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Faculteit Revalidatiewetenschappen

master in de revalidatiewetenschappen en de kinesitherapie

Masterthesis

What's the link between chronic non-specific low back pain and motor imagery performance

Joren Demulder
Maxim Van Rompuy

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

PROMOTOR :
dr. Liesbet DE BAETS

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2020
2021

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Acknowledgment

The master thesis was made possible by the University of Hasselt, department of rehabilitation sciences and physiotherapy. Special thanks to the promotor Dr. Liesbet De Baets and the co-promotor Dr. Thomas Matheve of this study for guiding us through the process and providing us with helpful feedback throughout. Furthermore, we would like to thank Stefanie Vanbrabant and the entire physical therapy staff of the Virga-Jesse hospital for assisting us in the recruitment of participants in both their campuses. Lastly, we would like to thank all participants of the study for their cooperation.

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Research context

This study provides important insights into the influence of CNSLBP and other psychological/clinical factors on motor imagery performance. This master thesis is a study of the department of rehabilitation sciences and physiotherapy and can be categorized into the musculoskeletal domain. The aim of this study is to gather more knowledge about the effects of CNSLBP and its psychological and clinical factors on motor imagery performance.

CNSLBP is a problem affecting all age groups, yet little is known about the effect of CNSLBP on the working body schema and more specifically on the motor imagery performance. Current studies present conflicting results as to why CNSLBP could influence motor imagery performance (Linder et al., 2016). Motor imagery performance is most commonly measured with timed implicit motor imagery tests such as the left right judgement task.

This study was conducted by two 2nd master's students of Uhasselt department RWS and was performed under the supervision of the promotor (Dr. Liesbet De Baets) and the co-promotor (Dr. Thomas Matheve).

The two students, Joren Demulder and Maxim Van Rompuy, recruited participants and wrote the thesis in a time span of one year, from February 2020 until May 2021. The students managed to recruit 50 participants in the CNSLBP group, which were recruited in the hospital Virga Jesse (Campus Stadsomvaart and St.Ursula) and via acquaintances of the students.

The protocol, questionnaires and iPad used for the testing were handed over to the students at the beginning of this period. The protocol was used to ensure uniform testing across the different years. Other data in this study was gathered in previous years of the ongoing study, seeing as this study is part of a larger research project.

Data of 158 healthy participants and 100 CNSLBP participants were given to the students to perform statistical analysis. Statistical analysis was performed by both students with the guidance of the promotor and co-promotor. The writing process was performed by the students with regular feedback from the promotor and co-promotor.

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Title:

What’s the link between chronic non-specific low back pain and motor imagery performance?

ABSTRACT

Background: Chronic non-specific low back pain (CNSLBP) is a very prevalent condition affecting all age groups. Studies have found functional brain changes associated with chronic pain like disruptions in the working body schema and impaired motor imagery performance which can be tested with the left/right judgement task.

Objectives: The main objective of this study is to determine the effect of chronic non-specific low back pain on the motor imagery performance of participants. More specifically on the left/right judgement task, with reaction speed and accuracy as outcomes.

Participants: A total of 308 participants were recruited: 150 reported CNSLBP and 158 healthy controls. Participants were recruited in hospitals and via acquaintances of the researchers.

Measurements: Reaction speed and accuracy were measured in both groups in a ‘vanilla’ and ‘context’ condition. Sociodemographic information, hours of sports, Tampa Scale for Kinesiophobia, Pain Catastrophizing Scale, Numeric Pain Rating Scale Now, Numeric Pain Rating Scale seven day average were questioned prior to testing.

Results: The CNSLBP group scored significantly worse on both reaction speed and accuracy in both the vanilla and context condition (vanilla condition reaction speed ($p<0.0001$), accuracy ($p=0.001$); context condition reaction speed ($p<0.008$), accuracy ($p=0.002$)). Furthermore, in CNSLBP no specific psychological or clinical factors were significantly related to the outcomes of the LRJT except for age which was significant in the vanilla reaction speed model ($p=0.01$) as well as in the context accuracy model ($p=0.02$).

Conclusion: Results showed a significantly slower reaction speed and lower accuracy in participants with chronic non-specific low back pain compared to healthy individuals. No significant association was found when considering clinical and psychological factors except for age.

Keywords: Motor imagery performance, chronic non-specific low back pain, left-right judgement task, age, exercise, TSK, PCS, NRPS.

