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Faculteit Revalidatiewetenschappen

master in de revalidatiewetenschappen en de kinesitherapie

Masterthesis

The effect of script-driven imagery of emotions (relaxation, acceptance and hostile resistance) on postural control, end-tidal carbon dioxide and muscle activation patterns in healthy subjects

Jorn Claes
Sebastiaan Gijbels

Scriptie ingediend tot het behalen van de graad van master in de revalidatiewetenschappen en de kinesitherapie, afstudeerrichting revalidatiewetenschappen en kinesitherapie bij musculoskeletale aandoeningen

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We would like to thank Prof. Dr. L. Janssens, Prof. Dr. K. Bogaerts, Dr. N. Goossens, Dra. C. Amerijckx and Dr. R. Baggen for mentoring us with expert advice in an enthusiastic way.

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Context of the master thesis

This master thesis fits in the research domain of musculoskeletal (MSK) rehabilitation. Postural control is an important feature that allows us to interact with our environment during physical and daily activities. It is influenced by several aspects, of which one is the respiratory system. Increasing respiratory demands, for example during voluntary hyperventilation, imposes increased perturbations upon postural control through various mechanisms (David, Laval, Terrien, & Petitjean, 2012; Sakellari & Bronstein, 1997). Recent literature has already shown that these two systems, both the postural and respiratory system, can in turn be influenced by a person's psychological state and emotions. In particular, people exposed to (un)pleasant stimuli respond with changes in postural control, together with altered respiratory breathing patterns (Horslen & Carpenter, 2011; Van Diest et al., 2001).

In this study, participants were subjected to script-driven imagery to induce emotions. How this affects postural control, end-tidal carbon dioxide (PetCO2) and muscle activation, has however never been researched before. To reduce this gap in knowledge, the purpose of this study was to get a broader insight into the association between these outcome measures. More specifically, this cross-sectional study focused on the following research question: "What effect does script-driven imagery have on postural control, PetCO2 and muscle activation in healthy subjects?". The effect of script-driven imagery on the primary outcome measures (postural control, PetCO2, and muscle activation) was studied.

Seven healthy participants were recruited by means of posters and brochures at the campuses of Hasselt University and social media. Our intention was to investigate 12 people but due to the unforeseen circumstances of COVID-19, this was no longer possible, lowering the number to seven. The research was carried out by two master students in collaboration with the research team (Prof. Dr. L. Janssens; Prof. Dr. K. Bogaerts; Dr. N. Goossens; Dr. R. Baggen) at Rehabilitation Research Center (REVAL) in Diepenbeek. It will be contributing to the PhD project of Dra. C. Amerijckx, entitled "Hyperventilation in recurrent non-specific low back pain: a bottom-up and top-down perspective". Dra. C. Amerijckx provided us with a detailed protocol, to which we had to adhere. Our first objective was to present a critical

appraisal of the protocol with propositions to enhance the use of the protocol. In this protocol, equipment to collect data was described. They were outlined in the following way: bipolar electromyography (EMG) electrodes (Trigno, Delsys inc., Natick, USA) to measure muscle activation; handheld capnograph (Masimo Rad-97 TM Pulse CO-Oximeter® with NomoLine™ Capnography) for PetCO2; force plate (Advanced Medical Technology Inc. (AMTI), Watertown, USA) for postural control. Furthermore, digital scans of consent forms, digital (scans of) questionnaire responses, raw and processed numerical data (from force plates, EMG recording and capnography) were stored as software-specific files. Data processing was conducted by the two students with advice and help of Dr. R. Baggen and Dr. N. Goossens. Different programs were used for data reduction (Matlab) and statistical analysis (JUMP, SPSS). Finally, all this information was written on paper by two master students with as end result this master thesis part 2.

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1 Abstract

Background: The postural system allows us to interact with our environment during physical and daily activities by maintaining balance. It is influenced by several aspects, such as the respiratory system. These two systems can in turn be affected by a person's psychological state and emotions.

Objective: The objective was to use script-driven imagery to induce emotions and to investigate its effect on postural control, end-tidal carbon dioxide (PetCO2) and muscle activation in healthy individuals.

Method: Seven healthy participants were subjected to three scripts, depicting relaxation, acceptance and hostile resistance. During the entire testing, the primary outcome measures, namely postural control (force plate), PetCO2 (handheld capnography) and muscle activation patterns (electromyography) were measured. The effect of script (relaxation (R), acceptance (A), hostile resistance (HR)), phase of each script (baseline, imagery, recovery) and condition (before or after hyperventilation provocation), as well as their interactions, on the aforementioned parameters were examined.

Results: Script HR did not significantly affect PetCO2 and muscle activation patterns. However, and as hypothesized, script HR resulted in significantly less postural sway compared to script R and script A. More specifically, script HR caused significantly less Root Mean Square COP values in mediolateral direction (ML) than script A (Tukey: $p= 0.025$). This could also be applied for Standard Deviation of COP (Tukey: $p= 0.0042$ (ML)). Moreover, script HR induced significantly less Standard Deviation values of COP than script R (Tukey: $p= 0.044$ (ML)).

Discussion and conclusion: This study was the first to measure the effect of script-driven imagery of different emotions (relaxation, acceptance and hostile resistance) on postural control. Similar to other studies, our results suggest that stressful stimuli are associated with a reduction in postural sway. However, we found no significant effect of stressful stimuli on PetCO2 and muscle activation patterns.

Keywords: Imagery, Emotions, Respiration, Postural control, Electromyography

2 Introduction

Postural control, or the ability to maintain balance, requires interactions between sensory, motor and cognitive processes (Balasubramaniam & Wing, 2002). It allows people to interact with their environment and plays an important role in acquiring further motor competences. A specific aspect to consider is the respiratory component affecting postural control, since respiratory movements can cause perturbations in postural stability (Hunter & Kearney, 1981). In that view, the term 'posturo-respiratory synchronization' was proposed by Manor, Hu, Peng, Lipsitz, & Novak (2012) to define the association between postural control and the respiratory system.

It has been proven that voluntary manipulation of breathing changes the corticospinal excitability of non-respiratory muscles (Li & Rymer, 2011), such as the muscles of the lower extremities (David et al., 2012; Shirakawa et al., 2015). This resulted in small movements that have been demonstrated to compensate for respiratory-generated perturbances to postural balance (Hodges, Gurfinkel, Brumagne, Smith, & Cordo, 2002). While small perturbations to postural balance are provoked by respiratory-induced abdominal and thorax motion (Hodges et al. 2002; Hunter & Kearney, 1981), these perturbations are usually insignificant or absent in healthy adults (Gurfinkel, Kots, Paltsev, & Feldman, 1971; Hamaoui, Do, Poupard, & Bouisset, 2002). Conversely, respiratory-induced postural perturbations are more explicit in individuals with known postural control problems, for instance those with lower back complications (Grimstone & Hodges, 2003; Hamaoui et al., 2002) and older adults (Manor, Hu, Peng, Lipsitz, & Novak, 2012). Furthermore, the diaphragm is known as the principal inspiratory muscle. It also has a major role in controlling the spine, which is crucial in terms of postural control (Hodges & Gandevia, 2000). When the respiratory function of the diaphragm is put to the test, it may become challenging to preserve its postural function. This may be at the expense of postural control (David et al., 2012). Moreover, voluntary hyperventilation (VH) has been shown to be associated with an increase in center of pressure (COP) displacement during upright standing (Hodges et al., 2002). In the same way, an increase in postural sway has been found in healthy subjects when inspiratory resistive loading was applied (Janssens et al, 2013). In conclusion, these findings emphasize the importance of the respiratory system with regard to postural

control. However, it remains unknown whether disturbances in postural control, caused by increased breathing system exertion, are still present after quiet breathing has resumed.

Respiration works flawlessly when an individual breathes efficiently but becomes dysfunctional in case of inappropriate breathing in response to altering needs of the individual. As a consequence, the coordination of respiratory control mechanisms may fail under certain emotional and stressful conditions. This type of breakdown is defined by excessive ventilatory activity, also called hyperventilation (Wientjes, 1992). Furthermore, imaging fear could lead to an increase in breathing frequency (Lang, Kozak, Miller, Levin, & McLean, 1980), which, in turn, could can cause hyperventilation (Garssen & Kreukniet, 1987). Also the imaging of psychological relevant stressors can induce stress-physiological responses, including a decrease in end-tidal carbon dioxide (PetCO2) and an increase in breathing frequency. This was already observed both in healthy subjects and subjects with chronic fatigue syndrome (Bogaerts et al., 2007; Van Diest et al., 2001). In addition, hyperventilation has been related to the exposure of highly arousing negative emotions (Turpin, 1986). Also, several studies have shown that in case of emotional stress, the diaphragm demonstrated indications of hypertonicity, i.e. it became flattened and immobile (Faulker, 1941; Wolf, 1991). In regard to emotional stress, personality traits are thought to play significant roles in appraising situations as more threatening. Healthy subjects with trait negative affectivity for example have been shown to be more prone to experiencing negative mood states and emotions (Watson & Clark, 1984). Likewise, people with perfectionist trends were more subject to anxiety and depression (Mclaughin et al., 2011), and stress (Giota & Gustafsson, 2017; Schreiber, Grant, & Odlaug, 2012). On the subject of hyperventilation, research has demonstrated that individuals with higher scores on neuroticism showed an increased risk of hyperventilation (Shu et al., 2007). If participants were concerned about complaints related to over-breathing, secondary stress might further exacerbate over-breathing and hyperventilation symptoms (Ringsberg & Akerlind, 1999). This further illustrates the relation between a person's emotional state and their breathing. How this affects our motor behavior, in particular postural control, is however still largely unknown.

As described above, it is at present well-established that changes in respiratory demand can be induced by psychological aspects on the one hand and can lead to postural perturbations on the other hand. Taking this into account, it may be plausible that postural control is influenced by emotional contexts through breathing (Hagenaars, Oitz, & Roelofs, 2014). An emotional setting that has been researched in detail in postural control is postural threat, which is a situation where postural balance is challenged. For instance, standing on an elevated surface has been shown to evoke rises in sympathetic arousal, stress response and fear of falling (Cleworth, Horslen, & Carpenter, 2012; Horslen, Dakin, Inglis, Blouin, & Carpenter, 2014), but also a reduction in postural sway (Cleworth et al., 2012). This reduction in postural sway was in line with studies on aversive or threatening images (Azevedo et al. 2005; Hagenaars, Stins, & Roelofs, 2012; Roelofs, Hagenaars & Stins, 2010), proposing that this results from a maladaptive 'freezing' mechanism in reaction to arising threat, anxiety and stress. Indeed, it has already been shown that arousal is linked to increasing whole-body muscle stiffness (Fridlund et al. 1986). By way of contrast, some studies reported withdrawal behavior in reaction to unpleasant visual stimuli (Hillman, Rosengren, & Smith, 2004), implying an increase in postural sway. For instance, greater postural sway was proven to be associated with higher levels of state anxiety (Ohno, Wada, Saitoh, Sunaga, & Nagai, 2004). Individuals experiencing a robust fear response demonstrated an increase in sway amplitude as well (Davis, Campbell, Adkin, & Carpenter, 2009). From the findings above, the conclusion could be reached that the presence of emotional stimuli might provoke different postural changes, namely either increased or decreased postural sway. The use of script-driven imagery is a valid tool to induce emotions (Lang & Peter, 1979; Van Diest et al., 2001), however, the effect on postural control and PetCO2 has never been researched before.

In the current study, each participant was asked to imagine four scripts (neutral, acceptance, relaxation and hostile resistance) as vividly as possible in order to experience the story at the fullest. Each script aimed to elicit different emotions. Thus, the aim of the current study was to examine the effect of these different emotions on postural control, PetCO2 and muscle activation patterns. Secondary objective included investigating whether VH has long-lasting effects on these outcome measures after free breathing has resumed. In view of the first objective, we hypothesized that individuals demonstrate (1) a significant

decrease in PetCO2, (2) a significant reduction or increase in postural sway and (3) a higher activity of auxiliary respiratory muscles, in response to the imaging of the hostile resistance scripts compared to the neutral and acceptance scripts. Related to the secondary objective, we theorized that imaging after VH induces (4) similar effects to script HR on the primary outcome measures in comparison with imaging before VH. Lastly, we hypothesize that (5) participants with certain personality traits, for example perfectionism, report more negative meanings and worries about the imagery trials, which will reinforce the effect of these trials on the outcome measures.

3 Methods

3.1 Experimental setup

This study was a cross-sectional study.

3.2 Subjects

Seven healthy participants (four men and three women) were recruited by means of posters and brochures at the campuses of Hasselt University and social media. Potential subjects were informed about the study procedure. The following criteria were used to exclude subjects: modified low back pain disability questionnaire scores >2/100 (Denteneer et al., 2018); previous spinal surgery; Chronic Obstructive Pulmonary Disease (COPD); interstitial lung disease; pulmonary vascular disease; asthma (except for exertional asthma); acute cardiovascular or gastrointestinal diseases (e.g., recent acute myocardial infarction, recent coronary artery bypass grafting or percutaneous coronary intervention, heart failure, short bowel syndrome, enteric fistulas, severe diarrhea, sickle cell disease, intracranial hemorrhage); neuromuscular disease (e.g. Multiple Sclerosis, Amyotrophic Lateral Sclerosis, cardiovascular accident or diseases interfering with normal lower limb and trunk functioning); acute pain; secondary chronic pain; pregnant and lactating women; acute lower limb problems (e.g., recent anterior cruciate ligament rupture, recent ankle distortion); vestibular disorders; and major psychiatric comorbidity (e.g. anorexia nervosa, bulimia nervosa, alcohol use disorder, substance other than alcohol use disorder, psychotic disorder, (hypo-)mania,…). Participants with comorbid depression or anxiety disorder were eligible for inclusion. The study was approved by the local medical ethics committee (ZOL: B371201941765 and Clinicaltrials.gov: NCT04074798) and all participants provided written informed consent.

3.3 Materials

Bipolar electromyography (EMG) electrodes (Trigno, Delsys inc., Natick, USA) were placed on selected anatomical locations (See Table 1) on the right side of the body, parallel to the orientation of the muscle fibers to measure muscle activation. A nasal cannula was installed, which was connected to a handheld capnograph (Masimo Rad-97 TM Pulse CO-Oximeter® with NomoLine™ Capnography) to measure end-tidal partial carbon-dioxide pressures (PetCO2). COP was measured by a force plate (Advanced Medical Technology Inc. (AMTI), Watertown, USA).

Table 1
Overview of EMG placing

Muscle	Placement of EMG electrodes
M. Deltoideus anterior	One finger distal and anterior to the acromion. In the direction of the line between the acromion and the thumb.
M. Rectus abdominus	Two cm lateral to the umbilicus.
M. Obliquus abdominis internus	Two cm medial and inferior to the anterior superior iliac spine.
M. Erector spinae pars lumbalis	Two cm lateral to the spine at L3 vertebra level.
M. Multifidus	Maximally one cm lateral to the spine at L4-L5 level.
M. Intercostalis externus	At the second or third intercostal space, parasternal at the midclavicular line.
M. Sternocleidomastoideus	On the sternal head, at the lower one third of the line between the sternal notch and the mastoid attachment in the direction of this line. The electrode may not be placed in the middle or upper parts of the muscle.
M. Trapezius pars descendens	At 50% on the line from the acromion to the spine on vertebra C7.

EMG= electromyography, L=lumbar vertebra, C=cervical vertebra

3.4 Questionnaires

First, a questionnaire with regard to demographical data (age, sex, weight and body mass index) was filled in by the participants. This was followed by an electronic bundle of 12 questionnaires. The International Physical Activity Questionnaire - Short Form (IPAQ-SF) is a questionnaire used to estimate the habitual physical activity level. The Nijmegen Questionnaire (NQ) is a screening tool to detect patients with perceived symptoms of hyperventilation (Van Doorn, Colla, & Folgering, 1983). A score of 18 and more indicates a possible presence of hyperventilation symptoms. In the case of a score of 23 and more, this possibility increases until 80 percent. Dagelijks Leven Klachten Lijst (DLKL) was used to collect complaints which could be experienced in daily life. Next, the 12-item Short Form (SF-12) is a generic measure for the self-reported quality of life (Ware, Kosinski, & Keller, 1996). The Tampa Scale for Kinesiophobia (TSK) is a 17-item questionnaire with a cut-off score of 37, which evaluates kinesiophobia and pain-related fear (Miller, Kori, & Todd, 1991). The Need for Controllability and Predictability Questionnaire (NCP-Q) was used to rate the need for being able to control and predict situations (Nijs, Fonteyne, & Griffith, 2013). Furthermore, the Positive And Negative Affect Schedule (PANAS) is a questionnaire

that consists of two parts, namely positive affectivity and negative affectivity (Watson, Clark, & Tellegen, 1988). Subjects were asked to indicate on a 5-point scale the extent to which these items apply to their feelings at the moment. The Pain Solutions Questionnaire (PaSoL) was used to measure assimilative (efforts to change or solve pain) and accommodative (accepting pain is unsolvable and changing life goals) responses to problems associated with pain (De Vlieger, Van den Bussche, Eccleston, & Crombez, 2006). Next, the Toronto Alexithymia Scale 20 (TAS-20) evaluates characteristics linked to the alexithymia personality trait (Taylor, Ryan, & Bagby, 1985). A score of 60 or more indicates the presence of alexithymia. The Interoceptive Awareness Questionnaire (IAQ) was used to detect adaptive and maladaptive body awareness (Van den Bergh et al., 2012). The Multidimensional Perfectionism Scale (Stöber et al., 1998) evaluates four subscales of perfectionism (adaptive and maladaptive). Lastly, Vragenlijst Belastende Ervaringen (VBE) is a short questionnaire (Nijenhuis, van der Hart, & Vanderlinden, 1995) to detect aversive experiences in the past (e.g. life threatening experiences, physical/emotional/sexual abuse, death of a child or partner…). Each questionnaire used in this study is described shortly in Appendix 1.

