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Faculteit Revalidatiewetenschappen

master in de revalidatiewetenschappen en de kinesitherapie

Masterthesis

The weight discrimination task: A test paradigm for proprioceptive sense of weight

Michelle Vaes
Karen Van Aken
Scriptie ingediend tot het behalen van de graad van master in de revalidatiewetenschappen en de kinesitherapie, afstudeerrichting revalidatiewetenschappen en kinesitherapie bij kinderen

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Sint – Truiden, Kermt, 6 June 2022 M.V., V.K.

Research context

This master thesis was carried out within the research domain of health and rehabilitation psychology. This research group focuses on individuals with Medically Unexplained Physical Symptoms (MUPS). It is part of the doctoral dissertation of dra. Indra Ramakers, focusing on proprioception and interoception in individuals with fibromyalgia (FM), with a second hypothesis to investigate a possible association between interoception and proprioception. FM is referred to as a persistent somatic disorder, in which the relationship between the subjective experience and the indicators of an objective physiological dysfunction is highly variable and depends on characteristics of the individual, the context and the interaction between them (Van den Bergh et al., 2017). This includes interoceptive processes, that are descripted in literature as all the processes by which the central nervous system perceives, interprets, and integrates signals coming from within the body (Berntson et al., 2019; Ceunen et al., 2016; Craig, 2004; Horváth et al., 2021a). Interoceptive dysfunctions have been associated with (unexplained) somatic symptoms (Van den Bergh et al., 2017) and a lower interoceptive accuracy has been associated with increased somatoform symptom reports (Schaefer et al., 2014). Until this day, conflicting results exist (Borg et al., 2018; Sharp et al., 2021) and high-quality research on the subject is lacking. Despite the fact that interoception is a frequently researched phenomenon, consensus lacks on the scope of the concept. In recent literature, other research teams started linking proprioception (the sense of position of the body and its velocity during movement (Tuthill & Azim, 2018)) within the umbrella definition of interoception (Craig, 2004; Horváth et al., 2021a). But the theoretical concepts and research applications from interoceptive research (interceptive accuracy, interceptive sensibility, interoceptive awareness) (Garfinkel et al., 2015), have never been translated to the domain of proprioception. Therefore, the doctoral dissertation will explore interoception and proprioception in a FM population; which will possibly give more insight into their interrelationship. If associations can be shown, rehabilitation programs could be actively directed to address both these problems and their interactions.

This master thesis is a preliminary study of the doctoral dissertation of dra. Indra Ramakers and thus part of a larger research project in which a new proprioceptive task was developed to measure proprioceptive accuracy in the upper extremity. This new weight discrimination task (WDT) was developed based on a validated interoceptive accuracy test, the respiratory occlusion discrimination (ROD) task (Van Den Houte et al., 2021), with the goal to establish a new test paradigm for measuring sense of weight in the future. Both students were involved in preparations of this preliminary study project, where they were actively involved in researching and developing the new research paradigm with the intention to match with the validated interoceptive accuracy task as closely as possible. The research team kept the final say in the development of the new paradigm, but the students were involved in the elaboration of the chosen paradigm and were present at the pilot testing of the new task. Both students were actively involved in the recruitment of participants for this study and one of them was present during data-collection. Data processing was mainly done by the doctorate student, but the analysis was carried out independently by the students. Academic writing was divided between the two students with mutually set deadlines to check on each other's work.

Abstract

Background: Proprioceptive accuracy has been widely studied in literature, covering eight different proprioceptive senses. Sense of weight, one of these aspects of proprioception, has not been investigated frequently in literature. Resulting in the lack of a standardised, validated paradigm to do so. Proprioception is recently seen as a part of interoception in the its broadest sense, which includes the perceiving, interpreting, and integrating of all signals coming from within the body.

Objectives: The objective was to develop a novel task to measure proprioceptive accuracy of an individual's sense of weight, based on the validated respiratory occlusion discrimination task (ROD) used in interoceptive research. More specifically, the objective was to validate this new weight discrimination task (WDT) in terms of internal consistency, discriminant validity and task performance.

Methods: Healthy individuals (N = 33) were assessed in their ability to discriminate sense of weight (WDT), by means of an adaptive staircase procedure. Task performance was defined as the overall just noticeable difference (JND) in the WDT, and internal consistency analysed correlations between both staircases. Discriminant validity was tested by comparing performance on the new WDT task to performance on a postural control task.

Results: Mean task performance was 37.12 grams (SD = 13.42), indicating that participants were able to distinguish weights up to a difference of 37.12 grams for 70% of the time. Other results consisted of a non-significant and unacceptable internal consistency of this task (r_{29} = .17, p = .364, α = .25) and discriminant validity was low in both conditions (RPW stable r_{26} = -.03, p = .893; RPW unstable r_{26} = .36, p = .062).

Conclusion: Further research is indicated with a bigger sample size. This validation study leads the way for more studies regarding proprioception and eventually links to interoception.

Keywords: Proprioception, sense of weight, validation

Introduction

Proprioceptive accuracy is the ability of an individual to perceive proprioceptive information, that is, information referring to the actual state of body position and movement. This information originates from mechanoreceptors located in various parts of the locomotor system (Horváth et al., 2022). With respect to joint-related proprioceptive accuracy, a number of measurement paradigms exist (Han et al., 2016) testing either one of eight senses of ***proprioception***: (1) perception of joint position, (2) movement and movement extent, (3) trajectory, (4) velocity, and the sense of (5) force, (6) muscle tension, (7) weight, and (8) size (Horváth et al., 2022). Psychophysics of these paradigms are different, which makes their accuracy both joint- and task- specific (De Jong et al., 2005; Elangovan et al., 2014; Grob et al., 2002; Horváth et al., 2022; Li et al., 2016; Niespodziński et al., 2018; Yang et al., 2020). A commonly used test for proprioceptive accuracy is the use of local muscle vibrations to investigate proprioceptive processing. An example is the application of muscle vibrations to the triceps surae and lumbar paraspinal muscles, to investigate shifts in proprioceptive processing leading to postural control impairments in patients with low back pain (Brumagne, Janssens, Knapen, et al., 2008; Claeys et al., 2015; Goossens et al., 2019; Kiers et al., 2014). This is relevant to observe proprioceptive accuracy during postural control as this task is a product of efficient cooperation between the somatosensory – to which proprioception belongs - , visual, and vestibular system (Shumway-Cook & Horak, 1986). Proprioception is influenced by everyday life parameters such as sports activity (Barrack et al., 1984; Vuillerme et al., 2001), age (Ferlinc et al., 2019; Henry & Baudry, 2019) and pathological conditions (Korakakis et al., 2021; Miklovic et al., 2018; Peng et al., 2021).