1. Introduction

Chronic non-specific low back pain (CNSLBP) affects all age groups on a personal level, with a prevalence of CNSLBP ranging from 4.2% in individuals aged 24-39 to 19.6% aged 20-59 (Meucci et al., 2015). CNSLBP is one of the most prominent contributors to disease burden globally and is characterized by considerable socioeconomic burden as it is responsible for high amounts of sick leave and disease costs, hinders daily activities and negatively affects moods and relations (Liao et al., 2009).

Around 90% of the low back pain (LBP) population is classified as non-specific LBP. This diagnosis is based on the exclusion of other pathologies, which means there is no known cause for the LBP. LBP can be acute, subacute or chronic (persisting longer than three months) (Koes et al., 2006). Previous studies found that conditions such as CNSLBP could cause functional brain changes, which could cause alterations in the working body schema and associated mechanisms. This includes a distorted body image or perceived size, shape, and orientation of the body's painful parts and tracking the movements and positions of these parts in space (Bray & Moseley, 2011). An example of a chronic pain condition causing these alterations would be the deficits of bodily self-awareness and proprioception found in persons with chronic LBP (Holmes & Spence, 2004; Schwoebel et al., 2001).

Because there is a lack of a clear pathoanatomical cause in CNSLBP, current treatments focus on reducing pain and its consequences (Maher et al., 2017). The amount of different therapies used to treat CNSLBP indicate that multiple factors affect LBP such as; age, sex, handedness, participation in sports or not, acute or chronic pain and pain severity. Therefore it is important to look into these factors and their possible effects on motor imagery performance. (Gardner et al., 2012; Liao et al., 2009; Pelletier et al., 2018; Stevans et al., 2021; Uritani et al., 2018; Wallwork, Butler, Fulton, et al., 2013). Research about the effects of age concluded that an increase in age results in an increase in reaction speed and a decrease in accuracy (Breckenridge et al., 2017; Breckenridge et al., 2020; Linder et al., 2016; Wallwork, Butler, Fulton, et al., 2013). Conflicting results were found regarding the influence of gender (Breckenridge et al., 2017; Gardner et al., 2012; Wallwork, Butler, Fulton, et al., 2013). Preceding studies that compared handedness concluded that left or right-handedness had no influence (Botnmark et al., 2016; Breckenridge et al., 2017; Takeda et al., 2010; Wallwork, Butler, Fulton, et al., 2013). Little is known about the influence of exercising hours each week (Dey et al., 2012; Wallwork et al., 2015). Preceding studies regarding pain were tested in varying populations with a multitude of pathologies which makes it difficult to generalize these results to the LBP population (Bowering et al., 2014; Bray & Moseley, 2011; Heerkens et al., 2018; Linder et al., 2016; Pedler et al., 2013; Pelletier et al., 2018; Schmid & Coppieters, 2012; Stanton et al., 2013; Stanton et al., 2012; Uritani et al., 2018).

In clinical practice, a pragmatic way to investigate the integrity of the working body schema is via timed implicit motor imagery tests, for example, the left/right judgement task (LRJT) (Bray & Moseley, 2011). The LRJT involves viewing images of a body part and determining whether they belong to or are rotated or flexed to the left or right side of the body and involves implicit motor imagery as subjects mentally imagine their body part in the orientation of the presented image, with absence of physical movement (Breckenridge et al., 2019; Parsons, 1987). Examples of the LRJT include determining whether images of hands, feet, shoulders belong to the left or right of the body or whether the presented image of a person's neck or back is rotated towards the left or right (Breckenridge et al., 2019). The LRJT will be used in this study to assess the motor imagery performance of participants.

In healthy people reaction speed is proportional to the time taken to physically move their body to match the presented image, and are slower for images depicting awkward positions, reflecting biomechanical constraints consistent with the use of implicit motor imagery. Slow reaction speed is thought to reflect delayed neural processing or decreased cortical weighting of a given body part or spatial zone (Breckenridge et al., 2019). Poor accuracy is thought to indicate disrupted cortical proprioceptive representation of the body part.

Seeing as previous literature was mainly centred on physical factors of the LBP population and their influence on the outcomes of the LRJT, little is known about the psychological side such as kinesiophobia and pain catastrophizing and how this might affect motor imagery performance. These components could relate or lead to changes in trunk motor control but further research into these factors is needed (Boersma & Linton, 2006; Karayannis et al., 2013; Watson et al., 1997). Therefore the primary objective of this study is to determine the effect of CNSLBP on the motor imagery performance of participants. Therefore persons with CNSLBP will be compared to persons without low back pain. The secondary objective of this study is to assess the influence of psychological and clinical factors mentioned above on the outcomes of the LRJT in the CNSLBP group.