3.5 Basic postural control (phase 1)

In total, this study was subdivided in four phases. During most trials, the participants were standing barefoot on the force plate (subjects were free to choose the position of their forefeet, but the distance between the heels had to be 10 cm). Standardization of this position was done by drawing the contours of the feet on a transparent sheet (drew when participants were standing for the first time on the force plate).

Basic postural control was assessed during four conditions (not randomized). The duration of each trial was 90 seconds. However, only the data from the first 60 seconds of relaxed upright standing and the data measured during the fast ballistic arm movement up to 90 degrees anteflexion were used for analysis. Before the start of the next trial, participants were asked to bend their knees slightly, in order to minimize the risk of venous pooling and potential syncope. COP (force plate) and EMG activity were continuously measured.

Table 2
Overview of the four conditions of basic postural control

Basic postural control	
Stable + vision	After 60 seconds of relaxed upright standing on a stable support surface (i.e., force plate) with eyes open, a fast ballistic arm movement up to 90 degrees anteflexion was asked, followed by 30 seconds recovery measurement.
Stable + no vision	After 60 seconds of relaxed upright standing on a stable support surface (i.e., force plate) with eyes closed, a fast ballistic arm movement up to 90 degrees anteflexion was asked followed by 30 seconds recovery measurement.
Unstable + vision	After 60 seconds of relaxed upright standing on an unstable support surface (i.e., foam pad placed on top of the force plate) with eyes open, a fast ballistic arm movement up to 90 degrees anteflexion was asked followed by 30 seconds recovery measurement.
Unstable + no vision	After 60 seconds of relaxed upright standing on a foam pad and eyes closed, a fast ballistic arm movement up to 90 degrees anteflexion was asked followed by 30 seconds recovery measurement.

3.6 Postural control during imaging before hyperventilation provocation (phase 2)

Four imagery scripts of one minute each were used (Appendix 2). Imagery with the aid of scripts has been proven to be valid to draw out emotions in psychophysiological studies (Lang & Peter, 1979; Van Diest et al., 2001), as well as in positron emission tomography (PET) studies on the neuroanatomy of emotions (Dougherty et al., 1999; Lane, Reiman, Ahern, Schwartz, & Davidson, 1997). The imagery protocol used in this study was an adapted version of the one used by Bogaerts et al. (2007) in patients with chronic fatigue syndrome. Hence, in this study three different scripts for emotional imagery, namely targeted to induce either relaxation, acceptance or hostile resistance, were used. A neutral script was always presented first to familiarize the participants with the instructions and the procedure of the experiment. However, the data from the neutral script served as practice trial and were not used for analysis. Next, the participants imagined the relaxation script (R), the script describing an action set of hostile resistance (HR), and the script describing an action set of acceptance (A) of the situation and its consequences in a randomized order. The randomization was performed by the researcher by creating as many different sequences as possible. Two versions of the HR and A scripts were used: one version described the participant having unexpected visitors and the other version described the

patient waiting in line at a grocery store. In this part of the study (phase 2), the HR script of unexpected visitors and the A script about waiting in the grocery store were used.

The following protocol was used for each participant (Fig 1). Just before the start of the experiment, participants were asked to fill out the PANAS-state questionnaire and the DLKL. The participants were then asked to stand on a foam pad with eyes closed (lights were switched off) and to breathe through the nose. COP, PetCO2, and EMG activity were continuously measured. First, the subjects listened to relaxing music (first minute of Holberg Suite in G major on. 40: II Sarabande) for one minute. During the following minute, the imagery script was presented, and the participant had to start imagery as soon as possible. A 90 s silence period followed during which the patient had to keep on imaging the described scene. After 60 s, a short low-level auditory signal, announced during the instructions, was given as a reminder to continue the imagery as vividly as possible. It is important to note that the subjects not only had to visualize the situation, but were in particular asked to imagine the accompanied feelings as vividly as possible. Finally, a one minute recovery period followed in which the patient had to stop the imagery and listened to relaxing music (first minute of Gymnopédie no. 1 (E. Satie). After each imaging condition, the subjects were asked to answer some questions related to the condition (Manikin assessment (Lang, Bradley, & Cuthbert, 1990; Mehrabian & Russell, 1974), likert scales, VAS concentration, DLKL, questions on attentional focus according to Johnson et al., (2017), PANAS and one last question about fear of falling). These questions or questionnaires are described as well in appendix 1.

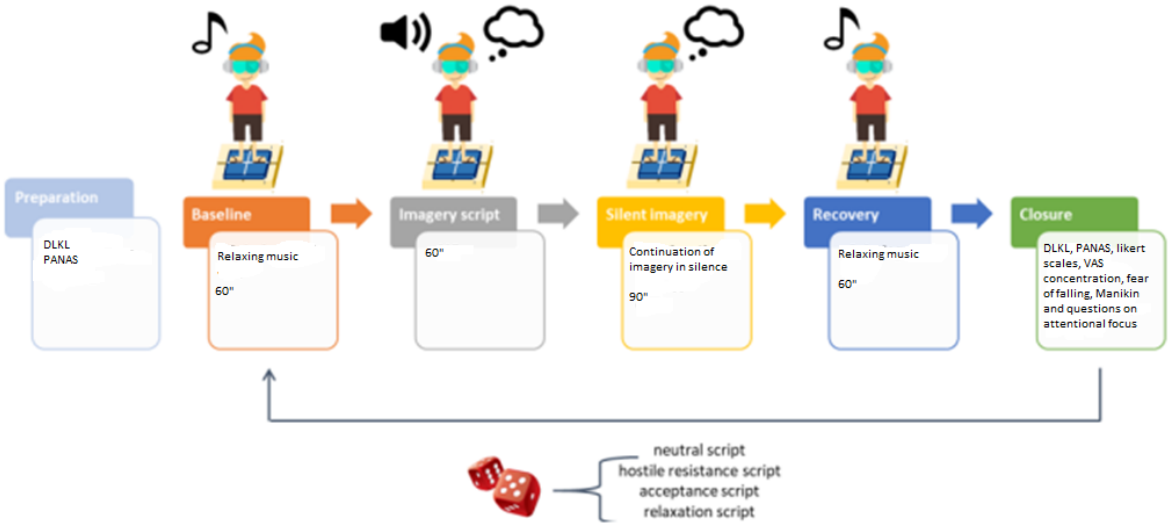

Fig. 1: Flowchart of postural control with imagery ®By courtesy of Charlotte Amerijckx

3.7 Voluntary hyperventilation (phase 3)

This phase consisted of three parts: a baseline measurement of ten minutes, hyperventilation provocation, and a recovery period of five minutes. PetCO2 was measured continuously. The participants were positioned comfortably on a chair with a backrest, both feet supported by the ground, buttock and back against the backrest, arms lying relaxed on a towel on the thighs with hand palms facing down. During the hyperventilation provocation, participants were asked to voluntarily augment their ventilation (breathing through the mouth) by increasing both breathing depth and frequency (60 bpm). An investigator demonstrated the correct breathing pattern and frequency by making large movements of the arms and body and joined the first few breaths. Once subjects started to experience bodily symptoms, they were asked to raise their hand and subsequently to continue breathing normally through their nose (start of recovery phase). After the five minute recovery period, they were asked to rate the symptoms they experienced at the end of hyperventilation provocation by means of the DLKL.

3.8 Postural control during imagery after hyperventilation provocation (phase 4)

Immediately after finishing Phase 3, phase 2 was repeated except for the following two remarks. First, the neutral script was not repeated because the participants were already familiarized with the instructions and the procedure of the experiment. Secondly, the A script of unexpected visitors and the HR script about waiting in the grocery store were used (appendix 2).

3.9 Data processing

Centre of pressure (COP) displacement magnitudes were calculated by the software (Simi) based on forces exerted on the force plate in X, Y & Z axes. COP displacement was measured in distance (m) from the center of the force plate in either medio-lateral (ML) or anterior-posterior (AP) direction. All COP data were filtered using a 4th-order Butterworth filter with a lowpass cut-off at 6Hz prior to processing. COP baseline offset was corrected by subtracting mean COP in either direction from all COP measurements in the corresponding direction.

All EMG data (in V) were filtered using a 4th-order Butterworth filter with a high-pass filter at 20Hz, full-wave rectified, and smoothed using a 100-point moving average filter. After determining the maximum activation for each individual muscle over all trials, data from all other trials were normalized to this maximum value and expressed in %. The maximum activation was determined during the fast ballistic arm movement up to 90 degrees anteflexion during phase 1.

Raw waveform signals for PetCO2 data were uploaded to a personal computer, calibrated, and reduced (parameter extraction, trend generation) by the VivoLogic software. This output was visually inspected before exporting the data to spreadsheets for further statistical processing. Next, the minimal value of PetCO2 during the first minute of recovery after hyperventilation provocation was calculated. The last calculation was the time between the moment when the subject stopped with hyperventilation and the moment when the subject reached the mean value measured during baseline.

3.10 Statistical analysis

For phase 1 (basic postural control) of this study, we calculated whether the support surface and/or vison had on effect on COP and EMG activity. For Phases 2 and 4, the questionnaire responses were analyzed with script (R, A, HR) and condition (before and after hyperventilation provocation) as within-subject factors. In case of COP, EMG and PetCO2, a third within-subject factor was used, namely the phase of script (baseline, imagery, recovery). Lastly, we calculated change scores by subtracting the mean baseline COP/EMG

activity/PetCO2 from the mean COP/EMG activity/PetCO2 of the imagery phase. Then we checked if the two factors script (R, A, HR) and condition (before and after hyperventilation provocation) influenced the outcome measures.

In case of normally distributed data (assessed by Shapiro-Wilk test), we used repeated measures ANOVA to check if the within-subjects factors had a significant effect on the questionnaire responses, COP, EMG and PetCO2. Furthermore, we checked whether there was an interaction effect between the within-subject factors. Moreover, Bonferroni's multiple comparison test (in the case that de x variable had two options) or the Tukey test (in the case that de x variable had three options) compared means as post hoc method in case of a significant effect. If data did not confirm normal distribution, a non-parametric statistical test (Friedman) was used. With this test, it is not possible to calculate interaction effects. Then, we used the Wilcoxon Signed-ranks test to compare two dependent 'groups' to identify whether the scripts, phase of script or condition had a significant effect on the outcome measures (questionnaires, COP, EMG activity and PetCO2). In detail, we compared each relevant situation next to another specific situation (dependent on the outcome measure (see the paragraph above)). As a result, we used a very strict correction method (Bonferroni) for multiple comparisons in these situations dependent on the amount of comparisons.

4 Results

4.1 Demographic features

In total seven healthy individuals were included. Characteristics of the group are presented in Table 3. It should be pointed out that the participants were young students. The group was homogeneous with regard to the demographic features.

Table 3

Participants characteristics

Participants characteristics	
Age (years)	22 ± 1
Sex (f/m)	3/4
Weight (kg)	69.57 ± 13.35
Length (cm)	176.57 ± 13.73
BMI (kg/m^2)	22.43 ± 2.15
Modified LBP disability questionnaire (0-100)	0.00 ± 0.00

Values are presented as mean ± standard deviation.

4.2 Postural control

4.2.1 Basic postural control (phase 1)

Support surface and vision separately had a significant effect on each parameter of postural control, except for the latter, which had no significant effect on the COP maximum velocity in AP and ML direction. Unstable compared to stable support surface caused significantly more postural sway ($p< 0.01$). A similar effect was observed in trials with no vision compared to those with vision ($p< 0.05$). These results and their corresponding F-ratios and p-values are summarized in table 4.

Table 4

Results of center of pressure

	Stable		Unstable	
	Vision	No vision	Vision	No vision
COPmax –COPmin ML (m)				
• M	0.026	0.032	0.037	0.053
• SD	0.0098	0.0078	0.0085	0.012
	Main effect vision		**Main effect surface**	
• F ratio	**7.53**		**42.30**	
• Pvalue	**0.034**		**0.0006**	
COPmax –COPmin AP (m)				
• M	0.031	0.015	0.024	0.031
• SD	0.0056	0.0080	0.0065	0.0056
	Main effect vision		**Main effect surface**	
• F ratio	**36.62**		**56.10**	
• P value	**0.0009**		**0.0003**	
COPstd ML (m)				
• M	0.0039	0.0045	0.0051	0.0073
• SD	0.00072	0.0011	0.00075	0.0017
	Main effect vision		**Main effect surface**	
• F ratio	**9.90**		**70.36**	
• P value	**0.02**		**0.0002**	

COPstd AP (m)				
• **M**	0.0017	0.0025	0.0038	0.0048
• **SD**	0.00077	0.0011	0.00098	0.0012
		Main effect vision		**Main effect surface**
• **F ratio**		**2.77**		**102.56**
• **P value**		**0.0031**		**0.0001**
COPrms ML (m)				
• **M**	0.0039	0.0045	0.0051	0.0073
• **SD**	0.00072	0.0011	0.00075	0.0017
		Main effect vision		**Main effect surface**
• **F ratio**		**9.90**		**70.36**
• **P value**		**0.020**		**0.0002**
COPrms AP (m)				
• **M**	0.0017	0.0025	0.0038	0.0048
• **SD**	0.00077	0.0011	0.00098	0.0012
		Main effect vision		**Main effect surface**
• **F ratio**		**22.77**		**102.46**
• **P value**		**0.0031**		**<0.0001**
COPmeanvel ML (m/s)				
• **M**	0.0054	0.0062	0.011	0.022
• **SD**	0.0011	0.0056	0.0019	0.0091
		Main effect vision		**Main effect surface**
• **F ratio**		**11.82**		**57.36**
• **P value**		**0.014**		**0.0003**
COPmeanvel AP (m/s)				
• **M**	0.0030	0.0037	0.0078	0.012
• **SD**	0.0010	0.0019	0.0016	0.0049
		Main effect vision		**Main effect surface**
• **F ratio**		**9.09**		**87.35**
• **P value**		**0.0236**		**<0.001**
COPmaxvel ML (m/s)				
• **M**	0.11	0.15	0.20	0.23
• **SD**	0.045	0.065	0.081	0.0074
		Main effect vision		**Main effect surface**
• **F ratio**		1.47		**30.28**
• **P value**		0.27		**0.0015**
COPmaxvel AP (m/s)				
• **M**	0.042	0.047	0.062	0.095
• **SD**	0.016	0.025	0.014	0.040
		Main effect vision		**Main effect surface**
• **F ratio**		2.12		**22.56**
• **P value**		0.20		**0.0032**
COPswaypath ML (m)				
• **M**	0.50	0.71	1.01	2.04
• **SD**	0.10	0.24	0.17	0.84
		Main effect vision		**Main effect surface**
• **F ratio**		**12.71**		**49.60**
• **P value**		**0.012**		**0.0004**
COPswaypath AP (m)				
• **M**	0.27	0.35	0.71	1.13
• **SD**	0.090	0.17	0.15	0.45
		Main effect vision		**Main effect surface**
• **F ratio**		**9.50**		**77.88**
• **P value**		**0.022**		**0.0001**
COPswaypath total (m)				
• **M**	0.57	0.80	1.24	2.33
• **SD**	0.12	0.29	0.20	0.94
		Main effect vision		**Main effect surface**
• **F ratio**		**12.35**		**57.65**
• **P value**		**0.013**		**0.0003**