In current literature, it is frequently assumed that proprioception is part of the broader concept 'interoception'. In this broad approach, ***interoception*** is seen as a subjective experience where also somatic sensations, and not merely visceral sensations have an important role (Ceunen et al., 2016). Interoception is therefore defined as all processes by which the central nervous system perceives, interprets, and integrates signals coming from within the body (Berntson et al., 2019; Ceunen et al., 2016; Craig, 2004; Horváth et al., 2021a). Interoceptive processes are conceptualized and measured at different levels within and outside conscious awareness. On a conscious level, three dimensions of interoception have been described: 1) interoceptive accuracy, 2) interoceptive sensibility, and 3) interoceptive awareness (Garfinkel et al., 2015). Interoceptive accuracy is the objectively measured ability to detect or discriminate body signals which is quantified by the performance on behavioural tasks. Next, interoceptive sensibility is the self-reported ability to detect or discriminate body signals and is typically measured by questionnaires. Last, interoceptive awareness is known as the metacognitive understanding of interoceptive accuracy and measured by relating interoceptive accuracy scores to confidence ratings (Garfinkel et al., 2015).

Interceptive accuracy, is mostly measured by comparing the perception of a physiological (mostly cardiac, respiratory or gastric) (Prentice & Murphy, 2022) signal with an objective measure of that (natural or induced) physiological signal. An example is the heartbeat counting task (HTC). In this task, participants count their heartbeats at rest during different time intervals, while the heartbeat is objectively derived from an electrocardiogram (Schandry, 1981). A disadvantage to this technique is that it does not easily lend itself to signal detection or signal differentiation techniques (which are the golden standard techniques in exteroception research), because it is difficult to precisely manipulate cardiac signals in a non-invasive manner. Van Den Houte et al. (2021) created a new paradigm to measure interoceptive accuracy, which does not depend on those types of signals. By using signal differentiation with respiratory occlusions, they could manipulate the interoceptive signal in a non-invasive external way more precisely. This resulted in the Respiratory Occlusion Discrimination (ROD) task. Participants had to distinguish the lengths of two different respiratory occlusions during the same inspiration, and subsequently a just noticeable difference (JND) between two occlusion lengths was obtained. This new paradigm proved to have good internal consistency, test-retest reliability, and discriminant validity making the ROD task a promising instrument to measure interoceptive accuracy.

Based on the increasing evidence that proprioception is a sub-concept of interoception (Craig, 2004; Horváth et al., 2021a), the research group transformed the paradigm of the ROD task into a new proprioceptive task to assess proprioceptive accuracy. Specifically a weight discrimination task (WDT) using the elbow flexor muscles was chosen for this. WDTs in the upper extremity were only limitedly used in literature and when it was, it was not done in a standardised and/or validated way (Fleury et al., 1995; Héroux & Tremblay, 2005; Horváth et al., 2021a; Pavony & Lenzenweger, 2013; Sharma & Noohu, 2014; Torres et al., 2017). Therefore, this master thesis lays the foundation for the use of a new proprioceptive accuracy task. Within this task, proprioceptive accuracy is defined as the ability to discriminate between two weights. Similar to the ROD task Van Den Houte et al. (2021), an adaptive staircase paradigm was used to efficiently measure participant’s ability to distinguish two weights, resulting in a JND. The main purpose of this master thesis was to investigate the internal consistency, discriminant validity and task performance of the newly developed WDT. The second purpose was investigating the influence of demographic factors, including age, smoking and sport participation, on WDT performance.

Methods

Participants

Participants were recruited through poster distribution on social media. When potential participants were interested, a local researcher could be contacted, after which an information form and informed consent was provided (Appendix 1). During this contact, questions regarding the study were answered by the researcher. Further, exclusion criteria existing of (1) pregnancy, (2) not between 18-65 years old, (3) not possessing a Covid safe certificate, (4) having self-reported psychiatric conditions as depression, burn- out, anxiety-, eating-, psychotic-, personality disorders or substance abuse, (5) having the diagnosis of a chronic medical condition such as epilepsy, heart disorders, rheumatoid arthritis, diabetes mellitus or persistent somatic complaints (e.g. hyperventilation, COVID-19, chronic pain, fatigue or tinnitus, (6) taking antidepressants, sleep medication or anti- anxiety drugs (e.g. anxiolytics), (7) neck pain at the time of testing, (8) a recent whiplash trauma less than three months ago or more than three months ago with present complaints, (9) diagnosis of vestibular or neurological conditions, (10) recent orthopaedic problems in the lower limb (e.g. acute inversion trauma) which could influence balance, or in the upper limb (e.g. a fracture or overuse injury) were reviewed. After reviewing the exclusion criteria, participants could indicate if they were eligible for the study or not, without specifying which exclusion criterium they met. If found eligible for the study, participants were invited for testing at REVAL, building A at het university of Hasselt. An informed consent was signed before any data collection. Data were collected between March and April 2022. The study was approved by the Committee for Medical Ethics UHasselt (CME UHasselt) on 8th of March 2022.

Procedure

Three consecutive proprioceptive measurements were conducted. Firstly, the role of proprioception during postural control was evaluated by measuring the effect of muscle vibration on the centre of pressure (COP) in upright standing. Secondly, proprioception’s sense of position was measured with a joint repositioning task of the cervical spine. This test went beyond the scope of this master thesis and was therefore not discussed further. Lastly, proprioception’s sense of weight was measured by looking for the JND between two weights.