2. Methods

2.1 Design overview

In this cross-sectional study, testing and questionnaires were administered on the same day for each individual participant. All persons that enrolled in the study were asked to read and sign an informed consent if they agreed to participate in the study. This study has been approved by the Medical Ethics Committee UHasselt and Jessa Hospital.

2.2 Participants and settings

2.2.1 Participants

All participants from both the CNSLBP and healthy group were adults aged between 18-65 years old who were able to understand spoken and written Dutch.

Inclusion criteria of the CNSLBP group consisted of persons suffering from chronic non-specific LBP (i.e., LBP > three months, ≥ three times per week). The control group consisted of persons that had not experienced LBP in the past year. Exclusion criteria for both groups were as follows: back surgery in the past, back infiltrations containing corticosteroids in the past six months, having performed sensorimotor training of any kind in the past year (passive physiotherapy and general exercises were allowed), having previously performed a left-right judgement task or if they had any major underlying illness such as multiple sclerosis, cerebrovascular accident. Participants in the CNSLBP group were also excluded if they had specific LBP (e.g., vertebral fracture, radicular involvement).

2.2.2 Settings

The testing was largely performed at the department of Physical Medicine and Rehabilitation of the Jessa Hospital, Belgium. In addition to this, participants were also recruited via acquaintances of the researchers.

The recruitment and testing were performed by two different researchers. Study recruitment took place from November 2019 to March 2021.

2.3 Procedure

2.3.1 Participant instructions

On the day of testing, the participant was informed that they had to complete various questionnaires (only sociodemographic data for the healthy persons), after which they would be asked to perform a short test on the iPad. The participants were informed that the entire protocol should take about 30-45 minutes in total.
After signing the informed consent, participants filled in the different questionnaires followed by the LRJT. The testing was performed with the subject in a secluded room, with as few distractions of noise, music or other people as possible. Phones were put on silent mode and the examiner stood a few meters behind the participant without talking to avoid any distraction and to ensure proper execution of the test.

2.3.2 Sociodemographic data and questionnaires

Sociodemographic information: consisted of age, sex, weight, and height. Participants in the CNSLBP group were asked when they had their first episode of back pain and when their current episode of back pain started in case of intermittent pain.

2.3.2.1 Numeric pain rating scale

The Numeric pain rating scale (NPRS) (Downie et al., 1978; Jensen et al., 1994; Katz & Melzack, 1999; Price et al., 1994) designed to measure pain intensity, consists of an 11-point scale, ranging from zero to ten, with zero meaning no pain and ten the worst pain imaginable. The participant then circles the number that best represents the intensity of their pain. This was questioned in function of a mean numeric pain rating score of the past seven days (NPRS7D) and a second time about the numeric pain rating score of their current pain intensity (NPRSNow). Responsiveness of the NPRS in LBP has been assessed as well as reliability and validity in chronic pain patients (Childs et al., 2005; Jensen & McFarland, 1993).

2.3.2.2 The Tampa scale for kinesiophobia

The Tampa scale for kinesiophobia (TSK) was used to assess participants' fear of movement (Goubert et al., 2000). The TSK consists of 17 statements of which participants had to indicate to what extent they agree with the statement (one= strongly disagree, two= somewhat disagree, three= somewhat agree, four strongly agree.). Examples of these statements include: I am scared to injure myself whilst doing exercises, my pain would probably be less if I would exercise more. These add up to a score between 17-68 with a lower score indicating fear of movement and higher scores indicating more pain-related fear. The reliability, validity and responsiveness of the TSK have been established (Chapman et al., 2011; Lundberg et al., 2011).

2.3.2.3 The Pain Catastrophizing Scale

The Pain Catastrophizing Scale (PCS) is a self-assessment questionnaire to investigate negative thoughts about pain in clinical and non-clinical populations (Sullivan et al., 1995). Catastrophizing reflects “an exaggerated negative mental set brought to bear during actual or anticipated pain experience”. The PCS consists of 13 statements that contain a number of thoughts and feelings that people can experience when they are in pain. Each item is scored on a five-point scale, with zero being not applicable and four signifying always applicable. Higher scores on the PCS indicate higher levels of catastrophizing. The reliability, content and construct validity and internal consistency have been established (Lamé et al., 2008; Osman et al., 1997; Sullivan et al., 1995; Sullivan et al., 1998).