COPnormsway ML (m^2/s)				
• **M**	0.0054	0.0074	0.011	0.022
• **SD**	0.0011	0.0026	0.0019	0.0091
	Main effect vision		**Main effect surface**	
• **F ratio**	**11.82**		**57.36**	
• **P value**	**0.014**		**0.0003**	
COPnormsway AP (m^2/s)				
• **M**	0.0030	0.0037	0.0078	0.012
• **SD**	0.0010	0.0019	0.0016	0.0049
	Main effect vision		**Main effect surface**	
• **F ratio**	**9.09**		**87.35**	
• **P value**	**0.024**		**<0.0001**	
Sway area (m^2)				
• **M**	0.000096	0.00015	0.00029	0.00050
• **SD**	0.000047	0.000087	0.00012	0.00018
	Main effect vision		**Main effect surface**	
• **F ratio**	**18.36**		**58.39**	
• **P value**	**0.0052**		**0.0003**	

Values are presented as mean + standard deviation
COP=centre of pressure, AP=anterior-posterior, ML=medio-lateral, std= standard deviation, rms= root mean square, meanvel=mean velocity, maxvel=maximum velocity, swaypath=total sway path, normsway= time-normalized sway path, M=mean, Med=median, SD=standard deviation, IQR=interquartile range, m=meter, s=second

Moreover, a significant interaction effect of support surface and vision could be found for a number of parameters, more specifically COP mean velocity ($F_{(1,6)}$= 11.85, p= 0.014 (ML); $F_{(1,6)}$= 11.40, p= 0.015 (AP)), COP total sway path ($F_{(1,6)}$= 9.83, p= 0.020 (ML); $F_{(1,6)}$= 9.57, p= 0.021 (AP)), time-normalized sway path ($F_{(1,6)}$= 11.85, p= 0.014 (ML); $F_{(1,6)}$= 11.40, p= 0.015, (AP)), cumulative sway path ($F_{(1,6)}$= 9.70, p= 0.020) and sway area ($F_{(1,6)}$= 10.55, p= 0.018). There was a common thread in each of these parameters. Unstable support surface with no vision compared with vision led to an significant increase in these parameters: COP mean velocity (Tukey: p= 0.012 (ML); p= 0.018 (AP)), COP total sway path (Tukey: p= 0.013 (ML); p= 0.020 (AP)), time-normalized sway path (Tukey: p= 0.012 (ML); p= 0.018 (AP)), cumulative sway path (Tukey: p= 0.013) and sway area (Tukey: p= 0.0068). Unstable relative to stable support surface with no vision also led to an significant increase in COP mean velocity (Tukey: p= 0.0010 (ML); p= 0.0003 (AP)), COP total sway path (Tukey: p= 0.0015 (ML); p= 0.0005 (AP)), time-normalized sway path (Tukey: p= 0.0010 (ML); p= 0.0003 (AP)), cumulative sway path (Tukey: p= 0.0011) and sway area (Tukey: p= 0.0008). Unstable support surface with no vision created more sway relative to stable support surface with vision as well, found in COP mean velocity (Tukey: p= 0.0015 (ML); p= 0.0007 (AP)), COP total sway path (Tukey: p= 0.0016 (ML); p= 0.0008 (AP)), time-normalized sway path (Tukey: p= 0.0015 (ML); p= 0.0007 (AP)), cumulative sway path (Tukey: p= 0.0013) and sway area

(Tukey: p= 0.0006). Further, unstable relative to stable support surface with vision led to a significant increase in COP total sway path (Tukey: p= 0.011 (AP)) and time-normalized sway path (Tukey: p= 0.0081 (AP)) and sway area (Tukey: p= 0.016). Lastly, a significantly increased COP time-normalized sway path was found when standing on unstable support surface with vision compared to on stable support surface with no vision (Tukey: p= 0.041 (AP)).

4.2.2 Effect of imagery on COP before and after hyperventilation provocation (phase 2 + 4)

The results of the effects of imagery on COP are listed in Appendix 3. The effect of script (R, A, HR), phase of each script (baseline, imagery, recovery) and condition (before or after hyperventilation provocation), as well as their interaction, on the aforementioned parameters are described below.

First of all, a main effect of script was found for Root Mean Square (RMS) ($F_{(2,12)}$= 4.70, p= 0.031 (ML)) and standard deviation (SD) ($F_{(2,12)}$= 8.54, p= 0.0049 (ML)) of COP, but not for other COP variables (p> 0.05). More specifically, script A caused significantly higher RMS values of COP than script HR (Tukey: p= 0.025 (ML)). This could also be applied for SD of COP (Tukey: p= 0.0042 (ML)). Moreover, script R induced significantly higher SD values of COP than script HR (Tukey: p= 0.044 (ML)).

Moreover, a significant main effect of the phase of each script was seen for all following COP parameters: COP amplitude max & min ($F_{(2,12)}$= 6.31, p= 0.013 (ML); $F_{(2,12)}$= 10.31, p= 0.0025 (AP)), RMS of COP ($F_{(2,12)}$= 5.37, p= 0.022 (ML); $F_{(2,12)}$= 4.42, p= 0.036 (AP)), SD of COP ($F_{(2,12)}$= 5.17, p= 0.024 (ML); $F_{(2,12)}$= 4.33, p= 0.39 (AP)), sway area ($F_{(2,12)}$= 62.63, p<0.0001), and cumulative sway area ($F_{(2,12)}$= 62.63, p<0.0001). The imagery phase caused significantly more COP total sway path (Tukey: p<0.0001 (ML); p<0.0001 (AP)) , COP range between maximum and minimum amplitude (Tukey: p= 0.049 (AP)), sway area (Tukey: p<0.0001) and cumulative sway area (Tukey: p<0.0001) than the recovery phase, and significantly more COP range between maximum and minimum amplitude (Tukey: p= 0.010 (ML); p= 0.0019 (AP)), COP total sway path (Tukey: p<0.0001 (ML); p<0.0001 (AP)), sway area (Tukey: p<0.0001) and cumulative sway area (Tukey: p<0.0001) than the baseline phase. In addition,

during recovery, the RMS of COP (Tukey: p= 0.018 (ML)) and SD of COP (Tukey: p= 0.019 (ML); p= 0.031 (AP)) in both directions were significantly greater than in the baseline phase. Finally, in the recovery phase, there was significantly more RMS of COP (Tukey: p= 0.049 (AP)) compared to during imagery.

The condition affected COP maximum velocity ($F(1,6)= 10.03$, p= 0.019 (ML)), but not other COP parameters (p> 0.05). More precisely, the trials after the voluntary hyperventilation resulted in significantly less COP maximum velocity (Tukey: p= 0.019 (ML)) than the trials before voluntary hyperventilation.

A significant interaction effect of phase x condition was found for the parameters COP total sway path ($F_{(2,12)}= 6.84$, p= 0.010 (ML)), COP mean velocity ($F_{(2,12)}= 5.90$, p= 0.017(ML)) and COP time-normalized sway path ($F_{(2,12)}= 5.90$, p= 0.017 (ML)) . The post-hoc tests showed that the imagery phase, before and after voluntary hyperventilation, elicited significantly more COP total sway path (Tukey: p<0.0001 (ML)) as compared to the baseline and recovery phases before/after VH. Furthermore, there was a trend towards more COP mean velocity (Tukey: p= 0.092 (ML)) and COP time-normalized sway path (Tukey: p= 0.091 (ML)) at baseline prior to VH relative to baseline after VH.

4.2.3 Change scores (baseline VS imagery)

Overall, no significant main and interaction effects of script and condition on the change scores were found (p> 0.05), except for COP maximum velocity (AP, main effect of condition, $F(1,6)=7.23$, p= 0.036), which showed a significantly higher mean after voluntary hyperventilation than before (Tukey: p= 0.036).

4.3 EMG

4.3.1 Basic postural control (phase 1)

As with postural control, the first section is devoted to describing the effect of phase 1 (table 5) on the muscle activation patterns. For m. Trapezius pars descendens and m. Obliquus internus, repeated measures ANOVA was used due to normally distributed data. The Friedman test was performed for the other muscles because these data was not normally distributed. The Friedmann test was significant for m. Multifidus ($X^2(3)= 11.23$, p= 0.011) while not for the other muscles (p> 0.05). However, the post-hoc tests did not show a

significant difference but rather a trend towards more EMG activity during the unstable vs. stable support surface with vision and more EMG activity during the unstable support surface with no vision vs. vision.

Table 5
Results of EMG

	Stable		Unstable	
	Vision	No vision	Vision	No vision
M. Rectus abdominus (%)				
• M/Med	3.39	3.36	2.95	3.01
• SD/IQR	5.86	5.89	5.45	5.52
M. Obliquus abdominis internus (%)				
• M/Med	10.0	12.04	9.71	10.54
• SD/IQR	3.86	4.43	4.03	4.53
M. Erector spinae pars lumbalis (%)				
• M/Med	6.82	6.91	6.66	8.20
• SD/IQR	5.95	4.77	5.96	7.58
M. Multifidus (%)				
• M/Med	1.80	1.80	1.86	1.99
• SD/IQR	9.03	9.05	5.92	13.07
M. Intercostalis externus (%)				
• M/Med	2.11	3.25	2.62	2.75
• SD/IQR	3.89	4.65	4.09	3.72
M. Sternocleidomastoideus (%)				
• M/Med	2.61	2.73	2.98	3.31
• SD/IQR	6.85	6.22	11.68	6.69
M. Trapezius pars descendens (%)				
• M/Med	2.19	1.92	2.06	2.72
• SD/IQR	1.02	1.28	1.33	1.66

Values are presented as mean + standard deviation or as median + interquartile range as a percentage the activity measured during the fast ballistic arm movement up to 90 degrees anteflexion
M=mean, Med=median, SD=standard deviation, IQR=interquartile range

4.3.2 Effect of imagery on EMG before and after hyperventilation provocation (phase 2 + 4)

Moreover, the findings of phase 2 and phase 4 are outlined in the following part. The main effect of script, phase of each script and condition, as well as their interaction effects, on muscle activation were described below. Again, the median and interquartile range for each phase, condition and script are listed in appendix 4. The Friedmann test was found to be significant for three muscles: m. Erector spinae pars lumbalis ($X^2(17)= 46,41$, $p= 0.000$), m. Multifidus ($X^2(17)= 68.14$, $p= 0.000$) and m. Sternocleidomastoïdeus ($X^2(17)= 28,21$, $p= 0.000$). In addition, no significant differences were observed in pairwise comparison.

4.3.3 Change scores (baseline VS imagery)

The Friedmann test did not found significantly different change scores between scripts and condition ($p> 0.05$), except from M. Multifidus ($X^2(5)= 13.041$, $p=0.023$). No significant

differences were observed in pairwise comparison, however there was a trend towards more EMG activity during script HR relative to script A before phase 3.

4.4 PetCO2

4.4.1 Effect of imagery on PetCO2 before and after hyperventilation provocation (phase 2 + 4)

Analysis of the findings of phase 2 and phase 4 are included in this section (table 6). The main effect of script, phase of each script and condition, as well as their interaction effect, on PetCO2, was examined. The Friedmann test was not significant ($X^2(17)= 21.54$, $p = 0.20$).

Table 6
Results of PetCO2

	Pre hyperventilation provocation								
	Relaxation			**Acceptance**			**Hostile resistance**		
	Baseline	Imagery	Recovery	Baseline	Imagery	Recovery	Baseline	Imagery	Recovery
PetCO2 (mm HG)									
• **Med**	33.93	34.53	34.00	34.45	34.13	33.56	33.31	34.05	33.48
• **IQR**	2.55	2.68	1.84	2.76	2.23	2.36	3.87	2.05	2.44
	After hyperventilation provocation								
	Relaxation			**Acceptance**			**Hostile resistance**		
	Baseline	Imagery	Recovery	Baseline	Imagery	Recovery	Baseline	Imagery	Recovery
PetCO2 (mm HG)									
• **Med**	34.17	34.32	33.36	33.76	34.53	34.08	34.55	33.65	33.56
• **IQR**	2.86	1.82	2.12	2.83	2.27	1.96	1.03	0.90	1.04

Values are presented as median + interquartile range
Med=median, IQR=interquartile range

4.4.2 Change scores (baseline VS imagery)

There was a significant difference found in mean of the parameter, measured during the phase baseline and imagination, between scripts ($F(2,12)= 6.23$, $p= 0.014$) but not between conditions. The post-hoc test showed a significantly higher score in script HR relative to script R, in other terms the mean value of PetCO2 was significantly higher during the imagery phase of script HR than in script R.

4.4.3 Hyperventilation provocation (phase 3)

The mean values during each phase of $PetCO_2$ of each subject are listed in table 7. The sharpest decline in PetCO2 was observed in approximately the first minute after cessation of HV, reaching its lowest drop during this period. The recovery towards baseline showed high interindividual differences. Even more, one subject did never obtain full recovery.

Table 7
Results of PetCO2

Subjects	Mean value during baseline (mm HG)	CO2out min after HP (mm HG)	CO2 recovery time (s)
1	34.95	13	180
2	34.02	32	2
3	33.62	21	38
4	34.45	21	262
5	35.24	20	/
6	32.42	22	132
7	34.85	25	2

CO2out min after HP=the minimal value of CO2out during the first minute of recovery after hyperventilation provocation
CO2 recovery time=the time between the moment when the subject stops with hyperventilation and the moment when the subject reaches the mean value measured during baseline
/=subject did not reach the mean baseline value during the recovery phase

4.5 Relation between COP, EMG and PetCO2 during scripts

Imagination of a script did not significantly affect PetCO2 and muscle activation patterns. Based on these findings, there was no link between the results of the three primary outcome measures.

The following graphs represent the data of the primary outcomes of a representative participant. By representative we mean what supports the main result of phase 2 and 4. Time-normalized data is used for each graph for each script. Phase 2 consists of the first three scripts and phase 4 consists of the last three scripts.