Proprioceptive use during postural control task

To measure the effect of muscle vibrations on postural control, two test conditions were used: (1) upright standing posture on a stable support surface and (2) an upright standing posture on an unstable support surface, obtained by standing on a foam cushion (Airex Balance Pad Elite, Airex Switzerland). The last test condition was more difficult since proprioceptive signals coming from the ankles are less reliable in this condition (Kent & Keating, 2005) forcing individuals to use more proximal proprioceptive information to maintain upright standing. Two trials were conducted in each test condition, with each trial lasting 60 seconds (sec). During the whole testing period, a student was present next to the participant in case balance was lost. Participants stood barefoot on a force plate (AMTI, USA, 500H) with their arms loosely hanging aside the body. Heels were 10cm apart and the foot position could be chosen by the participant, this to their own comfort. Visibility was restricted in all trials by wearing taped glasses. Participants were instructed to keep their eyes open and their gaze straight ahead. In each trial, participants were instructed to remain in a relaxed upright position (Brumagne et al., 2008). Muscle vibrations (Maxon motors, CH; 15sec, 40HzN, 0.5mm) were applied on the calf muscles (triceps surae muscles) (trial 1) and the lower back (lumbar paraspinal muscles) (trial 2), to measure its effect on displacement on the anterior-posterior COP, using a force plate. Muscle vibrations create an illusion of muscle elongation by stimulating type Ia afferents in the muscle spindles (Cordo et al., 2005; Roll & Vedel, 1982). To maintain balance, a compensatory mechanism of the COP to the opposite side will take place in case proprioceptive information of the vibrated muscle is used to maintain balance (Brumagne, Janssens, Knapen, et al., 2008; Claeys et al., 2011; Claeys et al., 2015; Johanson et al., 2011). The relative proprioceptive reweighting ratio (RPW) is considered the most valid measure (Kiers et al., 2014) to quantify postural response on muscle vibrations:

RPW = ([ankle]/([ankle]+ [low back]).

With [ankle] and [low back] as absolute values of the average COP displacement (Claeys et al., 2011; Ito et al., 2020; 2021). An RPW-score of 1 corresponds to 100% dependence of the ankle muscles, while a score of 0 means 100% dependence on the lumbar paraspinal muscles (Brumagne et al., 2008; Janssens et al., 2010) . RPW was used in this master thesis to identify the amount of ankle or lumbar proprioception plays a dominant role in postural control (Brumagne et al., 2004).

Proprioceptive use during weight discrimination task (WDT)

A new task was developed based on the ROD task, a validated task for interoceptive accuracy measurements (Van Den Houte et al., 2021) and a weight discrimination task of the upper extremity (Chang & Lenzenweger, 2005; Horváth et al., 2021b). Participants were seated comfortably in a chair with the upper arm relaxed against the trunk and their elbow flexed to approximately 90°. Vision was restricted with taped glasses and eyes were closed during the task. Before the task, participants were instructed: (1) to extend their elbow and return to the starting position between each trial and (2) that no movement of the shoulder, elbow and/or wrist was allowed during the trial. One trial consisted of the random presentation of two weights in the dominant hand, each to be held for 6 sec. After each trial, they were asked to indicate which of the presented weights was the heaviest.

As described by Van Den Houte et al. (2021), an adaptive staircase paradigm was used to investigate the participants' ability to detect the JND between two weights in the upper extremity. Through this two-down one-up procedure, a 70.7% correct differentiation point in psychometric function could be reached (Levitt, 1971), meaning that the JND was observable by participants 70% of the time was searched. In a forced choice task with two weights, participants were presented with a weight pair on each trial. This pair consisted of a reference weight (always 400 grams 'g') and a test weight, heavier or lighter than the reference weight. The mass of the test weight was dependent on the answer to the previous trial - if the correct answer was given twice, the difference between the reference weight and the tested weight became smaller. If participants failed to distinguish the weights once, the test weight became less similar to the reference weight. The paradigm included both an upward going staircase (approaching the reference weight with a test weight lighter than the reference weight) and a downwards going staircase (approaching the reference weight with a test weight heavier than the reference weight). The staircases were presented intertwined, accordingly to the ROD task as described by Van Den Houte et al. (2021). Weights consisted of glass bottles filled with sand, identical in shape and size. Test weights ranged between 290 g and 510 g, in increments of five grams. The step size, or the weight by which the test weight increased/decreased, varied throughout the experiment. Larger steps of 15 g were taken at the beginning of the experiment up until a difference of 50 g to the reference weight (400 g), and thus steps of 15 g until the weight of 450 g or 350 g was reached. Smaller steps of five grams were given at the end to find more subtle differences in weight. These steps were integrated in the staircase paradigm. The paradigm showed a reversal when a change in direction happened in one of the staircases, which happened when a series of a constant type of answers (constant correct or incorrect) was followed by a change in type of answer, for example 4 correct answers followed by an incorrect answer. The procedure ended when both staircases had reached six reversals. The average of a staircase was calculated as the difference between six reversal points of the staircase and the reference weight.

Secondary outcome measures

Participants were asked to fill in a questionnaire to identify certain characteristics, such as age, smoking habits, sport participation and history of covid infection(s). Participants answered 'Yes or No' on the question about sport, based on the objective that they performed at least 1 hour of this type of exercise each week. Answers were transferred to an excel file, where the data was linked to the correct participants code. A presentation of this data of the participants can be found in table 1.

Data - analysis

Statistical analysis of the results from the WDT was performed. Data not normally distributed were transformed, using the Box Cox transformation. These data were used to research (1) distribution of task performance, (= the average between the downwards and upwards JND), with a lower JND indicating a better ability to distinguish the test weight from the reference weight and thus better task performance and proprioceptive accuracy; (2) internal consistency, by investigating the relationship between the average downwards JND and the average upwards JND; and (3) discriminant validity, obtained with a Pearson correlation between WDT task performance and performance on the postural control task. Internal consistency was statistically evaluated by using a paired t-test between the staircases, a Pearson correlation and Cronbach's alpha. A paired t-test was used to compare both conditions (stable and unstable support surface) of the RPW. Lastly, we calculated the interference of the characteristics of participants on the results of the WDT, such as: age, sport participation and smoking behaviour. The interference, of both sport participation and smoking behaviour, was analysed by using One way Anova or a paired t-test, while the interference of age was analysed using Pearson correlation. All analyses were executed with JMP Pro 16 (SAS Institute Inc. 2020–2021. *JMP® 16.1 Automation Reference*. Cary, NC: SAS Institute Inc.).

Results

Participants

Thirty-three individuals (18 men) participated in this study (mean age in years = 32, *SD* = 13.25). Due to technical problems in the final stages of WDT data collection, data of three participants were lost. The corresponding data of these participants were excluded from the postural control task. For both of the tasks data were used from *N* = 30 participants. In the postural control task, parts of data from six participants (*N* = 3 in stable conditions and *N* = 3 in unstable conditions) were lost, also due to technical problems. Resulting in *N* = 27 used data for both the stable and the unstable condition.