2.3.3 Left Right Judgement Task

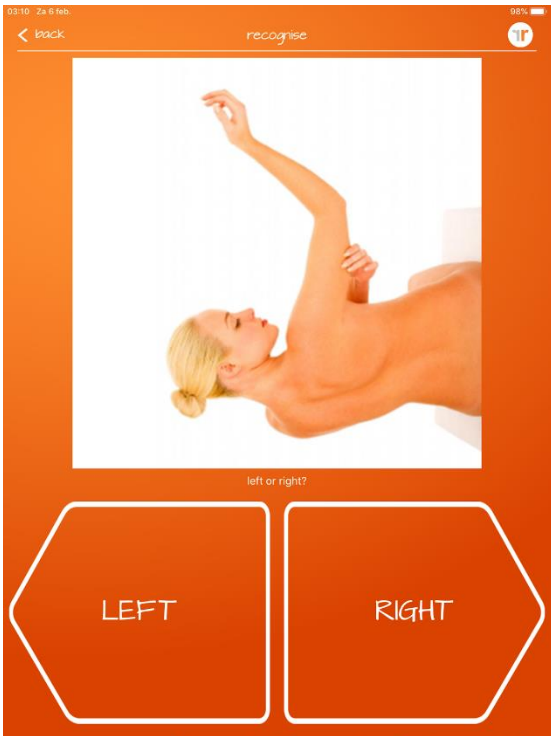

Figure 1 - Recognise Back app 2021

The ‘Left Right Judgement Task’ from ‘the recognise online’ platform from Adelaide Australia was used because it is a valid and reliable testing method for assessing motor imagery performance in low back pain (Williams et al., 2019). More specifically the app 'Recognise back’ was used on an iPad (7th gen) to test motor imagery performance.

A standardized test protocol was used to test the Left/right judgment. Participants were asked to sit on a chair with their back against the backrest and their feet on the floor with an iPad directly in front of them on a table at a comfortable height. During the test, both arms remain on the table with the fingers floating above the arrow buttons on the iPad (right finger above the right arrow, left finger above the left arrow). Participants were not allowed to turn the iPad and they were not allowed to turn their head or body to match the rotation in the picture. The test was then explained to the participant as follows: ‘you will see pictures where a person’s trunk will either be bent or turned to the left or right side (the examiner demonstrates what he means by performing these turns and bends) and you will have to judge if this person’s trunk is bent to the left or right side, from the perspective of the person in the picture. The pictures themselves can be rotated in every direction (0°, 180°, 90° to the left or right) and you have seven seconds to answer before it skips to the next one. Selecting if the person in the picture is rotated to the left or right is performed through two large buttons as seen in (Figure 1 - Recognise back app, 2021)'. If persons did, for example, turn the iPad, they were reminded by the examiner not to do it. However, the test was not stopped. Participants performed four trials. The first trial consisted of 10 pictures in the ‘vanilla condition’ (= pictures of simple back movements (e.g. 3D flexion, one-dimensional side-bending) with a neutral background (See Figure 1). This was a familiarisation trial to check if there were any questions and if the participants understood the task. If there were no questions, the actual test in the vanilla condition was performed,

Figure 2 - Recognise back app, Context setting 2021

which consisted of 40 pictures that had to be assessed. After this part, a two-minute break was given before the second part started. The second part consisted of a familiarisation trial of 10 pictures in a ‘context condition’ (= persons in the pictures perform daily life activities, eg. sports, or with a noisy background) (Figure 2 - Recognise back app, Context condition, 2021). If there were no questions the actual test was performed, which consisted of 40 pictures in a context condition that had to be assessed.

For both the vanilla condition as well as the context condition, the accuracy (%) of correctly classified pictures and also the average reaction speed (seconds) were measured. The recognise app automatically measures these parameters, and shows them at the end of the test. The accuracy and reaction speed are registered separately for pictures where the person is rotated or bent to the left or the right side. Both for the vanilla and the context condition, averages were calculated based on the results for the left and right sides. This results in one average score for accuracy and an average score for reaction speed, both for the vanilla and context mode.
The utility, validity, and repeatability of this approach have been established (Wallwork, Butler, Fulton, et al., 2013; Wallwork, Butler, & Moseley, 2013; Wallwork et al., 2015).

2.4 Data analysis

Data analyses were performed in JMP PRO 15.2.