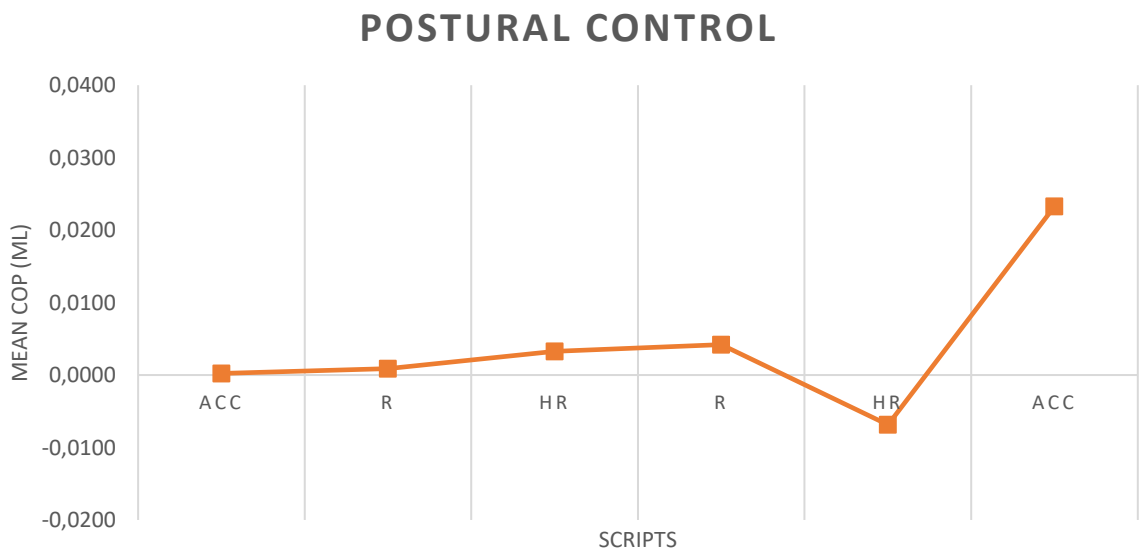

Fig. 2: results of center of pressure

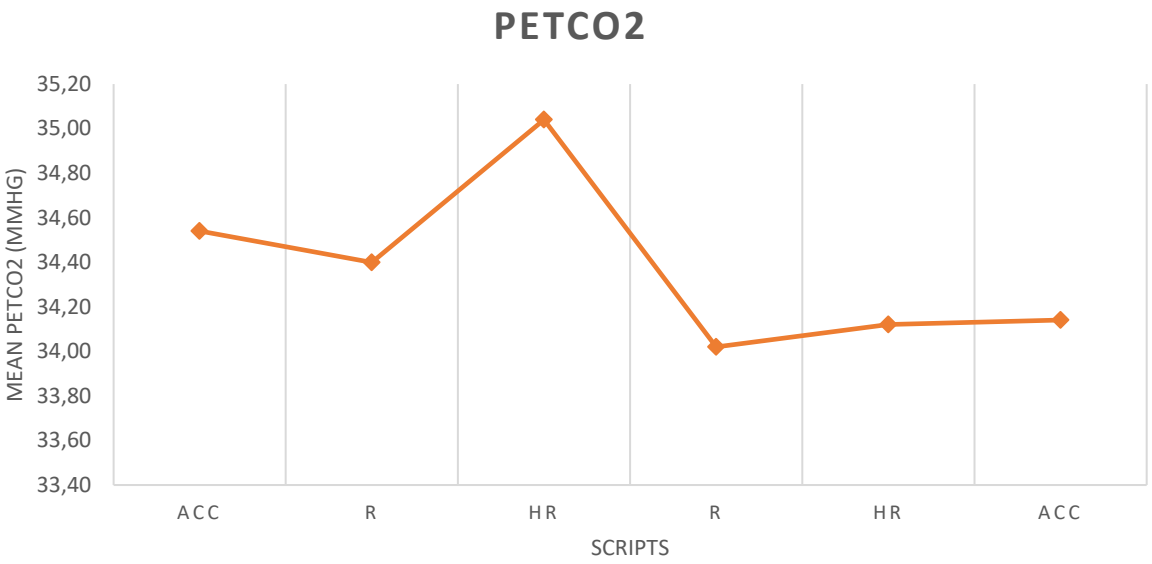

Fig. 3: results of PetCO2

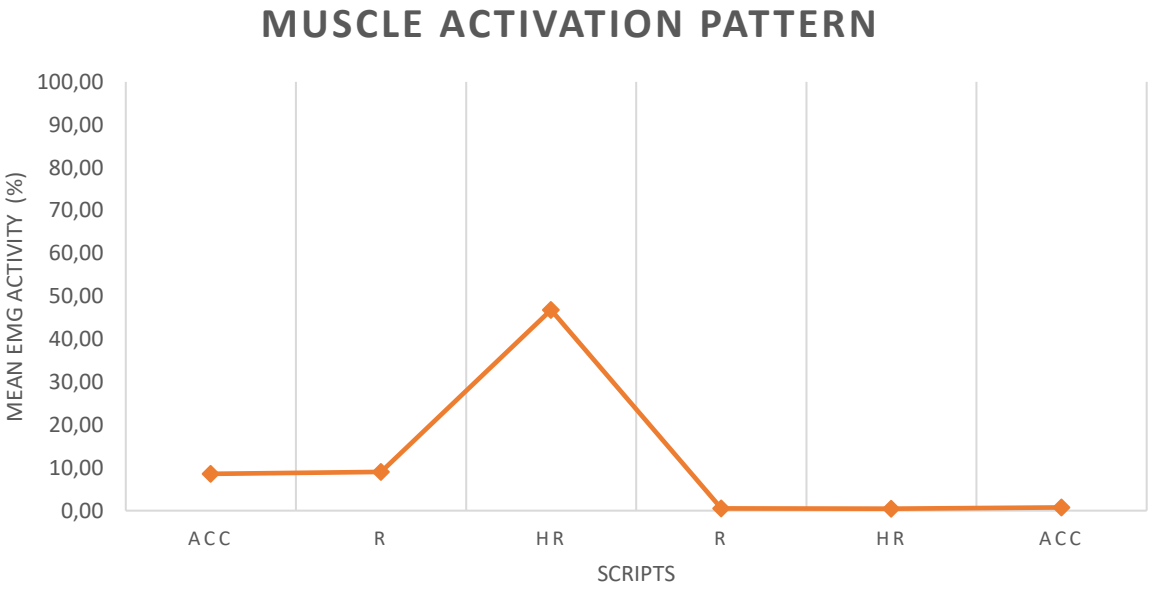

Fig. 4: results of muscle activation pattern of m. multifidus

4.6 Questionnaires about hyperventilation complaints, general physical complaints in daily life and psychological characteristics

4.6.1 Electronic bundle of questionnaires

The results of each questionnaire are presented in table 8. The participants reported similar scores on the questionnaires. Of the questionnaires with a cut-off score (NQ, TSK and TAS-20), only the mean score of the TAS-20 lay above the cut-off score. The mean value on the TAS-20 lay within the interval 52-60, which meant they possibly had alexithymia.

Table 8:
Results of the electronic bundle of questionnaires

Electronic bundle of questionnaires	
IPAQ-SF	High: four, average: three, low: zero
NQ (0-64)	7.9 ± 7.08
DLKL (39-195)	61.6 ± 17.78
SF-12	106.1 ± 8.63
Mental score	52.7 ± 2.14
Physical score	53.4 ± 7.28
TSK (17-68)	22.9 ± 1.57
NCP-Q (15-75)	40.3 ± 9.81
PANAS (20-100)	48.7 ± 7.06
PA (10-50)	26.0 ± 3.27
NA (10-50)	22.7 ± 3.95
PaSol (0-84)	48.7 ± 7.06
TAS-20 (20-100)	55.9 ± 6.77
IAQ (19-95)	56.1 ± 8.40
MPS (35-175)	80.1 ± 17.47
VBE (0-55)	0.0 ± 0.00

Values are presented as mean ± standard deviation.
IPAQ-SF=International Physical Activity Questionnaire -Short Form, NQ=Nijmegen Questionnaire, DLKL=Dagelijks Leven Klachten Lijst, SF-12=12-item Short Form, TSK=Tampa Scale for Kinesiophobia, NCP-Q=Need for Controllability and Predictability Questionnaire, PANAS=Positive And Negative Affect Schedule, PaSoL=Pain Solutions Questionnaire, TAS-20=Toronto Alexithymia Scale 20, IAQ=Interoceptive Awareness Questionnaire, MPS=Multidimensional Perfectionism Scale, VBE=Vragenlijst Belastende Ervaringen

4.6.2 Effects of imagery on questionnaires before and after hyperventilation provocation (phase 2 + 4)

The mean and standard deviation for each phase is listed in table 9 and 10. In this paragraph, the results are described whether the questionnaires were filled in differently per script and per condition. Three items, namely fear of falling ($F(2,12)= 4.50$, $p= 0.035$), PANAS PA ($F(2,12)= 4.90$, $p= 0.028$) and Manakin valence ($F(2,12)=11.43$, $p= 0.0017$) were significantly affected by the script. Subjects scored significantly higher on PANAS PA after listening to script A compared to script HR (Tukey: $p= 0.028$). Furthermore, script HR led to a significantly higher score on the Manakin valence, i.e. more stress, relative to script R (Tukey: $p= 0.0017$) and script A (Tukey: $p= 0.011$). Lastly, listening to script A resulted in a trend towards a lower score on fear of falling compared to script R (Tukey: $p= 0.057$) and script HR (Tukey: $p= 0.057$). Moreover, condition had a significant effect on the following parameters: PANAS subscales PA ($F(1,6)= 26.02$, $p= 0.0022$) and NA ($F(1,6)= 7.13$, $p= 0.037$).

The participants reported significantly higher scores before the voluntary hyperventilation than after (Tukey: p= 0.0022 (PA); Tukey p= 0.037 (NA)).

Table 9
Results of questionnaires during phase 2

	Relaxation	Acceptance	Hostile resistance
Likert scale question 1 (1-9)			
• **M**	4.29	4.14	4.29
• **SD**	2.14	1.77	1.98
Likert scale question 2 (1-9)			
• **M**	5.00	4.57	5.57
• **SD**	2.08	2.37	2.30
VAS concentration (0-100)			
• **M**	78.57	70.00	64.29
• **SD**	10.69	20.82	22.25
Manikin: valence (1-9)			
• **M**	2.57	3.14	5.43
• **SD**	1.62	1.07	2.57
Manikin: arousal (1-9)			
• **M**	7.14	6.71	5.71
• **SD**	2.91	1.38	2.36
Manikin: dominance (1-9)			
• **M**	8.00	6.86	5.86
• **SD**	1.15	1.21	2.85
DLKL (39-195)			
• **M**	42.00	42.29	44.86
• **SD**	2.71	2.69	5.01
PANAS (20-100)			
• **M**	39.00	41.71	38.57
• **SD**	5.69	5.99	7.02
PA (10-50)			
• **M**	22.43	23.86	21.00
• **SD**	3.15	3.53	4.51
NA (10-50)			
• **M**	16.57	17.86	17.57
• **SD**	2.88	3.53	3.69
Fear of falling (1;9)			
• **M**	2.71	2.43	2.71
• **SD**	1.70	1.40	1.25

Values are presented as mean + standard deviation
M=mean, Med=median, SD=standard deviation, IQR=interquartile range, VAS=visual analogue scale, DLKL=Dagelijks Leven Klachten Lijst, PANAS=Positive And Negative Affect Schedule

Table 10
Results of questionnaires during phase 4

	Relaxation	Acceptance	Hostile resistance
Likert scale question 1 (1-9)			
• **M**	4.57	4.57	4.57
• **SD**	2.23	1.90	1.62
Likert scale question 2 (1-9)			
• **M**	5.29	5.00	5.29
• **SD**	2.29	1.73	2.06
VAS concentration (0-100)			
• **M**	61.43	71.43	71.43
• **SD**	19.52	16.76	14.64
Manikin: valence (1-9)			
	2.57	3.57	6.43

• M	1.72	1.72	1.62
• SD			
Manikin: arousal (1-9)	7.71	7.14	5.29
• M	1.70	1.21	2.36
• SD			
Manikin: dominance (1-9)	6.71	6.86	5.43
• M	2.21	1.21	2.30
• SD			
DLKL (39-195)			
• M	42.83	41.86	44.71
• SD	1.81	2.27	6.42
PANAS (20-100)			
• M	35.00	39.43	35.57
• SD	7.44	7.28	7.59
PA (10-50)			
• M	19.14	22.43	19.14
• SD	4.38	4.16	4.81
NA (10-50)			
• M	15.86	17.00	16.43
• SD	3.48	3.21	3.60
Fear of falling (1-9)			
• M	2.86	2.29	2.86
• SD	1.77	1.38	1.57

Values are presented as mean + standard deviation
M=mean, Med=median, SD=standard deviation, IQR=interquartile range, VAS=visual analogue scale, DLKL=Dagelijks Leven Klachten Lijst, PANAS=Positive And Negative Affect Schedule

4.6.3 Attentional focus questionnaire

Participants answered five questions that examined attentional focus after each imagery trial. Table 12 provides an overview of the answers. Each question was related to one category, which were taken from Zaback et al. (2016). The number of times the participants were focused on movement processes and task-irrelevant information was substantially higher compared to the other categories.

Table 11
Results of attentional focus questionnaire

Category	Score
Movement processes	16 (R:5, A:6, HR:5)
Task objectives	9 (R:3, A:2, HR:4)
Threat-related stimuli	3 (R:0, A:0, HR:3)
Self-regulatory strategies	9 (R:2, A:5, HR:2)
Task-irrelevant information	15 (R:6, A:5, HR:4)

R=relaxation, A=acceptance, HR=hostile resistance

5 Discussion

The purpose of this study was to investigate the effect of script-driven imagery of different emotions (relaxation, acceptance and hostile resistance) on postural control, PetCO2 and muscle activation patterns. With regard to postural control, our results were consistent with our hypotheses. We found a reduction in COP excursion in response to stressful stimuli as an indicator of the postural stiffening strategy, suggesting an interaction between a person's emotional state and postural control. However, this finding did not emerge with the other two coping strategies acceptance and relaxation. In contrast to our hypotheses, imagery of a stressful situation did not significantly affect PetCO2 and muscle activation patterns.

5.1 Baseline postural control (without imagery)

As hypothesized, we found that standing on an unstable support surface without vision led to more postural sway than the other conditions. The control of upright standing is subjected to sensory input from the environment and the person's relation to that environment. Crucial resources for providing this information are the somatosensory, vestibular and visual systems. When the feet are supported on an unstable support surface as in the current trials with the foam, somatosensory input will be less reliable and thus input of the the other two components will gain in importance (Buchanan & Horak, 1998; Buchanan & Horak, 1999, Horak, Shupert, Dietz, & Horstmann, 1994; Maurer, Mergner, Bolha, & Hlavacka, 2000; Nashner, Black, & Wall, 1982;). Therefore, the absence of vision made the tasks much more challenging by eliminating a relevant resource for sensory information (i.e., vision), causing an increase in postural sway (Fitzpatrick, Gorman, Burke, & Gandevia, 1992; Krishnamoorthy, Slijper, & Latash , 2002; Latash, Simoneau, Leibowitz, Ulbrecht, Tyrrell, & Cavanagh, 1992).

5.2 Effect of imagery of emotions on postural control

The stressful situation associated with an auditory script creating HR induced a reduction in COP excursion in ML direction while standing without vision on unstable support surface. A more stressful response to script HR was confirmed by the subjects, who reported significantly higher scores on the valence subscale of the Manakin after imagery. Studies using aversive or threatening images (Hillman et al., 2004; Roelofs et al., 2010) and postural threat, such as an elevated surface, (Adkin, Frank, Carpenter, & Peysar, 2000;

Carpenter, Frank, & Silcher, 1999; Carpenter, Frank, & Silcher, & Peysar, 2001) to elicit emotional activation demonstrated a reduction in postural sway accompanied by muscle co-contraction and ankle stiffness, measured by EMG activity of m. tibialis anterior and m. soleus. An increase in body stiffness provoked by negative stimuli was characterized by a freezing response (Volchan et al., 2017). However, the effect of stressful stimuli on postural control has been rather conflicting across studies. Azevedo et al. (2005) found a decrease in COP amplitude in ML direction in reaction to aversive images, whereas Stins and Beck (2007) did not demonstrate any alteration in ML sway amplitude by using the comparable pictures. Roelofs et al. (2010) and Lelard et al (2013) found a reduction in COP amplitude in AP direction, while other studies did not show a significant effect (Azevedo et al., 2005; Facchinetti et al., 2006). Surprisingly, trunk muscle activation patterns did not show significant differences throughout the different trials. In contrast to postural control (COP) research, there are at present rather few studies investigating EMG during quiet standing. In conclusion, stressful stimuli led to the reduction in COP excursion as an indicator of the postural stiffening strategy, also known as freezing, but did not affect EMG activity.

Freezing can be defined by posturographic data as a reduction in amplitude, area and SD of COP displacements. This motor behavior might be explained by changes in EMG activity of the trunk musculature, as well as stress-related alterations in two of the sensory systems relevant to postural control: the proprioceptive (Davis et al., 2011; Horslen, Murnaghan, Inglis, Chua, & Carpenter, 2013) and vestibular system (Horslen et al. 2014; Lim et al., 2017). Several studies showed proprioceptive changes in states of height-induced fear and anxiety (Davis et al. 2011; Horslen et al., 2013). They found an increase in muscle spindle sensitivity of the m. tibialis anterior and m. soleus in postural threat conditions, resulting in increased muscle stiffness and a stiffer stance, all attributing to a freezing strategy. This stiffening response might also be actively generated through an increase in EMG activity of the trunk musculature. In patients with chronic low back pain, pain-related fear induces altered movement patterns, more specifically a protective stiffening of the spine, when confronted with a specific task but not in general (Matheve, De Baets, Bogaerts, & Timmermans, 2019). As such, less postural sway during stressful situation might be a consequence of increased activity of the trunk muscles in this study. Nelson-Wong and Callaghan (2010) demonstrated that some individuals reported

increasing co-activation patterns of trunk flexor-extensor pairs during a standing protocol. For this reason, further increase in trunk muscle activity towards the end of the testing was expected in our study, although could not be confirmed by the EMG results. On the other hand, this freezing response might also be due to viscoelastic (i.e, passive) muscle properties and so decreasing the amount of EMG activity required to keeping balance. For instance, a study (Runge, Shupert, Horak, & Zajac, 1999) found that changes in postural control as a result of small perturbations in balance were recognized as being passive biomechanical responses owing to a lack of trunk muscular activity. However, another paper (Saffer, Kiemel, & Jeka, 2008) suggested that the involvement of active and viscoelastic muscular control noticed during upright standing are difficult to dissociate clearly, making it challenging to assume either an increase or a decrease in EMG activity. Davis et al. (2011) suggested that freezing might be associated with a more global fight/flight reaction, possibly through direct connection between sympathetic activation and the spindles in the ankle muscles (Barker & Saito, 1981). Horslen et al. (2013) presumed that normal postural sway in individuals has been used not only to balance but to preserve a certain volume or quality of sensory information (Carpenter, Murnaghan, & Inglis, 2010; Murnaghan, Horslen, Inglis, & Carpenter, 2011). An increase in spindle sensitivity to enhance balance-relevant sensory input would then suggest that less postural sway would be needed to sustain a necessary volume of sway-generated sensory input. Furthermore, anatomical connections between the vestibular cortex and limbic and prefrontal regions (Carmona, Holland, & Harrison, 2009; Indovina, Riccelli, Staab, Lacquaniti, & Passamonti, 2014) support the evidence for threat-related psychological and autonomic state changes to modify the output of the vestibular system (Staab, Balaban, & Furman, 2013). Lim et al. (2017) demonstrated that an increase in vestibulo-muscular coupling in leg and hip muscles was aligned with a threat-related stiffening reaction. Lastly, one study (Fridlund, HatWeld, Cottam, & Fowler, 1986) found that arousal was associated with increased whole-body stiffness. In summary, freezing can be a explained by changes in the proprioceptive and vestibular system and EMG activity of trunk musculature and also by arousal. Although the current research is only applicable to postural threat, it would be reasonable to believe that these mechanisms are generalizable to script-driven imagery of different emotions (relaxation, acceptance and hostile resistance), since these two paradigms affect postural control in the same way.