A summation of all collected participant characteristics can be found in table 1.

Table 1

Participants' Characteristics (N = 30)

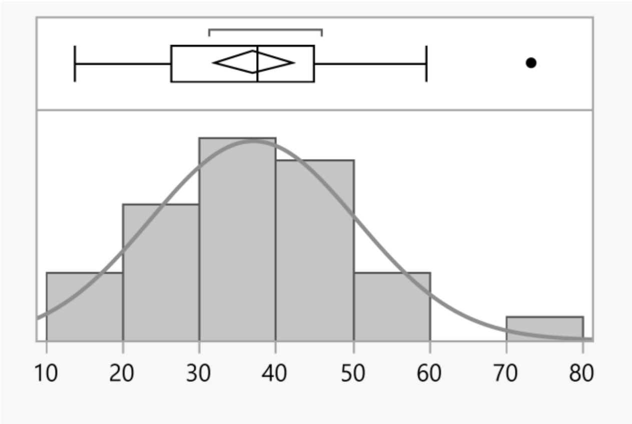
	N	Mean	*SD*
Age (years)		33	13.62
Height (cm)		174.78	8.11
Weight (kg)		74.51	13.84
BMI		24.09	3.93
Sporting / Week (h)		4.29	2.71
Gender (M/F)	17/13		
Sport (Yes/No)	26/4		
Education level (4/3/2)	16/10/4		
Medication use (Yes/No)	2/28		
Smoking (Yes/No)	4/26		
Drinking Alcohol (Yes/No)	27/3		
Alcohol consumptions (D/W/R)	1/16/9		
Covid-19 infection (Yes/No)	14/16		
Dominant Hand (Right/Left)	29/1		

Notes: *N* = Number; *SD* = Standard deviation; BMI = Body Mass Index; h = Hours; Education level 4 = University; Education level 3 = Graduate School; Education level 2 = High School; D = Daily; W = Weekly; R = Rarely

WDT performance

The average JND of the WDT was 37.12 g (*SD* = 13.42), indicating that on average, participants were able to differentiate 37.12 g from the reference weight 70.7% of the time, graphic presentation is showed in figure 1.

Figure 1
Graphic representation of the average JND of the WDT



Note: $N = 30$

Table 2 describes the average trial number and weight in the six different reversals in both upwards and downward staircase. The average number of trials and the average time needed to complete the entire staircase procedure were respectively 64 trials (*SD* = 10.26), and 22.61 min (*SD* = 4.29).

Table 2
Average trial number and weight at each reversal point

	Downwards going staircase				Upwards going staircase			
	Trial number		Weight (g)		Trial number		Weight (g)	
Reversal #	**Mean**	*SD*	**Mean**	*SD*	**Mean**	*SD*	**Mean**	*SD*
1	22.27	8.44	436.50	26.82	21.73	6.84	359.00	23.83
2	27.20	9.25	449.50	25.20	36.40	7.56	346.33	21.65
3	37.40	8.54	430.17	19.93	36.27	9.46	364.83	18.87
4	42.93	9.39	437.67	18.88	42.53	10.48	355.83	18.53
5	52.13	9.74	424.83	13.42	52.53	11.41	369.67	17.22
6	57.67	10.22	427.83	12.37	58.67	12.38	365.33	15.14

Internal consistency of the WDT

The average JND in the downwards going staircase was 65.58 g (*SD* = 17.20), while the average JND in the upwards going staircase was 71.14 g (*SD* = 16.02). Using the paired t-test, the difference between the staircases was not significant ($t_{29} = 5.56$, $p = .165$) and a non-significant correlation between the two staircases of the JND ($r_{29} = .17$, $p = .364$), with an unacceptable Cronbach's alpha of .25 (Statisticshowto, 2022; Statology, 2020) was present.

Discriminant validity of the WDT

The average RPW was 43.53% (*SD* = 22.08) in the stable support surface condition and 56.36% (*SD* = 24.4) in an unstable support surface condition. Differences between both conditions were not significant ($t_{23} = -7.48$, $p = .21$).

There was no significant correlation between the RPW ratios and the average JND (RPW stable r_{26} = -.03, p = .893; RPW unstable r_{26} = .36, p = .062).

Relationship of WDT with participants' characteristics

Performance on the WDT was not significantly related to any of the participants 'characteristics. A more detailed description of the distribution of groups concerning participants' characteristics can be found in table 1. Table 3 gives a summary of the statistical results of the groups concerning age, sport, and smoking.

Table 3

Analysis of participants' characteristics on the average JND of the WDT

Characteristics	F Ratio	Prob > F	*r*	Signif. Prob
Sport	0.38	0.54		
Smoking	3.57	0.07		
Age			0.07	0.73

Discussion

The primary goal of this research paper was to investigate if a new paradigm for a WDT could be an accurate and valid tool to measure proprioceptive accuracy by analysing task performance, internal consistency, and discriminant validity. Results showed a low internal consistency of the new WDT and a high discriminant validity compared to the postural control task. Due to the fact that there are different possible meanings of discriminant validity, multiple definitions are circulating (Ronkko & Cho, 2022). In this study, the discriminant validity was used to analyse a correlation between two constructs and thus following the definition of McKenny et al. (2013, p. 167) “Evidence of discriminant validity exists if other constructs do not correlate strongly enough with the construct of interest to suggest that they measure the same construct.”. Proprioceptive information comes from various receptors located in the locomotor system and the skin (Horváth et al., 2022), which all have a specific function and are sensitive to different stimuli (Proske & Gandevia, 2012). This makes the content of the proprioceptive information specific to each tested region and to the way proprioceptive systems are challenged during testing (Elangovan et al., 2014; Goble, 2010; Han et al., 2016). The WDT investigates proprioceptive sense of weight, and the postural control test investigates the proprioceptive processing following muscle vibration. The constructs of the two used proprioceptive tests are therefore different, they use different ways of proprioceptive measurement and test different senses of proprioception. It could thus be expected that the discriminant validity between the two would be high and these results were in line with previously published literature, where there were also no associations found between two proprioceptive modalities (Horváth et al., 2021a). This highlights again the importance for future research to carefully choose the appropriate proprioceptive measurement tool, based on the theoretical considerations related to the research population and the aspect of proprioception one is interested in (Horváth et al., 2022). It is possible that the new paradigm for the WDT is not yet optimal. Despite the non-significant results, the new paradigm presents a starting point for future research.

