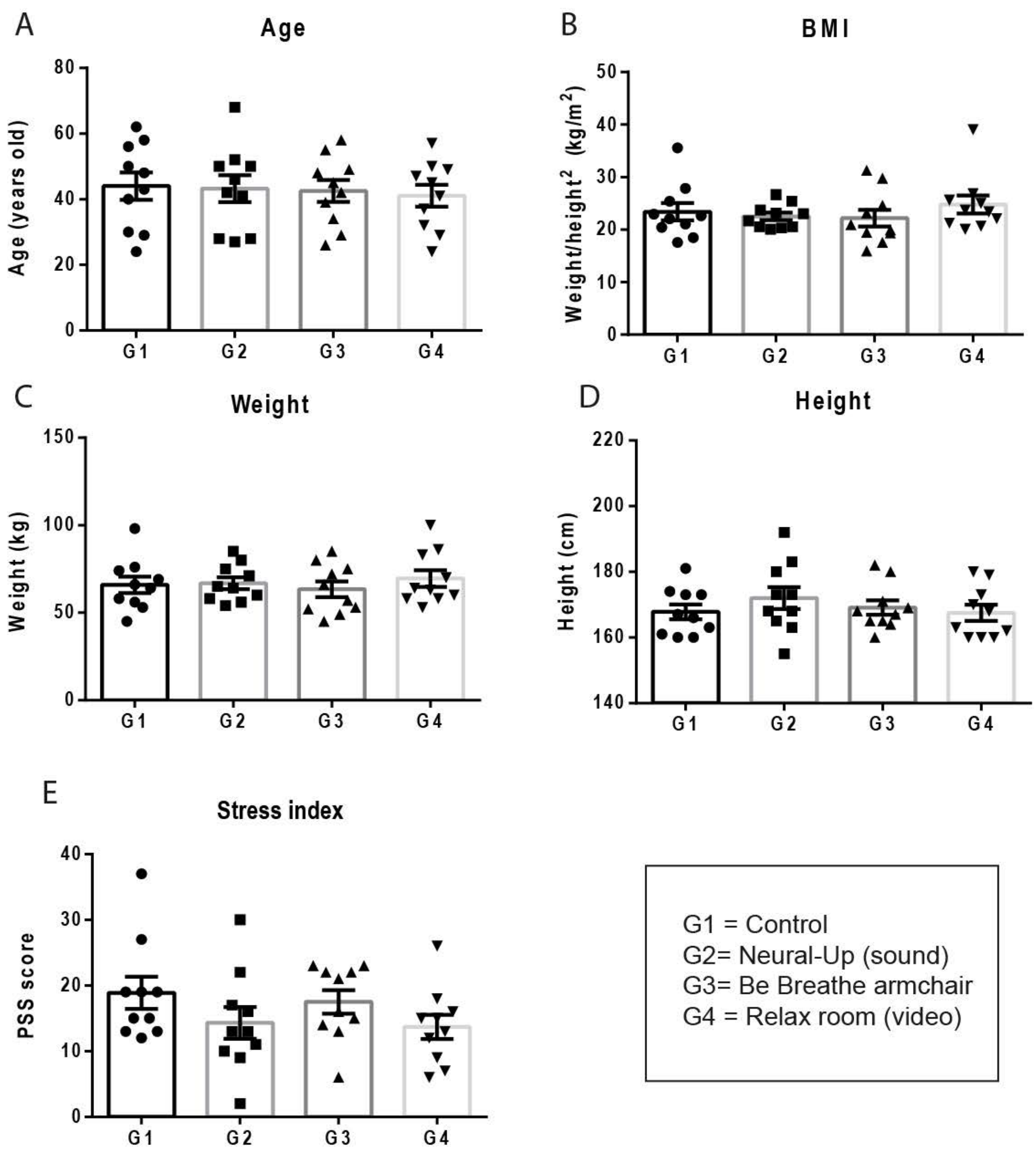
12- ***Give to the participant the survey to give back one week after the relaxing device experience.***

Date and time of the end of the session **:**

____

C Annex 3:

Comparison of the age, weight, height and body mass index and perceived stress at the beginning of the experiment (based on the PSS) of the participants in the four groups.



We compared data from the four groups using one-way ANOVA. There was no significant difference between groups (P>0.3).

D Acknowledgements

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E Data availability

The data that support the findings of this study and the repeated measures parametric analysis are available from the corresponding authors on reasonable request.

F Financial support

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G Conflict of interest

The authors declare they have no conflict of interest. The devices used in this study were kindly loaned by the companies with their agreement to proceed to the experiments. A research collaboration contract was signed between Sensoria Analytics and the CNRS.