The lack of consensus between the findings of the present and previous studies in terms of postural control strategy might be caused by different reasons. First of all, methodological differences could be a reason: participants in our setting stood with their feet 10 cm apart, whereas other studies had individuals stand with their feet together (Azevedo et al., 2005; Facchinetti et al., 2006) or on one leg (Stins & Beek, 2007). Therefore, our setting with a wider and therefore more stable base-of-support might not have allowed us to obtain similar findings in postural responses to negative stimuli in prior studies with narrower widths. Although participants were directed to stand with bare feet together, none of these studies used an unstable support surface, which makes it even more difficult to compare with our results. Perhaps, a situation where the postural system is challenged sufficiently might be a prerequisite for exposing the effect of emotion on balance. Furthermore, some studies (Hillman et al., 2004; Roelofs et al., 2010; Stins & Beek, 2007) made use of relatively short sampling durations (<10 s) to accurately describe the complete set of postural sway. Hence, it is not clear whether the postural reactions to unpleasant pictures in these studies represent sustainable adaptations in whole-body leaning or merely temporary postural responses to images. Moreover, it is relevant to extend understanding of the involvement of individual personal traits for explaining stress-related changes in postural control. For example, pain-related fear is associated with protective movement behavior in patients with chronic low back pain, although this fear is task-specific, emphasizing that each person reacts differently to a particular situation (Matheve et al., 2019). In the same way, it can be assumed that if we used scripts that were emotionally more relevant to our participants, we would have found other results. Furthermore, Zaback et al. (2015) found the personal traits physical risk-taking and movement reinvestment, in other words someone's propensity to focus on their movement, to be independent predictors of postural changes in postural threat conditions. Another example was that individuals with trait anxiety, in comparison with healthy individuals, experienced greater perceptions of fear and anxiety when confronted with a postural threat. Greater postural sway has been proven in fearful adults and people with anxiety disorders in contrast to non-fearful adults and healthy individuals, respectively (Maki, Holliday, & Topper, 1991; Perna et al., 2001). In our study, higher self-reported rates of fear of falling did not correlate with more postural sway. State NA also influences symptom perception. Individuals with high NA showed an increase in

symptom reports when presented with unpleasant pictures (Bogaerts et al., 2005, 2008, 2010; Constantinou, Bogaerts, Van Diest, & Van den Bergh, 2013). However, higher NA did not correlate with more postural sway in our study. Furthermore, postural strategy might also be modified by a person's previous experience with postural threat (Adkin et al., 2000; Brown & Frank, 1997; Maki & Whitelaw, 1993). For instance, subjects who had encountered a threatening situation before showed increased body sway amplitude relative to those with no experience (Adkin et al., 2000). Moreover, variance between methods used to elicit stress responses might be another reason why dissimilarity across studies is observed. As an illustration, one study (Lelard, Godefroy, Ahmaidi, Krystkowiak, & Mouras, 2017) found differences in postural and physiological responses when subjects were instructed to use mental simulation compared to passive observation of the same images. Lastly, the inconsistency between studies might also be related to the absence of control and/or attention for the potential effects of arousal. This study did not manipulate arousal independently from valence, since postural changes do not appear to be specific to stressors with negative valence as reported by Horslen & Carpenter (2011). They found that postural control depends more on arousal than valence. Indeed, positive valence induced similar responses (Lelard et al., 2014). Perhaps, this might be the reason why only a few parameters of COP were significantly subject to change due to aversive imagery, whereas the vast majority did not reach statistical significance. In short, the lack of consistency between our results and previous studies might be due to methodological differences, personal traits, variance between methods used to elicit stress responses and absence of control and/or attention for the potential effects of arousal.

In this study, subjects showed more postural sway during imagery relative to baseline and recovery, regardless of script and condition. There is a large number of evidence (Boisgontier et al., 2013) implying that postural control depends on cognitive resources, such as attention. Indeed, research suggests that alterations in attention might change postural control when threatened (Huffman et al., 2009; Zaback et al., 2015; Zaback, Carpenter, & Adkin, 2016). According to Wulf & Prinz (2001), directing attention to highly automated behavior might deteriorate tasks performance rather than improving it, which has been observed for various postural tasks (Wulf, 2013). Zaback et al. (2015) concluded that subjects with a greater trend towards consciously controlling their movement were

more prone to demonstrate increases in sway amplitude during postural threat conditions. In general, the participants in this study were most of the time attempting to consciously monitor or control their movement, possibly resulting in more postural sway. However, this proposal is speculative, since there are currently no studies with a similar setup to compare our results with and to explain our findings. To put it briefly, the changes found in postural sway between the phases of a script might be related to shifting the attention to a more conscious control of posture.

5.3 Effect of hyperventilation on PetCO2

Despite no significant main effect of script, phase of each script and condition on PetCO2 we did find a significant difference in changes scores. This could be due to the fact that the latter statistical analysis included fewer factors and levels, thereby having more power to observe a significant difference. Although our participants showed relatively low resting values of PetCO2 (Bogaerts et al., 2007), and thus possibly inducing hyperventilation responses more rapidly, no effect was evaluated. No significant differences in self-reported hyperventilation complaints were found between scripts and condition, confirming that indeed PetCO2 did not change between scripts and condition. Furthermore, our results imply that ±5min after the voluntary hyperventilation, no effects on postural control were observed.

Our finding is not consistent with other studies (Bogaerts et al., 2007; Van Diest et al., 2001), who found a significant reduction in PetCO2 during imagery of the fear-inducing script. This is in line with studies demonstrating a significant decline in PetCO2 in stressful and fearful situations (Alpers, Wilhelm, & Roth, 2000; Ley & Yelich, 1998). However, Dudley (1969) implied that arousal might be more relevant in explaining the variance in PetCO2 drops than valence, given that PetCO2 decreased during imaging of anxiety and anger but not during depression in their study. Moreover, one study viewed emotionally provoked respiratory changes as particularly defined by the action tendency behind the emotion, suggesting that hyperventilation responses should turn up during pleasant stimuli as well (Boiten, Frijda, & Wientjes, 1994). Indeed, the subjects in our study scored higher on the valence subscale of Manikin during the hostile resistance script, though no significant decrease in PetCO2 was found during the imagery, confirming this theory. This might be one explanation for why

our results differed from Van Diest et al. (2001), since they used eight different scripts with arousal and valence apart from each other. Additionally, Van Diest et al. (2001) asked their participants whether they intentionally controlled their breathing during the imagery trials. This question was not used in our study, which might explain why we did not find significant results. Another considerable difference was that participants in our study stood upright on an unstable support surface during imagery, whereas subjects were asked to sit down in a seat in the other two studies (Bogaerts et al., 2007; Van Diest et al., 2001). Due this interference between two tasks (e.g., balance and cognition), imagery of the scripts might no longer be executed in an optimal manner. The rationale behind the dual-task paradigm states that as one task becomes more complicated (and so demands more resources), executions of other tasks worsen (Shanbehzadeh, Salavati, Talebian, Khademi-Kalantari, & Tavahomi, 2018; Sherafat at al., 2014). In our study, subjects were most of the time attempting to consciously monitor or control their movement during the imagery according to the scores on AFQ. Consequently, the participants might have been less focused on mental simulating the scenes, resulting in less respiratory responding. One final point, Bogaerts et al. (2007) investigated patients with chronic fatigue syndrome, thereby making it difficult to extrapolate their results to ours.

These studies (Bogaerts et al., 2007; Van Diest et al., 2001) investigated the importance of script-driven imagery as catalyst for HV responses, but they did not evaluate the effect of breathing behavior on postural control. In fact, we are the first study to examine this interaction during imagery of scripts. Although PetCO2 during imagery and voluntary hyperventilation did not have a significant effect on postural control, we expected to see more postural sway for two reasons: altered breathing technique and increased respiratory load.

Various breathing techniques might differ in their effect on postural control. A paper (Hamaoui, Gonneau, &Le Bozec, 2010) showed that thoracic dominant breathing induced significantly more disturbance on posture in comparison to abdominal breathing in healthy individuals. Along with a decline in PetCO2, as a result of stressful stimuli, an increased proportion of ribcage motion might occur (Sackner, Gonzalez, Jenouri, & Rodriguez, 1984). Alterations of rib cage movement might influence the length-tension curve of the

diaphragm, making it much harder for this muscle to contract sufficiently. Since the abdominal muscles support the function of the diaphragm and can to certain degree compensate for a less powerful diaphragm (De troyer & Estenne, 1984; Cassart, Pettiaux, Gevenois, Paiva, & Estenne, 1997; Finucane, Panizza, & Singh, 2005), they might also increase their action. This inefficient breathing pattern can also in turn augment the muscle activity of the sternocleidomastoïdeus, upper trapezius and anterior neck muscles (De troyer & Estenne, 1984; Hruska, 1997; Verschakelen et al., 1995). Indeed, patients with chronic neck pain demonstrated rather thoracic dominant breathing, in conjunction with overactivity of the abovementioned muscles (Peri & Halford, 2004). It might be plausible that participants changed their breathing pattern to more thoracic dominant breathing the lower PetCO2 dropped due to stressful situations. Therefore, we expected to see more postural sway during imagery of HR but since there were no significant drops in PetCO2 as a response to the scripts, no increase in postural sway was found.

Suboptimal postural control has been found in case of increasing demand on the inspiratory muscles (e.g. during voluntary hyperventilation), causing the inspiratory muscles to be at risk of fatigue (David et al., 2012; Janssens 2010, 2013). A possible underlying mechanism could be the inspiratory muscle metaboreflex. In other terms, restriction of muscle blood flow and oxygenation at the level of the back muscles might occur, reducing the reliability of the back muscle proprioceptive input. This forced individuals to shift to an ankle-steered strategy, leading to more postural sway (Janssens et al., 2013). If the respiratory demand increases, the diaphragm can also become shortened and less efficient (Courtney, van Dixhoorn, Greenwood, & Anthonissen, 2011; Verschakelen & Demedts, 1995). This might be at the expense of postural control (David et al., 2012), perhaps resulting in more postural sway. Another reason why hyperventilation induces increased postural sway is that it results in distal parasthesia (Sakellari et al., 1997; Verschakelen et al., 1995), affecting accurate somatosensory signals needed to maintain balance. However, there were no participants except for one, whose recovery to baseline value for PetCO2 surpassed the 5 minutes. In other terms, voluntary hyperventilation could not have influenced phase 4 the since the time between the moment the subject stopped with hyperventilation and the moment the subject reached the mean value measured during baseline, was ± 5min. Hence, offering an

explanation for why no significant main effect was found for condition. In contrast to this study, other studies (Achenbach-Ng, Siao, Mavroudakis, Chiappa, & Kiers, 1994; Dejours, Labrouusse, & Teychenne, 1954) found that PetCO2 returned to baseline within 8-10 minutes and 9.5 minutes, respectively. The PetCO2 of their subjects dropped to a minimum value below our observed values since hyperventilation was attained for three minutes, which might explain the long recovery times. To sum up, we expected to see a trend towards more postural sway after voluntary hyperventilation due to the increased respiratory load but baseline value for PetCO2 had already been reached prior to the first postural control trial with imagery.

5.4 Strengths and weaknesses

This study has several weaknesses. First of all, our sample size was very small, which could possibly affect our results due to an increase in type Ⅱ error. Although significant results of (voluntary) hyperventilation on postural control were observed after examining eight, eleven and seventeen subjects (David et al., 2012; Hodges et al., 2001; Sakellari et al., 1997), it is considered to be a limitation. We had also several borderline significant findings, which might be seen as real differences by increasing the number of participants. Furthermore, the included participants were relatively young, which makes it difficult to generalize these findings to older adults. There was also no blinding of the researchers to the scripts and condition, when the questionnaires after every imagery trial were registered online, which might affected our results either by mistake or intentionally. Another limitation was that we did not validate these scripts in our healthy individuals to verify whether the scripts were emotionally relevant to our subjects, although they have been validated in other populations. Hence, this might have possibly weakened the effect of the scripts and the accompanying emotions. Because of the inability to empathize with the scripts, as well as the long duration of our trial, most of them were of the opinion that they had difficulty concentrating towards the end. This could have affected our results. In this study, Bonferroni's correction was used for the post-hoc analysis of EMG data. Therefore, we might not have found any results for this outcome measure due to this very strict correction method for multiple comparisons. This might also be explained by the downsides associated with conventional surface electrodes. These electrodes are primarily applicable for recording the activity of superficial muscles, but their activity may be affected by crosstalk

from muscles near or deep to the intended muscle. Measurement of deep muscles that have overlapping muscles are not accurate as well, according to this study (Besomi et al., 2019). Furthermore, the emotions evoked by listening to these scripts varies from person to person and might depend on many factors such as a broad spectrum of other patient traits, that are difficult to control. One strength of this study is that these possible confounding variables were recorded by means of questionnaires. Another strength is that the demographic characteristics were comparable between the participants. There were about as many women as men, which is important since gender-related variations exists in symptom reporting (Gijsbers van Wijk, Huisman, & Kolk, 1999), symptom perception processes (Roberts & Pennebaker, 1995) and in stress physiology (Taylor et al., 2000). Moreover, to prevent possible confounding by presentation order, the scripts were randomized to maximize their effect. Thus, the participants imagined the scripts in a randomized order. In this study, we used a very standardized protocol so that each participant would receive the test in an identical manner. Lastly, the trials were conducted in a well-controlled environment, so that our subject could be closely monitored.

5.5 Clinical implications

This study gives a broader insight into the link between hyperventilation, postural control and psychological measures. It is essential to recognize that emotional drivers might directly have an impact on balance control, since they have the ability to mask or modify underlying balance deficiencies. This is particularly relevant considering the high frequency of secondary psychological co-morbidities (e.g. depression disorders) in populations with known postural control problems, for instance people with low back pain. It might also contribute to a more comprehensive understanding about possible mechanisms through which clinical balance deficits might arise with the lack of apparent physiological dysfunction. Furthermore, our results imply that acceptance of a disease such as low back pain might be a more favorable coping strategy in dealing with the high burden associated with this condition. Consequently, there should be more focus on therapeutic interventions that emphasize on integrating these coping mechanisms as this is already being done in cognitive functional therapy and graded exposure.

5.6 Future research

In studies of postural control, it is recommended to implement measures to monitor and control for arousal for the reason that it might influence results. Moreover, further research should determine whether the stress-related reduction/increase in postural sway is adaptive or maladaptive with respect to increased or decreased vulnerability to falls in adults. They should also examine whether this strategy of increasing/reducing sway protects someone from falling in real-life settings. Furthermore, both acceptance and hostile resistance scripts might be associated with a wide variety of other psychological processes. Therefore, identifying which psychological factors are exactly accountable for the obtained effects should be an important focus for future research. The understanding of postural responses to script-driven imagery should be further assessed with the purpose of better understanding the variance between subjects (personality traits etc.). More focus should thus be placed to the psychological profile of the persons studied. Moreover, further research should implement physiological data, such as heart rate and skin conductance, to validate the capability of the clinical setting to elicit emotional activation. Finally, we recommended future studies to include more subjects, as well as a more heterogenic population. Other than that, it would be interesting to carry out this research in relevant populations, such as people with low back pain.

6 Conclusion

This study was the first to demonstrate the effect of script-driven imagery of different emotions (relaxation, acceptance and hostile resistance) on postural control and PetCO2. Similar to other studies, our results suggest that an increased stress reaction is associated with a reduction in postural sway. However, we found no significant effect of aversive stimuli on PetCO2 and muscle activation patterns. Considering our findings, it is advised to monitor and control for arousal when measuring postural control.

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8 Appendices

Appendix 1
Overview of questionnaires used during the study

1. **Electronic bundle of questionnaires**

- *International Physical Activity Questionnaire – Short Form (IPAQ-SF)*

The IPAQ-SF is a questionnaire used to estimate the habitual physical activity level. The short version evaluates the amount of heavy and mild physical activities, walking and sitting expressed as days per week and hours / minutes per day. The reproducibility of the Dutch short version was excellent, but construct validity was low (van Poppel et al., 2004). However, results of the IPAQ should be interpreted with caution since a systematic review on the validity found that the questionnaire overestimated physical activity as measured by objective criterion by an average of 84 percent (Lee, Macfarlane, Lam, & Stewart, 2011).