The second goal of this study was to investigate a possible influence of some characteristics of the participants, such as age, sport participation or smoking behaviour. These participant characteristics showed non-significant associations with the WDT. The lack of a significant association with age indicates that a higher age did not affect sense of weight in this study population. This differs from conclusions that were previously taken in studies exploring the more commonly investigated sense of joint position and movement. Evidence and consensus are present that aging has deleterious effects on joint proprioceptive accuracy (Goble, 2010; Ribeiro & Oliveira, 2007). Yet, studies investigating correlations between age and sense of weight, contradict one another on the possible influence (Landahl & Birren, 1959; Watson et al., 1979). Other evidence in literature suggests that proprioceptive ability was associated with the achieved level of competition of elite athletes (Han et al., 2015; Schwesig et al., 2009) and a lower performance on proprioceptive accuracy tests predicts a higher chance of injury (Karkousha, 2016) in that population. While other literature, combining age and sport expertise, found contradictions surrounding sport habits, where children benefited from a broader experience, but an older population did not (Busquets et al., 2018). This study also found no association between smoking behaviour and performance on this WDT, and therefore does not follow previous research where evidence was found that smokers enter older adulthood with a decreased physiological reserve, which impacts their balance (Strand et al., 2011) and proprioception. It is suggested that smoking has a negative effect on proprioception, with the effects of nicotine as the underlying mechanism (Iki et al., 1994; Pereira et al., 2001; Schmidt et al., 2014). The lack of significant evidence on the influence from these three characteristics on WDT performance may be due to several reasons. First of all, participant population, this population was generally young (mean age in years = 33, *SD* = 13.62) with a high report of sport participation. Eighty-five percent of the study population reported to exercise at least one hour each week, leading to a possible healthy user bias and non-participation bias. In addition was the type of sport not taken into the statistical analysis, while different types of sport have different effects on the postural control (Schwesig et al., 2009), meaning that some participants could possibly perform better on the researched and used proprioceptive tasks. There were also only four participants that reported to smoke (non-smokers: *N* = 26), which could influence the results of this research question, and again lead to a healthy user bias. The influence of smoking in this study does not correspond with the previous research. Although this could again be related to the fact that in previous research the influence of smoking was reported mainly on balance and proprioception in a balance context.

The reason for this thesis and the development of a new proprioceptive measurement tool is the lack of consensus regarding testing of proprioceptive accuracy. The difficulty in finding consensus can stem from the fact that proprioceptive accuracy is the ability of an individual to perceive all proprioceptive information (Han et al., 2016; Horváth et al., 2022). In this validation study, a new paradigm for one of the lesser investigated proprioceptive sense, sense of weight, was developed. This paradigm investigates more specifically the sense of weight by using the elbow flexor muscles. It was based on the ROD task, used to research interoceptive accuracy (Van Den Houte et al., 2021), which was found valid for interoceptive accuracy. In the process of developing this new paradigm for proprioception, it became apparent that existing literature used paradigms based on previously published methods and not on standardised and/or validated paradigms. They were often modified to meet the specific needs of these studies, which did not contribute to the standardisation of the test modality (Chang & Lenzenweger, 2005; Horváth et al., 2021a; Pavony & Lenzenweger, 2013; Watson et al., 1979). As this particular WDT was based on the validated ROD, it is possible for future research to investigate both of them together.

If the WDT paradigm could be optimised and later validated, this paradigm could be translated to the other senses of proprioception. As a result, the JND could possibly become a new uniform way of proprioceptive measurement and lead the way in developing consensus over the different senses of proprioception. It could not only generate consensus, but also provide the possibility to research associations between the different senses of proprioception. The new paradigm could, if validated, not only be used in healthy populations, but also in specific groups such as people with MUPS and in other acute and/or chronical impairments of the locomotor system.

As mentioned before, this validation study is a small part of a bigger research project. This big research project has the objective to investigate both interoception and proprioception in a MUPS population, the second goal of this research project is to find a possible link between interoception and proprioception. This is another implication of the new paradigm and could be researched by the fact that the WDT was based on the ROD task.

This validation study had besides the previous mentioned limitations, a few other limitations. Such as a small sample size (N = 33) and missing data in the data analysis. A strength of this study is the minimalization of the detection bias, as the student performing the statistical analysis was not present during the data collection and thus maximizing researcher blinding. Limitations specific to the new WDT paradigm were gathered through the observations done by the research partners and the opinions of the participants. The main observation was the long duration of the task, this led to 1) fatigue in the upper arm, 2) boredom, 3) difficulty to remain concentrated on the purpose of the task and 4) the mental component of remembering the previous weight to reference to. Furthermore, the construct of the WDT was different compared to that of the postural control task in this study. Properties of the WDT need to be re-evaluated and perhaps matched with the test to which it is compared. This in order to eliminate factors that could be responsible for the difference in performance between the tests. In this study, the difference of open eyes and closed eyes in the taped glasses could be regarded as such a factor. For example, the difference of open eyes in the taped goggles during the postural control task and closed eyes during the WDT.

The main limitations should be taken into account for future research, such as a bigger sample size to be able to validate the new paradigm, the psychometric properties and the observations of the participants.

In conclusion, there is to be said that the paradigm is not ready yet and further development is needed. However, it provides opportunities for further research.

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Appendices

Appendix 1: Questionnaire Characteristics

Proefpersoonnummer:

Algemene informatie

Geboortejaar: ....

Lengte: ....

Gewicht: ....

Doet u aan sport? (*omcirkel het juiste antwoord*): Neen / Ja

Zo ja, hoeveel uren per week : ....

Welke sport? ....

Studeert u nog? (*omcirkel het juiste antwoord*): Neen / Ja

Hoogste opleidingsniveau (*kleur het juiste bolletje in*): 0 Lager Onderwijs
0 Middelbaar Onderwijs
0 Hoger Onderwijs - Korte type
0 Hoger Onderwijs - Lange type
0 Universitair Onderwijs
0 Andere …………………

Neemt u medicatie? (*omcirkel het juiste antwoord*): Neen / Ja

Zo ja, welke? ....