- *Nijmegen questionnaire (NQ),*

The NQ is a screening tool to detect patients with perceived symptoms of hyperventilation. It consists of 16 items to be answered on a five-point scale giving rise to total scores between 0 and 64 (Van Dixhoorn & Duivenvoorden, 1985). Scoring 23 points or more is typically used as an indicator of significant symptoms of hyperventilation (Vansteenkiste, Rochette, & Demedts, 1991).

- *Dagelijks leven klachten lijst (DLKL)*

The Dagelijks Leven Klachten Lijst is a 39-item questionnaire regarding complaints which could be experienced in daily life. Each item represents a complaint experienced in the last year that should be scored on a 6-point scale ranging from never to very often. The scale is designed for a Dutch-speaking population (Wientjes & Grossman, 1994).

- *12-item Short form Health Survey (SF-12)*

The SF-12 is a generic measure for the self-reported quality of life by a patient. It is the short version of the SF-36 and exists out of 12 items coupled to either a mental component score or a physical component score. Although standard errors are nearly always larger for the 12-item SF, test-retest reliability and validity is good to excellent (Ware, Kosinski, & Keller,

1996). The questionnaire was cross-validated in a Dutch-speaking country (Gandek et al., 1998).

- *Tampa Scale for Kinesiophobia (TSK)*

The TSK is a 17-item questionnaire, which reliably evaluates kinesiophobia and pain-related fear (Swinkels-Meewisse, Swinkels, Verbeek, Vlaeyen, & Oostendorp, 2003). The total score ranges from 17 to 68 with higher scores indicating higher levels of pain-related fear.

- *Need for Controllability and Predictability Questionnaire (NCP-Q)*

The NCP-Q is a 15-item patient-reported questionnaire rating the need for being able to control and predict situations (ref). Currently, this scale is being validated for Dutch speaking patients.

- *Positive And Negative Affect Schedule (PANAS)*

The PANAS consist of ten positive (positive affectivity, PA) and ten negative adjectives (negative affectivity, NA). Participants need to indicate on a 5-point scale the extent to which these items apply to their feelings at the moment (Watson, Clark, & Tellegen, 1988). The reliability and construct validity of the Dutch state version has been documented (De Peuter, Van den Bergh, & Van Diest, 2006).

- *Pain Solutions Questionnaire (PaSoL)*

The PaSoL is a Dutch questionnaire designed to measure assimilative (efforts to change or solve pain) and accommodative (accepting pain is unsolvable and changing life goals) responses to problems associated with pain. It consists of 14 items with an adequate four factor structure. The internal consistency is good and the scale is important in explaining variability in disability and affective distress. The construct validity was confirmed by intercorrelations with subscales of the Chronic Pain Acceptance Questionnaire (De Vlieger, Bussche, Eccleston, & Crombez, 2006).

- *Toronto Alexithymia Scale 20 (TAS-20)*

TAS-20 is a 20-item questionnaire evaluating characteristics linked to the alexithymia personality trait with established validity. Alexithymia is linked to having trouble identifying

and describing emotions, a tendency to minimize emotional experiences and an external attention focus. Each item has to be rated on a five-point scale ranging from 'strongly disagree' to 'strongly agree'. The scale has three subscales: difficulty describing feelings, difficulty identifying feelings and externally-oriented thinking. Cut-off scores are: ≤51 = non-alexithymia, ≥61 = alexithymia and scores in between are classified as possible alexithymia (Bagby, Taylor, & Parker, 1994). The same factor structure was found for the Dutch version of TAS-20. Reliability was good to acceptable depending on which factor, however this evaluation was done in an adolescent population (Meganck et al., 2012).

- *Interoceptive Awareness Questionnaire (IAQ)*

The IAQ is a 19-item questionnaire used to evaluate adaptive and maladaptive body awareness. Each item should be scored on a 5-point scale ranging from 'strongly disagree' tot 'strongly agree'. Factor analysis on a large population (n = 1356) revealed two factors: awareness of bodily sensations (10 items) and attention to unpleasant bodily sensations (9 items). The item-scores within each of the factors are summed separately (Bogaerts et al., 2018; Van den Bergh et al., 2012).

- *Multidimensional Perfectionism Scale (MPS)*

The Frost MPS is a 35-item scale (Stöber et al., 1998) evaluating four subscales of perfectionism (adaptive and maladaptive). Every item represents a statement concerning a personal characteristic or expectations and thoughts from others and the self, and should be rated on a five-point scale ranging from completely true to completely untrue. The scale was originally validated using student participants and its validity is now determined in several clinical populations.

- *Vragenlijst belastende ervaringen (VBE)*

The VBE is a short questionnaire evaluating aversive experiences in the past (e.g. life threatening experiences, physical/emotional/sexual abuse, death of a child or partner,…). Every question should be answered with whether the participant experienced the situation and if yes, indicate on a scale from one to five to what extent the experience burdened them (Nijenhuis, van der Hart, & Vanderlinden, 1995).

2. Questionnaires script

- *Dagelijks leven klachten lijst (DLKL)*
- *Positive And Negative Affect Schedule (PANAS)*
- *Questions on attentional focus during the imagination (according to Johnson* et al., *2017)*

During the imagery, when you could not focus completely on the script, …

1. … did you consciously try to monitor or control specific parts of your body or movement? [movement processes]
2. … did you focus on the specific instructions provided to you about the task objectives like to keep a relaxed upright position, to gaze into the distance…? [task objectives]
3. … did you focus on feelings of anxiety or worry? [threat-related stimuli]
4. … did you use coping strategies to help remain confident, calm and/or focused? (e.g. regulated your breathing, purposeful distraction) [self-regulatory strategies]
5. … did you have thoughts unrelated to the task? (e.g. plans after the study, talks with friends, trivial distractions…) [task-irrelevant information]

- *9-point Likert scales*

Scale 1: how much effort did it take to imagine the script vividly? One is…, nine is…

Scale 2: to what extent did you feel like the script was described? One is very vividly, nine is not vividly at all.

- *Manikin assessment*

This assesses how participants felt during the imagery trial (Lang, Bradley, & Cuthbert, 1990; Mehrabian & Russell, 1974). In this system, values along each of the three dimensions are portrayed on a continuous scale in a non-verbal, pictorial way. For the valence dimension, values range from a smiling, happy figure to a frowning, unhappy figure. The arousal dimension ranges from an excited, wide-eyed figure to a relaxed, sleepy figure. For the dominance dimension, the scale ranges from a small figure (dominated) to a large figure (in control) to represent the dominance dimension. The participant can indicate any of the five figures comprising each scale, or any value in between two figures, resulting in a 9-point rating scale for each dimension.

- *VAS concentration*

“Which percentage of total time (text + silence period) where you able to concentrate on the imagination?”

- *Question about fear of falling*

“Could you give a score between zero and nine which represented your general fear of falling during the trials?” Zero means no fear at all and nine is the worst fear you can imagine.

3. Questionnaires voluntary hyperventilation

- *Dagelijks leven klachten lijst (DLKL)*

Appendix 2
Content of the scripts

Neutral

Ik ben in een appartement aan zee. Ik heb net mijn schoenen uitgedaan en ik zit nu op mijn gemak in de zetel. Ik luister met een half oor naar de radio. De vroege voorjaarszon schijnt door het raam naar binnen en hult mijn hele lichaam in een behaaglijke warmte. Ik kijk door het raam naar buiten en zie de zee. De zee is kalm. Het is vloed, maar het strand is nog redelijk groot. Enkele kinderen bouwen er zandkastelen. Ik zie enkele wandelaars en een hond voorbij lopen. Zij doen de meeuwen op het strand opvliegen.

Hostile resistance 1

Ik ben alleen thuis. De telefoon rinkelt: vrienden willen op bezoek komen... Oei, ik ben hier helemaal niet op voorbereid en ik heb al de hele dag zware rugpijn. Dit bezoek zal mij nog meer last bezorgen, maar het zou ook goed doen om mijn vrienden nog eens terug te zien. Mijn rugpijn verpest zoveel en verhindert mij te genieten van de kleine dingen in het leven. Ik kan de pijn maar niet uit mijn hoofd zetten. Ik voel frustratie opborrelen. Het is toch ook zo onrechtvaardig! Ik moet steeds maar vechten tegen mijn rugpijn en tegen de onzekerheid. Het is alsof het leven erop uit is om me te pakken. Het maakt me zo kwaad en opstandig. Ik zou het willen uitschreeuwen.

Acceptance 1

Ik ben alleen thuis. De telefoon rinkelt: vrienden willen op bezoek komen. Oei, ik ben hier helemaal niet op voorbereid en ik heb al de hele dag zware rugpijn. Dit bezoek zal mij nog meer last bezorgen, maar het zou ook goed doen om mijn vrienden nog eens terug te zien. Ik kan nog steeds genieten van de kleine dingen in het leven, ondanks de rugpijn. Laat mij dan maar pijn hebben, het is nu eenmaal zo en ik probeer er ook niet teveel mee bezig te zijn... Ik kijk uit naar de komst van mijn vrienden. Ik voel me innerlijk sterk en maak me geen zorgen over de rugpijn en mijn toekomst. Ik neem de dingen zoals ze komen.

Hostile resistance 2

Ik sta aan de kassa in een winkel. Er staat een hele rij mensen voor me aan te schuiven. Het lijkt wel uren te duren. Ik voel de rugpijn opkomen. Ik denk aan de hele weg die ik nog naar

huis moet afleggen. Dit ga ik niet aankunnen, ik zal de komende dagen niets meer waard zijn! Een gevoel van wanhoop en irritatie komt opzetten… Ik moet immers voortdurend over mijn grenzen gaan, een enorme strijd leveren tegen de pijn., die ik maar niet kan winnen. Het is zo oneerlijk. Het is alsof het leven erop uit is om me te pakken. Het maakt me enorm kwaad en opstandig! Ik zou het wel kunnen uitschreeuwen.

Acceptance 2

Ik sta aan de kassa in een winkel. Er staat een hele rij mensen voor me aan te schuiven. Het lijkt wel uren te duren. Ik voel de rugpijn opkomen. Ik denk aan de hele weg die ik nog naar huis moet afleggen. Misschien ben ik de komende dagen hierdoor niets meer waard. Maar ik slaag erin me daarover op dit moment niet teveel zorgen te maken, dat heeft immers geen zin. De toekomst kan ik toch niet voorspellen. Ik leef van dag tot dag en probeer te genieten van de kleine dingen in het leven. Ik richt mijn aandacht nu weg van de pijn, naar een stralende lentezon die door het raam schijnt en alles laat glinsteren. Het geeft me een krachtig gevoel vanbinnen.

Relaxation

Zondagnamiddag thuis. In de meest comfortabele zetel zit ik lekker gemakkelijk een boek te lezen. Het is gezellig warm, er staat een geurige kop koffie naast mij. Af en toe leun ik achterover, en tuur ik door het raam. Het is een zonnige herfstdag buiten. Een kalm briesje blaast gele, rode en bruine bladeren van de bomen. Ze dwarrelen langzaam naar beneden. Een passerende auto doet af en toe de bladeren van de grond weer opwaaien. Het briesje neemt ze even mee. Enkele zondagswandelaars passeren voor mijn raam. Ik neem een slokje koffie en zet de kop weer terug op het tafeltje. Ik word weer opgeslorpt door het verhaal in mijn boek.

Appendix 3

Results of COP during phase 2+4 (scripts)

	Pre hyperventilation provocation								
	Relaxation			**Acceptance**			**Hostile resistance**		
	Baseline	Imagery	Recovery	Baseline	Imagery	Recovery	Baseline	Imagery	Recovery
COPmax –COPmin ML (m)									
• **M**	0.035	0.041	0.037	0.033	0.039	0.033	0.031	0.041	0.036
• **SD**	0.0055	0.0072	0.0089	0.0079	0.0061	0.0090	0.0066	0.0064	0.0087
COPmax –COPmin AP (m)									
• **M**	0.025	0.027	0.026	0.023	0.027	0.025	0.023	0.031	0.026
• **SD**	0.0054	0.0060	0.011	0.0060	0.0096	0.0075	0.0053	0.0088	0.0066
COPstd ML (m)									
• **M**	0.0059	0.0062	0.0062	0.0059	0.0061	0.0066	0.0052	0.0059	0.0060
• **SD**	0.0012	0.0012	0.0012	0.0015	0.0016	0.0018	0.00087	0.00093	0.0011
COPstd AP (m)									
• **M**	0.0039	0.0043	0.0045	0.0041	0.0044	0.0044	0.0040	0.0044	0.0047
• **SD**	0.00098	0.0012	0.0013	0.0010	0.0012	0.0012	0.00080	0.0012	0.00090
COPrms ML (m)									
• **M**	0.0062	0.0063	0.0066	0.0061	0.0064	0.0070	0.0053	0.0060	0.0064
• **SD**	0.0016	0.0012	0.0013	0.0015	0.0017	0.0018	0.00095	0.0010	0.0012
COPrms AP (m)									
• **M**	0.0044	0.0043	0.0048	0.0045	0.0045	0.0045	0.0042	0.0044	0.0050
• **SD**	0.00099	0.0012	0.0014	0.0014	0.0013	0.0013	0.00088	0.0012	0.00091
COPmeanvel ML (m/s)									
• **M**	0.017	0.015	0.015	0.016	0.015	0.016	0.016	0.015	0.014
• **SD**	0.0059	0.0040	0.0053	0.0075	0.0059	0.0055	0.0050	0.0041	0.0032
COPmeanvel AP (m/s)									
• **M**	0.010	0.0092	0.010	0.011	0.0096	0.0099	0.0099	0.010	0.010
• **SD**	0.0046	0.0036	0.0048	0.0049	0.0042	0.0042	0.0047	0.0046	0.0037
COPmaxvel ML (m/s)									
• **M**	0.11	0.10	0.095	0.097	0.096	0.089	0.076	0.11	0.082
• **SD**	0.027	0.023	0.027	0.044	0.027	0.026	0.020	0.023	0.0086
COPmaxvel AP (m/s)									
• **M**	0.057	0.065	0.061	0.058	0.065	0.061	0.056	0.082	0.064
• **SD**	0.028	0.028	0.031	0.027	0.023	0.025	0.023	0.037	0.028
COPswaypath ML (m)									
• **M**	0.98	1.77	0.76	0.97	1.78	0.97	0.92	1.76	0.70
• **S**	0.34	0.48	0.26	0.44	0.70	0.55	0.29	0.48	0.16

COPswaypath AP (m)									
• **M**	0.61	1.10	0.49	0.62	1.14	0.49	0.59	1.21	0.50
• **SD**	0.27	0.43	0.24	0.29	0.50	0.20	0.28	0.54	0.18
COPswaypath total (m)									
• **M**	1.16	2.09	0.91	1.16	2.12	1.39	1.10	2.15	0.86
• **SD**	0.43	0.62	0.34	0.51	0.85	0.66	0.38	0.70	0.22
COPnormsway ML (m^2/s)									
• **M**	0.017	0.015	0.015	0.017	0.015	0.014	0.016	0.015	0.014
• **SD**	0.0058	0.0040	0.0053	0.0075	0.0059	0.0012	0.0050	0.0041	0.0032
COPnormsway AP (m^2/s)									
• **M**	0.010	0.0092	0.010	0.011	0.0096	0.099	0.010	0.010	0.010
• **SD**	0.0047	0.0036	0.0048	0.0049	0.0042	0.0042	0.0047	0.0046	0.0037
Sway area (m^2)									
• **M**	0.00032	0.00036	0.00040	0.00031	0.00036	0.00036	0.00028	0.00038	0.00037
• **SD**	0.00010	0.00014	0.00020	0.00012	0.00018	0.00016	0.000088	0.00014	0.00013
	Post hyperventilation provocation								
	Relaxation			**Acceptance**			**Hostile resistance**		
	Baseline	Imagery	Recovery	Baseline	Imagery	Recovery	Baseline	Imagery	Recovery
COPmax –COPmin ML (m)									
• **M**	0.035	0.041	0.039	0.034	0.041	0.038	0.035	0.035	0.036
• **SD**	0.0037	0.0097	0.0072	0.0055	0.0075	0.0057	0.0075	0.0046	0.0065
COPmax –COPmin AP (m)									
• **M**	0.025	0.030	0.026	0.027	0.030	0.026	0.024	0.028	0.030
• **SD**	0.0059	0.0010	0.0075	0.0088	0.0074	0.0051	0.0076	0.0079	0.012
COPstd ML (m)									
• **M**	0.0059	0.0065	0.0071	0.0063	0.0068	0.0070	0.0061	0.0061	0.0065
• **SD**	0.00049	0.0013	0.0015	0.0014	0.00096	0.0010	0.0015	0.0010	0.0011
COPstd AP (m)									
• **M**	0.0044	0.0045	0.0045	0.0045	0.0047	0.0047	0.0043	0.0044	0.0050
• **SD**	0.00093	0.0014	0.0012	0.0013	0.0012	0.0010	0.0013	0.0013	0.0014
COPrms ML (m)									
• **M**	0.0060	0.0065	0.0072	0.0065	0.0069	0.0072	0.0065	0.0063	0.0071
• **SD**	0.00039	0.0013	0.0014	0.0015	0.0010	0.00095	0.0015	0.0012	0.0013
COPrms AP (m)									
• **M**	0.0046	0.0046	0.0046	0.0048	0.0047	0.0051	0.0045	0.0044	0.0052
• **SD**	0.00091	0.0014	0.0012	0.0014	0.0012	0.0010	0.0015	0.0014	0.0013
COPmeanvel ML (m/s)									
• **M**	0.015	0.013	0.015	0.014	0.013	0.015	0.014	0.013	0.014
• **SD**	0.0032	0.0026	0.0028	0.0051	0.0030	0.0030	0.0043	0.0043	0.0038