Lijdt u aan een bepaalde aandoening (bijv. een longaandoening, een neurologische ziekte, hart-en vaatziekten, hyperventilatie, depressie, paniekstoornis, psychose, astma, ...)? (*omcirkel het juiste antwoord*): Neen / Ja

Zo ja, welke?: ....

Rookt u?
(*omcirkel het juiste antwoord*): Neen / Ja

Indien Ja, is dat dan: Dagelijks/ Wekelijks/ Zelden (*omcirkel het juiste antwoord*)

Drinkt u alcohol?
(*omcirkel het juiste antwoord*): Neen / Ja

Indien Ja, is dat dan: Dagelijks/ Wekelijks/ Zelden (*omcirkel het juiste antwoord*)

Heeft u een infectie met het coronavirus SARS-CoV-2 doorgemaakt?
(*omcirkel het juiste antwoord*): Neen / Ja

Indien ja op bovenstaande vraag, heeft u de infectie opgelopen vóór of nadat u gevaccineerd werd?
Specificeer (*kleur het juiste bolletje in*):
0 Ik liep COVID op vóór mijn vaccinatie
0 Ik liep COVID op nadat ik 1x gevaccineerd was
0 Ik liep COVID op nadat ik volledig (2x) gevaccineerd was
0 Ik ben niet gevaccineerd

Indien ja op vorige vraag, heeft u het gevoel dat u volledig hersteld bent van de COVID-19 infectie die u heeft doorgemaakt?
Specificeer (*kleur het juiste bolletje in*):
0 Ja, ik voel me volledig hersteld en heb geen klachten meer
0 Nee, ik voel me nog niet helemaal hersteld
0 Ik heb nooit klachten gehad

Sinds wanneer heeft u last van de klachten waarvoor u in behandeling bent bij Tumi Therapeutics?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

Appendix 2: Informed Consent

Msc. Indra Ramakers
Dr. Maaike Van Den Houte
Dr. Stef Feijen
Prof. dr. Lotte Janssens
Prof. dr. Pieter Meyns
Prof. dr. Katleen Bogaerts

Onderzoek naar proprioceptie in een gezonde populatie

DEELNEMERSINFORMATIE

Vooraleer u toestemt om aan deze studie deel te nemen, is het belangrijk dat u dit formulier leest. In dit informatie- en toestemmingsformulier worden het doel, de procedure, de voordelen, risico's en ongemakken gepaard gaande met de studie beschreven. Ook de voor u beschikbare alternatieven en het recht om op elk ogenblik de studie te verlaten, zijn hieronder beschreven. U hebt het recht om op elk ogenblik vragen te stellen over de mogelijke en/of bekende risico's die deze studie inhoudt.

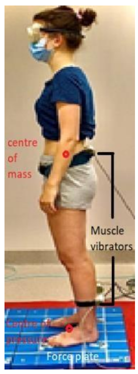
Doel en beschrijving van de studie
Het doel van deze studie is om proprioceptieve processen (proprioceptie verwijst naar het gevoel van lichaamshouding en beweging, proprioceptie heeft u bijvoorbeeld nodig voor balans) in gezonde personen te onderzoeken. Indien u toestemt om deel te nemen aan de studie, zal u gevraagd worden om deel te nemen aan 1 testsessies.

De testsessie zal plaatsvinden in het labo van de faculteit revalidatiewetenschappen van de universiteit Hasselt, te gebouw A in Diepenbeek, duurt circa 1,5 uur en bestaat uit:

a) Een taak waarbij spiervibrators worden bevestigd aan de enkels/ onderrug. U zal worden gevraagd om tijdens de vibratie rechtop te staan.

b) Een taak waarbij de nek in een hoek gedraaid zal worden door de onderzoeker waarna u actief terug naar de beginpositie mag draaien. Dit zal meermaals herhaald worden.

c) Een discriminatie taak die meet hoe goed mensen zijn in het waarnemen van verschillende gewichten. In de taak zal gebruik gemaakt worden van 2 gewichten, u zal deze in uw handen mogen vasthouden. Er zal u nadien gevraagd worden te beoordelen welke van deze 2 gewichten het zwaarste was. Dit zal meermaals herhaald worden.



Opdrachtgever van de studie
De opdrachtgever van de studie is de Onderzoeksgroep voor gezondheids- en revalidatiepsychologie van de UHasselt.

Vrijwillige deelname
U neemt geheel vrijwillig deel aan deze studie en u hebt het recht te weigeren eraan deel te nemen. Uw beslissing om al dan niet aan deze studie deel te nemen of om uw deelname aan de studie stop te zetten, zal geen enkele invloed hebben op uw verdere behandeling.

Indien u aanvaardt om deel te nemen, zal u deze informatiefolder krijgen om te bewaren en zal er u gevraagd worden het aangehechte toestemmingsformulier te ondertekenen.

U hebt het recht om uw deelname aan de studie op elk ogenblik stop te zetten, zelfs nadat u toestemming tot deelname hebt gegeven. U hoeft geen reden te geven voor het intrekken van uw toestemming tot deelname. Het intrekken van uw toestemming zal geen enkel nadeel of verlies van voordelen met zich meebrengen. Uw beslissing zal geen weerslag hebben op uw medische behandeling.

Risico's en ongemakken
Gezien er tijdens de testsessie gebruikt wordt gemaakt van spiervibraties, bestaat de kans dat de participant hierdoor het evenwicht kan verliezen. Hierdoor zal er steeds een onderzoeker naast de deelnemer staan om een eventuele val ten allen tijden te vermijden. Aan de overige taken zijn zeer weinig tot geen fysieke risico's of ongemakken verbonden.

Een mogelijks risico van deze studie is gegevensverlies van de data die we verzamelen.

In- en exclusiecriteria
U mag, om veiligheids- en methodologische redenen niet deelnemen aan de studie als u aan een van de volgende criteria voldoet:

Exclusiecriteria:
- Zwangerschap
- Jonger dan 18 jaar of ouders dan 65 jaar.
- Geen COVID-19 pas
- Een zelf gerapporteerde psychische aandoening zoals een depressie, burn-out, angststoornis, eetstoornis, middelenmisbruik, psychotische aandoening of persoonlijkheidsstoornis.
- Aanwezigheid van een chronische organische aandoening (Men spreekt van een chronische organische aandoening als deze een periode van minimaal 3 maanden aanwezig is. Voorbeelden zijn: Epilepsie, Hartaandoening, Reuma, Astma, diabetes, etc.) of persisterende lichamelijke klachten (bv. hyperventilatieklachten, langdurige COVID, chronische pijn of vermoeidheid, chronische tinnitus,…)
- Het nemen van antidepressiva, slaap medicatie (benzodiazepines) en angst remmende middelen (anxiolytica)
- Nekklachten op het moment van testing
- Recent whiplash trauma minder dan 3 maanden geleden of langer dan 3 maanden geleden met nog steeds aanwezige klachten
- Diagnose van vestibulaire of neurologische aandoeningen
- Recente orthopedische problematiek van de onderste ledematen (bv. acuut enkeltrauma) dat het evenwicht kan beïnvloeden, of van de bovenste ledematen (bv. fractuur of overbelasting letsel) dat de arm- of handkracht kan beïnvloeden

Voordelen
U zal geen persoonlijk rechtstreeks voordeel halen uit uw deelname aan deze studie. Uw deelname voorziet ons echter van kennis over proprioceptie en zal de domeinen van revalidatiewetenschappen en gezondheidspsychologie verder helpen.

COVID-19
Tijdens het eerste deel van het experiment is er fysiek contact nodig tussen proefpersoon en onderzoeker. Mondmaskers zijn gedurende het volledige experiment verplicht voor beiden. Alle materialen worden na gebruik gedesinfecteerd.

Verzekering
Conform de Belgische wet van 7 mei 2004 inzake experimenten op de menselijke persoon, is de opdrachtgever zelfs foutloos, aansprakelijk voor alle schade die de deelnemer en/of zijn rechthebbenden oplopen en die rechtstreeks dan wel onrechtstreeks verband houdt met de studie. De opdrachtgever van deze studie (UHasselt) heeft een verzekering afgesloten die deze aansprakelijkheid dekt. Indien U schade zou oplopen ten gevolge van uw deelname aan deze studie zal die schade bijgevolg worden vergoed conform de Belgische wet van 7 mei 2004.

Bescherming van de persoonlijke levenssfeer
Uitsluitend de onderzoekers verbonden aan dit onderzoek hebben toegang tot alle gegevens die verzameld worden. Ze zijn verplicht tot geheimhouding en stellen zich ook persoonlijk garant dat deze gegevens als zeer vertrouwelijk zullen behandeld worden. Een unieke numerieke code (die op geen enkele manier kan verwijzen naar uw identiteit) wordt aan u toegewezen en zal in plaats van uw naam aan alle informatie en gegevens van uw bijdrage aan deze studie gekoppeld worden, opdat uw identiteit geheim zal blijven. De resultaten zullen anoniem geanalyseerd worden met behulp van de codes die aan iedere deelnemer worden toegewezen en zullen voor de deelnemersgroep als geheel mogelijk gepresenteerd worden op wetenschappelijke vergaderingen of gepubliceerd worden in wetenschappelijke tijdschriften. Persoonlijke informatie over u zal niet gebruikt worden noch doorgegeven op enige manier. De informatie over u zal elektronisch (d.w.z. in de computer) of handmatig verwerkt en geanalyseerd worden om de resultaten van deze studie te bepalen. U hebt het recht aan de onderzoeker te vragen welke gegevens er over u worden verzameld in het kader van de studie en wat de bedoeling ervan is. U hebt ook het recht om aan de onderzoeker te vragen u inzage in uw persoonlijke informatie te verlenen en er eventueel de nodige verbeteringen in te laten aanbrengen. Hierbij worden het medisch beroepsgeheim, de internationale richtlijnen (ICH-GCP) en de Belgische wetgeving nageleefd (o.m. de wettelijke vereisten zoals bepaald in de Belgische Wet van 22 augustus 2002 inzake rechten van de patiënt). Bovendien zijn uw persoonlijke gegevens beschermd door de EU Verordening 2016/679 (Algemene Verordering Gegevensbescherming) of GDPR (General Data Protection Regulation) en de Belgische Wetgeving betreffende de bescherming van natuurlijke personen met betrekking tot de verwerking van persoonsgegevens.

Als u toestemt in deelname aan dit onderzoek, betekent dit dat u ook toestemming geeft voor het gebruik van uw gecodeerde medische gegevens voor de hierboven beschreven doelen en het overmaken ervan aan bovenvermelde personen en/of instanties.

Commissie voor ethiek
Deze klinische studie is beoordeeld door het leidinggevend Comité Medische Ethiek Ziekenhuis Oost-Limburg en de Universiteit Hasselt, die een definitief gunstig advies gaven voor deze studie op XX/XX/XXXX.

Contactpersonen in geval van vragen in verband met de studie
Als u vragen of opmerkingen heeft over de studie, kan u contact opnemen met:

Indra Ramakers (Psychologe, UHasselt, Lokaal onderzoeker), indra.ramakers@uhasselt.be
Prof. dr. Katleen Bogaerts (klinisch psychologe, UHasselt, hoofdonderzoeker), 011/29.21.27, katleen.bogaerts@uhasselt.be
Comité voor Medische Ethiek UHasselt (CME@uhasselt.be)

TOESTEMMINGSFORMULIER

Onderzoek naar associaties tussen interoceptie en proprioceptie in een gezonde populatie.

Deel enkel bestemd voor de proefpersoon:

Hierbij bevestig ik, ondergetekende (naam & voornaam) ________________________________
dat ik over de studie ben ingelicht en een kopie van de "Informatie voor proefpersonen" en het "Toestemmingsformulier" ontvangen heb. Ik heb de informatie gelezen en begrepen. De onderzoeker heeft mij voldoende informatie gegeven met betrekking tot de voorwaarden en de duur van de studie, én de mogelijke risico's en ongemakken die gepaard gaan met mijn deelname. Bovendien werd mij voldoende tijd gegeven om de informatie te overwegen en om vragen te stellen, waarop ik bevredigende antwoorden gekregen heb.