COPmeanvel AP (m/s)									
• **M**	0.0095	0.0094	0.0099	0.0094	0.0096	0.0097	0.010	0.0096	0.011
• **SD**	0.0037	0.0036	0.0038	0.0045	0.0037	0.0032	0.0053	0.0045	0.0053
COPmaxvel ML (m/s)									
• **M**	0.072	0.086	0.084	0.085	0.094	0.096	0.079	0.085	0.080
• **SD**	0.015	0.017	0.019	0.0041	0.018	0.029	0.025	0.022	0.017
COPmaxvel AP (m/s)									
• **M**	0.056	0.059	0.057	0.064	0.066	0.052	0.057	0.060	0.067
• **SD**	0.021	0.024	0.023	0.036	0.025	0.019	0.026	0.026	0.036
COPswaypath ML (m)									
• **M**	0.80	1.58	0.71	0.84	1.58	0.72	0.81	1.57	0.67
• **SD**	0.19	0.31	0.14	0.30	0.36	0.14	0.25	0.51	0.18
COPswaypath AP (m)									
• **M**	0.56	1.12	0.48	0.55	1.14	0.47	0.60	1.15	0.53
• **SD**	0.22	0.43	0.18	0.27	0.44	0.16	0.31	0.53	0.26
COPswaypath total (m)									
• **M**	0.98	1.95	0.86	1.00	1.96	0.86	1.02	1.96	0.87
• **SD**	0.26	0.50	0.20	0.39	0.53	0.20	0.38	0.71	0.30
COPnormsway ML (m^2/s)									
• **M**	0.014	0.013	0.015	0.014	0.013	0.015	0.014	0.013	0.014
• **SD**	0.0032	0.0026	0.0027	0.0051	0.0030	0.0029	0.0043	0.0043	0.0038
COPnormsway AP (m^2/s)									
• **M**	0.0095	0.0094	0.0099	0.0094	0.0096	0.0097	0.010	0.0096	0.011
• **SD**	0.0037	0.0036	0.0038	0.0046	0.0037	0.0032	0.0053	0.0045	0.0053
Sway area (m^2)									
• **M**	0.0003312	0.00042	0.00040	0.00035	0.00041	0.00041	0.0035	0.00035	0.00044
• **SD**	0.000073	0.00020	0.00015	0.00013	0.00016	0.00013	0.00017	0.00014	0.00019

Values are presented as mean + standard deviation

COP=centre of pressure, AP=anterior-posterior, ML=medio-lateral, std= standard deviation, rms= root mean square, meanvel=mean velocity, maxvel=maximum velocity, swaypath=total sway path, normsway= time-normalized sway path, M=mean, SD=standard deviation

Appendix 4

Results of EMG during phase 2+4 (scripts)

	Pre hyperventilation provocation								
	Relaxation			**Acceptance**			**Hostile resistance**		
	Baseline	Imagery	Recovery	Baseline	Imagery	Recovery	Baseline	Imagery	Recovery
M. Rectus abdominus (%)									
• **Med**	2.83	2.85	2.87	2.84	2.84	2.83	2.93	2.89	2.88
• **IQR**	5.16	5.23	5.22	5.44	5.36	5.21	5.27	5.22	5.26
M. Obliquus abdominis internus (%)									
• **Med**	6.19	8.12	5.52	10.12	10.06	7.17	9.13	10.44	6.57
• **IQR**	5.22	5.90	6.11	6.63	5.60	5.73	4.63	5.38	6.11
M. Erector spinae pars lumbalis (%)									
• **Med**	7.61	8.40	8.74	6.93	8.90	9.27	7.77	7.31	7.96
• **IQR**	7.91	8.43	8.01	6.54	8.07	10.01	7.32	8.10	7.45
M. Multifidus									
• **Med**	2.04	2.03	1.89	2.34	2.06	1.97	2.91	2.28	2.24
• **IQR**	11.13	8.98	9.78	10.11	10.21	9.28	12.41	12.31	12.23
M. Intercostalis externus (%)									
• **Med**	1.59	1.71	1.95	1.57	1.55	1.63	2.19	2.25	1.99
• **IQR**	1.94	1.94	1.98	2.11	2.23	2.37	2.18	3.21	3.88
M. Sternocleidomastoideus (%)									
• **Med**	2.53	2.46	2.44	2.33	3.10	2.45	3.23	2.88	3.01
• **IQR**	8.52	7.76	7.63	7.98	6.98	5.98	7.34	6.97	5.96
M. Trapezius pars descendens									
• **Med**	2.52	2.41	2.24	2.70	2.40	2.48	2.67	2.53	2.51
• **IQR**	2.35	2.10	1.74	2.54	2.04	2.08	2.30	1.76	1.66
	Post hyperventilation provocation								
	Relaxation			**Acceptance**			**Hostile resistance**		
	Baseline	Imagery	Recovery	Baseline	Imagery	Recovery	Baseline	Imagery	Recovery
M. Rectus abdominus (%)									
• **Med**	2.75	2.76	2.77	2.73	2.73	2.72	2.73	2.71	2.74
• **IQR**	5.19	5.31	5.22	5.18	5.16	4.94	5.28	5.41	5.39
M. Obliquus abdominis internus (%)									
• **Med**	8.70	9.17	5.67	7.75	9.26	5.61	10.00	9.72	6.58
• **IQR**	5.43	5.51	7.12	5.31	4.81	5.58	7.31	6.87	6.91
M. Erector spinae pars lumbalis (%)									
• **Med**	5.85	5.35	7.50	5.70	6.29	5.46	5.94	7.48	7.61
• **IQR**	6.31	7.82	7.63	6.23	8.12	6.73	6.32	7.38	7.83

M. Multifidus									
• **Med**	1.54	1.54	1.52	1.47	1.46	1.48	1.64	1.49	1.51
• **IQR**	7.55	7.18	6.88	8.65	8.48	7.35	7.14	8.28	7.70
M. Intercostalis externus (%)									
• **Med**	1.63	1.98	1.58	1.64	1.59	1.61	1.87	1.58	1.69
• **IQR**	1.82	1.76	1.98	2.97	3.21	3.32	1.89	1.73	1.66
M. Sternocleidomastoideus (%)									
• **Med**	2.66	2.67	2.55	2.85	2.93	3.87	2.72	3.74	2.77
• **IQR**	8.35	7.18	8.02	7.25	8.08	8.10	7.38	7.25	8.31
M. Trapezius pars descendens									
• **Med**	2.58	2.35	2.22	2.65	2.62	2.41	2.89	2.88	2.55
• **IQR**	2.19	2.81	1.75	2.17	2.25	1.97	2.36	2.03	1.73

Values are presented as median + interquartile range as a percentage the activity measured during the fast ballistic arm movement up to 90 degrees anteflexion

Med=median, IQR=interquartile range

Verklaring op Eer

Ondergetekende, student aan de Universiteit Hasselt (UHasselt), faculteit Revalidatie wetenschappen en kinesitherapie aanvaardt de volgende voorwaarden en bepalingen van deze verklaring:

1. Ik ben ingeschreven als student aan de UHasselt in de opleiding Revalidatiewetenschappen en kinesitherapie, waarbij ik de kans krijg om het kader van mijn opleiding mee te werken aan onderzoek van de faculteit Revalidatiewetenschappen en kinesitherapie aan de UHasselt. Dit onderzoek wordt beleid door Prof. Dr. Lotte Janssens en kadert binnen het opleidingsonderdeel Masterproef deel 2. Ik zal in het kader van dit onderzoek creaties, schetsen, ontwerpen, prototypes en/of onderzoeksresultaten tot stand brengen in het domein van Musculoskeletale revalidatie.

2. Bij de creatie van De Onderzoeksresultaten doe ik beroep op de achtergrondkennis, vertrouwelijke informatie[1], universitaire middelen en faciliteiten van UHasselt (hierna: de "Expertise").

3. Ik zal de Expertise, met inbegrip van vertrouwelijke informatie, uitsluitend aanwenden voor het uitvoeren van hogergenoemd onderzoek binnen UHasselt. Ik zal hierbij steeds de toepasselijke regelgeving, in het bijzonder de Algemene Verordening Gegevensbescherming (EU 2016-679), in acht nemen.

4. Ik zal de Expertise (i) voor geen enkele andere doelstelling gebruiken, en (ii) niet zonder voorafgaande schriftelijke toestemming van UHasselt op directe of indirecte wijze publiek maken.

5. Aangezien ik in het kader van mijn onderzoek beroep doe op de Expertise van de UHasselt, draag ik hierbij alle bestaande en toekomstige intellectuele eigendomsrechten op De Onderzoeksresultaten over aan de UHasselt. Deze overdracht omvat alle vormen van intellectuele eigendomsrechten, zoals onder meer – zonder daartoe beperkt te zijn – het auteursrecht, octrooirecht, merkenrecht, modellenrecht en knowhow. De overdracht geschiedt in de meest volledige omvang, voor de gehele wereld en voor de gehele beschermingsduur van de betrokken rechten.

6. In zoverre De Onderzoeksresultaten auteursrechtelijk beschermd zijn, omvat bovenstaande overdracht onder meer de volgende exploitatiewijzen, en dit steeds voor de hele beschermingsduur, voor de gehele wereld en zonder vergoeding:

   - het recht om De Onderzoeksresultaten vast te (laten) leggen door alle technieken en op alle dragers;

[1] Vertrouwelijke informatie betekent alle informatie en data door de UHasselt meegedeeld aan de student voor de uitvoering van deze overeenkomst, inclusief alle persoonsgegevens in de zin van de Algemene Verordening Gegevensbescherming (EU 2016/679), met uitzondering van de informatie die (a) reeds algemeen bekend is; (b) reeds in het bezit was van de student voor de mededeling ervan door de UHasselt; (c) de student verkregen heeft van een derde zonder enige geheimhoudingsplicht; (d) de student onafhankelijk heeft ontwikkeld zonder gebruik te maken van de vertrouwelijke informatie van de UHasselt; (e) wettelijk of als gevolg van een rechterlijke beslissing moet worden bekendgemaakt, op voorwaarde dat de student de UHasselt hiervan schriftelijk en zo snel mogelijk op de hoogte brengt.

- het recht om De Onderzoeksresultaten geheel of gedeeltelijk te (laten) reproduceren, openbaar te (laten) maken, uit te (laten) geven, te (laten) exploiteren en te (laten) verspreiden in eender welke vorm, in een onbeperkt aantal exemplaren;
- het recht om De Onderzoeksresultaten te (laten) verspreiden en mee te (laten) delen aan het publiek door alle technieken met inbegrip van de kabel, de satelliet, het internet en alle vormen van computernetwerken;
- het recht De Onderzoeksresultaten geheel of gedeeltelijk te (laten) bewerken of te (laten) vertalen en het (laten) reproduceren van die bewerkingen of vertalingen;
- het recht De Onderzoeksresultaten te (laten) bewerken of (laten) wijzigen, onder meer door het reproduceren van bepaalde elementen door alle technieken en/of door het wijzigen van bepaalde parameters (zoals de kleuren en de afmetingen).

De overdracht van rechten voor deze exploitatiewijzen heeft ook betrekking op toekomstige onderzoeksresultaten tot stand gekomen tijdens het onderzoek aan UHasselt, eveneens voor de hele beschermingsduur, voor de gehele wereld en zonder vergoeding.

Ik behoud daarbij steeds het recht op naamvermelding als (mede)auteur van de betreffende Onderzoeksresultaten.

7. Ik zal alle onderzoeksdata, ideeën en uitvoeringen neerschrijven in een "laboratory notebook" en deze gegevens niet vrijgeven, tenzij met uitdrukkelijke toestemming van mijn UHasseltbegeleider Prof. Dr. Lotte Janssens.

8. Na de eindevaluatie van mijn onderzoek aan de UHasselt zal ik alle verkregen vertrouwelijke informatie, materialen, en kopieën daarvan, die nog in mijn bezit zouden zijn, aan UHasselt terugbezorgen.

Gelezen voor akkoord en goedgekeurd,

Naam: Jorn Claes

Adres: M. van Beurdenplaan 9

Geboortedatum en -plaats : 18/11/1997 te Wilrijk

Datum: 24/05/'20

Handtekening:

Verklaring op Eer

Ondergetekende, student aan de Universiteit Hasselt (UHasselt), faculteit Revalidatiewetenschappen en kinesitherapie aanvaardt de volgende voorwaarden en bepalingen van deze verklaring:

1. Ik ben ingeschreven als student aan de UHasselt in de opleiding Revalidatiewetenschappen en kinesitherapie, waarbij ik de kans krijg in het kader van mijn opleiding mee te werken aan onderzoek van de faculteit Revalidatiewetenschappen en kinesitherapie aan de UHasselt. Dit onderzoek wordt beleid door Prof. Dr. Lotte Janssens en kadert binnen het opleidingsonderdeel [naam opleidingsonderdeel Masterproef deel 2. Ik zal in het kader van dit onderzoek creaties, schetsen, ontwerpen, prototypes en/of onderzoeksresultaten tot stand brengen in het domein van Musculoskeletale revalidatie (hierna: "De Onderzoeksresultaten").

2. Bij de creatie van De Onderzoeksresultaten doe ik beroep op de achtergrondkennis, vertrouwelijke informatie[1], universitaire middelen en faciliteiten van UHasselt (hierna: de "Expertise").

3. Ik zal de Expertise, met inbegrip van vertrouwelijke informatie, uitsluitend aanwenden voor het uitvoeren van hogergenoemd onderzoek binnen UHasselt. Ik zal hierbij steeds de toepasselijke regelgeving, in het bijzonder de Algemene Verordening Gegevensbescherming (EU 2016-679), in acht nemen.

4. Ik zal de Expertise (i) voor geen enkele andere doelstelling gebruiken, en (ii) niet zonder voorafgaande schriftelijke toestemming van UHasselt op directe of indirecte wijze publiek maken.

5. Aangezien ik in het kader van mijn onderzoek beroep doe op de Expertise van de UHasselt, draag ik hierbij alle bestaande en toekomstige intellectuele eigendomsrechten op De Onderzoeksresultaten over aan de UHasselt. Deze overdracht omvat alle vormen van intellectuele eigendomsrechten, zoals onder meer – zonder daartoe beperkt te zijn – het auteursrecht, octrooirecht, merkenrecht, modellenrecht en knowhow. De overdracht geschiedt in de meest volledige omvang, voor de gehele wereld en voor de gehele beschermingsduur van de betrokken rechten.

6. In zoverre De Onderzoeksresultaten auteursrechtelijk beschermd zijn, omvat bovenstaande overdracht onder meer de volgende exploitatiewijzen, en dit steeds voor de hele beschermingsduur, voor de gehele wereld en zonder vergoeding:

   - het recht om De Onderzoeksresultaten vast te (laten) leggen door alle technieken en op alle dragers;
   - het recht om De Onderzoeksresultaten geheel of gedeeltelijk te (laten) reproduceren, openbaar te (laten) maken, uit te (laten) geven, te (laten) exploiteren en te (laten) verspreiden in eender welke vorm, in een onbeperkt aantal exemplaren;

[1] Vertrouwelijke informatie betekent alle informatie en data door de UHasselt meegedeeld aan de student voor de uitvoering van deze overeenkomst, inclusief alle persoonsgegevens in de zin van de Algemene Verordening Gegevensbescherming (EU 2016/679), met uitzondering van de informatie die (a) reeds algemeen bekend is; (b) reeds in het bezit was van de student voor de mededeling ervan door de UHasselt; (c) de student verkregen heeft van een derde zonder enige geheimhoudingsplicht; (d) de student onafhankelijk heeft ontwikkeld zonder gebruik te maken van de vertrouwelijke informatie van de UHasselt; (e) wettelijk of als gevolg van een rechterlijke beslissing moet worden bekendgemaakt, op voorwaarde dat de student de UHasselt hiervan schriftelijk en zo snel mogelijk op de hoogte brengt.