- Ik heb begrepen dat ik mijn deelname aan deze studie op elk ogenblik mag stopzetten, zonder dat dit mij enig nadeel kan berokkenen.
- Ik ga akkoord met de verzameling, de verwerking en het gebruik van gegevens die tijdens het onderzoek werden verzameld, zoals beschreven in het informatieblad voor de proefpersoon.
- Ik ga akkoord met het gebruik door de opdrachtgever van deze gecodeerde gegevens voor wetenschappelijke doeleinden: de algemene resultaten voor de groep als geheel worden mogelijk gepresenteerd op wetenschappelijke vergaderingen of gepubliceerd in wetenschappelijke tijdschriften. De gegevens zullen niet gebruikt worden voor doelstellingen anders dan deze omschreven in het informatieblad voor de patiënt.
- Ik stem geheel vrijwillig toe om deel te nemen aan deze studie en om mee te werken aan alle gevraagde onderzoeken. Ik ben bereid informatie te verstrekken i.v.m. mijn medische geschiedenis, mijn geneesmiddelengebruik en eventuele deelname aan andere studies.

Datum: _____________________

Handtekening proefpersoon: ____

☐ Ik wil op de hoogte gehouden worden van de resultaten van dit onderzoek

☐ Ik heb interesse om deel te nemen aan andere onderzoeken van deze onderzoeksgroep, en mag hiervoor gecontacteerd worden.

Indien u een van bovenstaande vakjes heeft aangeduid, gelieve dan hier uw e-mailadres in te vullen:

e- mailadres : ____

Deel enkel bestemd voor het onderzoeksteam

Ik, ondergetekende, ____, bevestig hierbij dat ik,

____(naam van de proefpersoon voluit) heb

ingelicht en dat hij (zij) zijn (haar) toestemming heeft gegeven om deel te nemen aan de studie.

Datum: ___________________

Handtekening: _______________________________

Appendix 3: Declaration of honour – Michelle Vaes

Verklaring op Eer

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

1. Ik ben ingeschreven als student aan de UHasselt in de opleiding [kinesitherapie revalidatiewetenschappen, afstudeerrichting MSK], waarbij ik de kans krijg om in het kader van mijn opleiding OF ~~extracurriculair~~] mee te werken aan onderzoek van de faculteit [Revalidatiewetenschappen] aan de UHasselt. Dit onderzoek wordt beleid door [Prof. dr. Bogaerts] en kadert binnen [het opleidingsonderdeel [wetenschappelijke stage deel 2] OF ~~mijn aanstelling in het statuut student-onderzoeker~~]. Ik zal in het kader van dit onderzoek creaties, schetsen, ontwerpen, prototypes en/of onderzoeksresultaten tot stand brengen in het domein van [gezondheids- en revalidatiepsychologie (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;

[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 UHasseltbegeleide, Prof. dr. Bogaerts

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: Michelle Vaes

Adres: Heide 125, 3800 St-Truiden

Geboortedatum en –plaats : 25 maart 1998, Hasselt

Datum: 2/06/2022

Handtekening:

Appendix 4: Declaration of honour – Karen Van Aken

Verklaring op Eer

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

1. Ik ben ingeschreven als student aan de UHasselt in de opleiding [kinesitherapie revalidatiewetenschappen, afstudeerrichting MSK], waarbij ik de kans krijg om in het kader van mijn opleiding OF ~~extracurriculair~~] mee te werken aan onderzoek van de faculteit [Revalidatiewetenschappen] aan de UHasselt. Dit onderzoek wordt beleid door [Prof. dr. Bogaerts] en kadert binnen [het opleidingsonderdeel [wetenschappelijke stage deel 2] OF ~~mijn aanstelling in het statuut student-onderzoeker~~]. Ik zal in het kader van dit onderzoek creaties, schetsen, ontwerpen, prototypes en/of onderzoeksresultaten tot stand brengen in het domein van [gezondheids- en revalidatiepsychologie (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;

[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.

1. 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. Bogaerts.

2. 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: Karen Van Aken

Adres: Holrakkerstraat 209, 3510 Hasselt

Geboortedatum en –plaats : 14/07/1998, te Hasselt

Datum: 3/06/2022

Handtekening Karen Van Aken

Appendix 5: Inventory sheet

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
23 augustus 2021	Overleg met promotor en copromotoren over het verloop van het tweede deel van de masterthesis	Promotor: Copromotor/Begeleider: Student(e): Student(e):
12 oktober 2021	Overleg brainstorm toepassing ROD paradigma op proprioceptie.	Promotor: Copromotor/Begeleider: Student(e): Student(e):
27 oktober 2021	Overleg opstelling proprioceptie taak.	Promotor: Copromotor/Begeleider: Student(e): Student(e):
23 november 2021	Uitleg Taak posturale controle	Promotor: Copromotor/Begeleider: Student(e): Student(e):
30 november 2021	Uitleg Taak nekproprioceptie	Promotor: Copromotor/Begeleider: Student(e): Student(e):
2 en 7 december 2021	Pilot testing: Weight discrimination taak	Promotor: Copromotor/Begeleider: Student(e): Student(e):
23 december 2021	Eerste versie (Inleiding) laten nalezen door dra. Indra Ramaekers	Promotor: Copromotor/Begeleider: Student(e): Student(e):
9 maart 2022	Start testing	Promotor: Copromotor/Begeleider: Student(e): Student(e):
12 april 2022	Tweede versie (Inleiding, methode en protocol) laten nalezen door dra. Indra Ramaekers	Promotor: Copromotor/Begeleider: Student(e): Student(e):
15 mei 2022	Nalezen van gehele thesis door dra. Indra Ramekers	Promotor: Copromotor/Begeleider: Student(e): Student(e):
22 mei 2022	Finale versie bezorgd aan promotor en copromotoren ter goedkeuring verdediging.	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): Vaes Michelle, Van Aken Karen **Datum: 22 mei 2022**

Titel Masterproef: The weight discrimination task: a test paradigm for proprioceptive sense of weight.

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	X
Methodologische uitwerking	X	O	O	O	O	O
Data acquisitie	O	O	O	O	O	X
Data management	O	O	O	O	O	X
Dataverwerking/Statistiek	O	O	O	O	X	O
Rapportage	O	O	O	O	O	X

2) Niet-bindend advies: Student(e) krijgt toelating/~~geen toelating~~ (schrappen wat niet past) om bovenverm~~elde 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 w~~etenschappelijke sta~~ge/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)

Karen Van Aken

Datum en handtekening promotor(en)

23/05/2022

Datum en handtekening Co-promotor(en)

Appendix 6: Statistical route