- het recht om De Onderzoeksresultaten te (laten) verspreiden en mee te (laten) delen aan het publiek door alle technieken met inbegrip van de kabel, de satelliet, het internet en alle vormen van computernetwerken;
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De overdracht van rechten voor deze exploitatiewijzen heeft ook betrekking op toekomstige onderzoeksresultaten tot stand gekomen tijdens het onderzoek aan UHasselt, eveneens voor de hele beschermingsduur, voor de gehele wereld en zonder vergoeding.

Ik behoud daarbij steeds het recht op naamvermelding als (mede)auteur van de betreffende Onderzoeksresultaten.

7. Ik zal alle onderzoeksdata, ideeën en uitvoeringen neerschrijven in een "laboratory notebook" en deze gegevens niet vrijgeven, tenzij met uitdrukkelijke toestemming van mijn UHasseltbegeleider Prof. Dr. Lotte Janssens.

8. Na de eindevaluatie van mijn onderzoek aan de UHasselt zal ik alle verkregen vertrouwelijke informatie, materialen, en kopieën daarvan, die nog in mijn bezit zouden zijn, aan UHasselt terugbezorgen.

Gelezen voor akkoord en goedgekeurd,

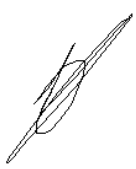
Naam: Sebastiaan Gijbels

Adres: Monseigneur Schruerslaan 16 Hasselt

Geboortedatum en –plaats : 11/02/1997 te Lommel

Datum:23/05/2020

Handtekening:



UHASSELT
KNOWLEDGE IN ACTION

Inschrijvingsformulier verdediging masterproef academiejaar 2019-2020,
Registration form jury Master's thesis academic year 2019-2020,

Gegevens student:
Information student:

Faculteit/School: **Faculteit Revalidatiewetenschappen**
Faculty/School: ***Rehabilitation Sciences***

Stamnummer: **1541086**
Student number

Naam student: **Claes Jorn**
Name student

Opleiding/*Programme*: **2 ma revalid. & kine musc.**

Gegevens masterproef
Information Master's thesis

Titel van Masterproef/*Title of Master's thesis:*

Wijziging/*Change:* The effect of script-driven imagery of emotions (relaxation, acceptance and hostile resistance) on postural control, end-tidal carbon dioxide and muscle activation patterns in healthy subjects

Promotor(en):
Supervisor(s)
Wijziging/*Change:* Prof. Dr. L. Janssens

Copromotor(en):
Co-supervisor(s)
Wijziging/*Change:* Prof. Dr. K. Boganerts; Dr. N. Goosens; Dr. R. Baggen; Dra. C. Amerijckx

Externe promotor(en):
External supervisor(s)
Wijziging/*Change:* .....

Externe co-promotor(en) :
External co-supervisor(s)
Wijziging/*Change:* .....

In geval van samenwerking tussen studenten, naam van de medestudent(en): Sebastiaan Bijcels
In case of group work, name of fellow student(s)
Wijziging/*Change:* .....

Wijzigingen gegevens masterproef
Changes information Master's thesis

In te vullen door student
To be filled out by the student

Wijziging gegevens masterproef:
Change information Master's thesis:

- ● Geen
  None
- o Ja, de wijzigingen werden in bovenstaand luik "Gegevens masterproef" aangebracht
  Yes, the changes are put in in the "Information Master's thesis" section above

In te vullen door promotor(en)
To be filled out by the supervisor(s)

De wijzigingen in bovenstaand luik "Gegevens masterproef" worden door de promotor
The changes in the "Information Master's thesis" section above are by the supervisor

- o goedgekeurd.
  approved
  met uitzondering van:.....
  with exception of
- o afgekeurd.
  disapproved

- o De scriptie is vertrouwelijk (wordt niet opgenomen in bib)
  Thesis confidential (not available in library)

Datum en handtekening student
Date and signature student
15/05/2020

Datum en handtekening promotor(en)
Date and signature supervisor(s)

Verdediging
Jury

In te vullen door de promotor(en)
To be filled out by the supervisor(s)

De promotor(en) geeft (geven) de student(en) het niet-bindend advies om de bovenvermelde masterproef in de bovenvermelde periode:
The supervisor(s) give(s) the student(s) the non-binding advice
o te verdedigen;
to defend the aforementioned Master's thesis within the aforementioned period of time;
o de verdediging is openbaar.
in public
o de verdediging is niet openbaar.
not in public
o niet te verdedigen
not to defend the aforementioned Master's thesis within the aforementioned period of time.

Optie: in te vullen door de student:
Option: to be filled out by the student:

In tegenstelling tot het niet-bindend advies van de promotor(en) wenst de student de bovenvermelde masterproef in de bovenvermelde periode:
In contrast to the non-binding advice put forward by the supervisor(s), the student wishes:
o niet te verdedigen.
not to defend the aforementioned Master's thesis within the aforementioned period of time.
● wel te verdedigen.
to defend the aforementioned Master's thesis within the aforementioned period of time.

Datum en handtekening student
Date and signature student
15/05/2020

Datum en handtekening promotor(en)
Date and signature supervisor(s)

UHASSELT
KNOWLEDGE IN ACTION

Inschrijvingsformulier verdediging masterproef academiejaar 2019-2020,
Registration form jury Master's thesis academic year 2019-2020,

Gegevens student:
Information student:

Faculteit/School: **Faculteit Revalidatiewetenschappen**
Faculty/School: ***Rehabilitation Sciences***

Stamnummer: **1539855**
Student number

Naam student: **Gijbels Sebastiaan**
Name student

Opleiding/*Programme*: **2 ma revalid. & kine musc.**

Gegevens masterproef
Information Master's thesis

Titel van Masterproef/*Title of Master's thesis:*

Wijziging/*Change:* The effect of script-driven imagery of emotions (relaxation, acceptance and hostile resistance) on postural control, end-tidal carbon dioxide and muscle activation patterns in healthy subjects

Promotor(en):
Supervisor(s)
Wijziging/*Change:* Prof. Dr. L. Janssens

Copromotor(en):
Co-supervisor(s)
Wijziging/*Change:* Prof. Dr. K. Boganerts; Dr. N. Goossens; Dr. R. Baggen; Dra. C. Amerijckx

Externe promotor(en):
External supervisor(s)
Wijziging/*Change:* .....

Externe co-promotor(en) :
External co-supervisor(s)
Wijziging/*Change:* .....

In geval van samenwerking tussen studenten, naam van de medestudent(en):
In case of group work, name of fellow student(s)
Wijziging/*Change:* Joren Claes

Wijzigingen gegevens masterproef
Changes information Master's thesis

In te vullen door student
To be filled out by the student

Wijziging gegevens masterproef:
Change information Master's thesis:

o Geen
None
● Ja, de wijzigingen werden in bovenstaand luik "Gegevens masterproef" aangebracht
Yes, the changes are put in in the "Information Master's thesis" section above

In te vullen door promotor(en)
To be filled out by the supervisor(s)

De wijzigingen in bovenstaand luik "Gegevens masterproef" worden door de promotor
The changes in the "Information Master's thesis" section above are by the supervisor
o goedgekeurd.
approved
met uitzondering van:.....
with exception of
o afgekeurd.
disapproved

o De scriptie is vertrouwelijk (wordt niet opgenomen in bib)
Thesis confidential (not available in library)

Datum en handtekening student
Date and signature student
15/05/2020

Datum en handtekening promotor(en)
Date and signature supervisor(s)

Verdediging
Jury

In te vullen door de promotor(en)
To be filled out by the supervisor(s)

De promotor(en) geeft (geven) de student(en) het niet-bindend advies om de bovenvermelde masterproef in de bovenvermelde periode:
The supervisor(s) give(s) the student(s) the non-binding advice
o te verdedigen;
to defend the aforementioned Master's thesis within the aforementioned period of time;
o de verdediging is openbaar.
in public
o de verdediging is niet openbaar.
not in public
o niet te verdedigen
not to defend the aforementioned Master's thesis within the aforementioned period of time.

Optie: in te vullen door de student:
Option: to be filled out by the student:

In tegenstelling tot het niet-bindend advies van de promotor(en) wenst de student de bovenvermelde masterproef in de bovenvermelde periode:
In contrast to the non-binding advice put forward by the supervisor(s), the student wishes:
o niet te verdedigen.
not to defend the aforementioned Master's thesis within the aforementioned period of time.
o wel te verdedigen.
to defend the aforementioned Master's thesis within the aforementioned period of time.

Datum en handtekening student
Date and signature student
15/05/2020

Datum en handtekening promotor(en)
Date and signature supervisor(s)

www.uhasselt.be
Campus Hasselt | Martelarenlaan 42 | BE-3500 Hasselt
Campus Diepenbeek | Agoralaan gebouw D | BE-3590 Diepenbeek
T + 32(0)11 26 81 11 | E-mail: info@uhasselt.be

UHASSELT
KNOWLEDGE IN ACTION

INVENTARISATIEFORMULIER WETENSCHAPPELIJKE STAGE DEEL 2

DATUM	INHOUD OVERLEG	HANDTEKENINGEN
12/08/19	- Overleg planning MP 2 - Eerste uitleg over concrete doelen	Promotor: Copromotor/Begeleider: Student(e): Student(e):
7/10/19	- overleg i.v.m inleiding + methode uitschrijven	Promotor: Copromotor/Begeleider: Student(e): Student(e):
oktober November december	- uitschrijven inleiding + methode: af en toe contact via mail	Promotor: Copromotor/Begeleider: Student(e): Student(e):
Februari	- Testen die we gaan doen oefenen onder studenten, promotor en copromotor	Promotor: Copromotor/Begeleider: Student(e): Student(e):
4/03/20 + 12/03/20	- De metingen op de deelneners uitgevoerd	Promotor: Copromotor/Begeleider: Student(e): Student(e):
15/04/20	- Overleg i.v.m. statistiek (video call)	Promotor: Copromotor/Begeleider: Student(e): Student(e):
16/04/20 t.e.m. 13/05/20	- Regelmatig basis contact via mail over statistiek, uitschrijven resultaten en discussie	Promotor: Copromotor/Begeleider: Student(e): Student(e):
Half mei	- 2x de volledige tekst aangepast op feedback van promotor, copromotor	Promotor: Copromotor/Begeleider: Student(e): Student(e):
23/06/20	- oefenpresentatie	Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):

In te vullen door de promotor(en) en eventuele copromotor aan het einde van MP2:

Naam Student(e): ..... Datum:.....

Titel Masterproef: .....

1) Geef aan in hoeverre de student(e) onderstaande competenties zelfstandig uitvoerde:
   - NVT: De student(e) leverde hierin geen bijdrage, aangezien hij/zij in een reeds lopende studie meewerkte.
   - 1: De student(e) was niet zelfstandig en sterk afhankelijk van medestudent(e) of promotor en teamleden bij de uitwerking en uitvoering.
   - 2: De student(e) had veel hulp en ondersteuning nodig bij de uitwerking en uitvoering.
   - 3: De student(e) was redelijk zelfstandig bij de uitwerking en uitvoering
   - 4: De student(e) had weinig tot geringe hulp nodig bij de uitwerking en uitvoering.
   - 5: De student(e) werkte zeer zelfstandig en had slechts zeer sporadisch hulp en bijsturing nodig van de promotor of zijn team bij de uitwerking en uitvoering.

Competenties	**NVT**	**1**	**2**	**3**	**4**	**5**
Opstelling onderzoeksvraag	O	O	O	O	O	O
Methodologische uitwerking	O	O	O	O	O	O
Data acquisitie	O	O	O	O	O	O
Data management	O	O	O	O	O	O
Dataverwerking/Statistiek	O	O	O	O	O	O
Rapportage	O	O	O	O	O	O

2) Niet-bindend advies: Student(e) krijgt toelating/geen toelating (schrappen wat niet past) om bovenvermelde Wetenschappelijke stage/masterproef deel 2 te verdedigen in bovenvermelde periode. Deze eventuele toelating houdt geen garantie in dat de student geslaagd is voor dit opleidingsonderdeel.

3) Deze wetenschappelijke stage/masterproef deel 2 mag wel/niet (schrappen wat niet past) openbaar verdedigd worden.

4) Deze wetenschappelijke stage/masterproef deel 2 mag wel/niet (schrappen wat niet past) opgenomen worden in de bibliotheek en docserver van de UHasselt.

Datum en handtekening Student(e)	Datum en handtekening promotor(en)	Datum en handtekening Co-promotor(en)

COVID-19 Addendum - Masterproef 2

Gelieve dit document in te laten vullen door de promotor en ingevuld toe te voegen aan je masterproef.

Naam promotor(en) ……Prof. Lotte Janssens, Prof. Katleen Bogaerts, Dra. Charlotte Amerijckx.
……...

Naam studenten …….Jorn Claes & Sebastiaan Gijbels…….
……...

1) Duid aan welk type scenario is gekozen voor deze masterproef:

☐ scenario 1: masterproef bestaat uit een meta-analyse - masterproef liep door zoals voorzien
☐ scenario 2: masterproef bestaat uit een experiment - masterproef liep door zoals voorzien
☒ scenario 3: masterproef bestaat uit een experiment - maar een deel van de voorziene data is verzameld
    ☒ 3A: er is voldoende data, maar met aangepaste statische procedures verder gewerkt
    ☐ 3B: er is onvoldoende data, dus gewerkt met een descriptieve analyse van de aanwezige data
☐ scenario 4: masterproef bestaat uit een experiment - maar er kon geen data verzameld worden
    ☐ 4A: er is gewerkt met reeds beschikbare data
    ☐ 4B: er is gewerkt met fictieve data

2) Geef aan in hoeverre de student(e) onderstaande competenties zelfstandig uitvoerde:

- NVT: De student(e) leverde hierin geen bijdrage, aangezien hij/zij in een reeds lopende studie meewerkte.
- 1: De student(e) was niet zelfstandig en sterk afhankelijk van medestudent(e) of promotor en teamleden bij de uitwerking en uitvoering.
- 2: De student(e) had veel hulp en ondersteuning nodig bij de uitwerking en uitvoering.
- 3: De student(e) was redelijk zelfstandig bij de uitwerking en uitvoering
- 4: De student(e) had weinig tot geringe hulp nodig bij de uitwerking en uitvoering.
- 5: De student(e) werkte zeer zelfstandig en had slechts zeer sporadisch hulp en bijsturing nodig van de promotor of zijn team bij de uitwerking en uitvoering.

Competenties	NVT	1	2	3	4	5
Opstelling onderzoeksvraag	☒	☐	☐	☐	☐	☐
Methodologische uitwerking	☒	☐	☐	☐	☐	☐
Data acquisitie	☐	☐	☐	☐	☒	☐
Data management	☐	☐	☐	☐	☒	☐
Dataverwerking/Statistiek	☐	☐	☐	☒	☐	☐
Rapportage	☐	☐	☐	☐	☒	☐

Datum

20/5/2020

Inschrijvingsformulier MP2 Inbox ×

Lotte JANSSENS
aan Jorn, mij, Nina, Chloé, Nina

di 19 mei 14:41 (9 dagen geleden)

Beste studenten,

Van de coördinatoren van de MP2 kregen we door dat ik jullie als promotor geen handtekening moet bezorgen op het inschrijvings- en voortgangsformulier, maar dat een email reply in deze omstandigheden volstaat. Bij deze bezorg ik jullie een akkoord voor het ingediende voortgangsformulier en de toelating om jullie MP2 te verdedigen.

Verder vraag ik jullie nog 2 zaken:
- Graag naast de formele indiening ook een finale Word-versie van jullie MP2 aan de (co)promotoren per e-mail te bezorgen
- Graag ook alle finale documentatie van de data- en statistische verwerking bezorgen, bij voorkeur wat gelabeld (of met wat toelichting) zodat we eraan uit kunnen (vb. Excel files, output JMP of SPSS, etc). Dit zodat we met hiermee verder kunnen gaan wanneer we nog bijkomende subjecten rekruteren in de toekomst.

De oefenpresentaties zullen zoals gepland op 23 juni blijven doorgaan, maar dan wel via Google Meet.

Verder wens ik jullie veel succes toe in deze laatste (en ongewone) fase van jullie opleiding. Zet nog even door met jullie masterproef, examens, eventuele stages. En dan kunnen we jullie hopelijk binnenkort als volwaardig collega beschouwen. Succes.

MVG,

Lotte Janssens