Research question 1: Group comparison CNSLBP vs. healthy participants

The outcomes of the LRJT (reaction speed vanilla, accuracy vanilla, reaction speed context, accuracy context) of the CNSLBP group and the healthy group were compared. The data were checked for normality with a normal quantile plot and the Shapiro-Wilk test,

homoscedasticity was checked with the Brown-Forsythe test and the data were unpaired. If data were normally distributed, a t-test for independent samples was used, for not normally distributed data, a Wilcoxon test was used.
Because of the sensitivity to outliers that is present in this statistical method, a correction of outliers was performed. Outliers were identified through a box plot.

Research question 2: Effect of clinical/psychological factors on LRJT outcomes

To analyse the association of clinical and psychological factors on the outcomes of the LRJT, multiple linear regression models were composed. This was done using the data from the CNSLBP group. First, correlation analyses were performed between each of the four outcomes and the variables of interest (reaction speed vanilla, accuracy vanilla, reaction speed context and accuracy context), which were the dependent variables in the regression models. Independent variables with p values less than 0.2 were added in a regression model. Four regression models were built. The data were checked for normality with a normal quantile plot and the Shapiro-Wilk test. Linearity and homoscedasticity were checked with the 'Residuals by Predicted' plot. The parametric 'Pearson' and non-parametric 'Spearman's rho' were used. In Pearson and Spearman rho correlations, a score of 0 indicates no correlation and a score of 1 or -1 a maximal (inverse) correlation.

A standard least squares model was used to provide the best fit of data. Model assumptions were checked for each model separately. The normality of residuals was checked through a Shapiro-Wilk test. Linearity and the constant variance of errors were checked with the residual vs. predicted plot to verify there was no pattern and if there was an equal distribution of data. Assumptions for linear regression were verified. In case the assumptions were not met, a log transformation of the dependent outcome was performed, and assumptions were verified again. In case the assumptions were still not met, no regression model was built. R^2, beta, standard beta, p-values, t-values and confidence intervals (95%) of each parameter were extracted from the regression models.
To test our hypothesis the p-value of 0.05 was considered as a benchmark for statistical significance.

3. Results

The study population consisted of 158 healthy participants and 150 CNSLBP participants. An outlier correction was performed. However, after this analysis without outliers, no significantly different results were observed therefore the results shown in this study are not corrected for outliers. Participants' demographics can be found in Table 1.

Table 1
Participants demographics

Baseline characteristics

	CNSLBP group	Healthy group
#participants (n)	n = 150 (82F, 68M)	n = 158 (83F, 75M)
Age (18y-65y)	41.47 (12.66)	40.61 (12.73)
Hours of sports (h)	2 (2.40)	2.28 (2.97)
TSK (17-68)	36.4 (7.40)	
PCS (0-52)	18.56 (9.61)	
NPRSNow (0-10)	4.11 (2.05)	
NPRS7D (0-10)	5.01 (1.72)	

CNSLBP: chronic non-specific low back pain; hours of sports: the weekly amount of sports generally performed by the participants; TSK: Tampa scale for Kinesiophobia; PCS: Pain catastrophizing scale; NPRSNow: 11 point scale ranging from 0-10 representing the intensity of pain at the time of the testing; NPRS7D: 11 point scale ranging from 0-10 representing the average intensity of pain felt in the last seven days

3.1 CNSLBP Vs. healthy participants

The residuals of the data were normally distributed in the context group, (reaction speed and accuracy) but were not normally distributed in the vanilla group (reaction speed and accuracy). Equal variances were only seen in the reaction speed of the context group. Hence for the reaction speed in the context condition, a t-test for independent samples was used and for the accuracy in the context condition and both reaction speed and accuracy in the vanilla condition, a Wilcoxon/Welch test was performed. The means and standard deviations can be found in Table 2.

Results regarding the reaction speed of participants showed significantly slower reaction speeds were observed in the CNSLBP group in both the context (p=0.008) and vanilla (p<0.0001) conditions compared to the healthy participant group. Results regarding the accuracy of the participants showed significantly lower scores in the CNSLBP group compared to the healthy participant group regarding accuracy in both the context (p=0.002) and vanilla (p=0.001) conditions.

Table 2
Mean scores LRJT

	CNSLBP group	Healthy group	p-value
Speed			
Vanilla	1.79 (0.61)	1.54 (0.59)	p<0.0001**
Context	2.90 (0.75)	2.70 (0.71)	p=0.008**
Accuracy			
Vanilla	88.03 (10.45)	91.63 (8.89)	p=0.001**
Context	63.98 (14.22)	68.69 (14.52)	p=0.002**

Mean scores of each of the outcomes of the LRJT for each group and condition and p-values for the between group differences CNSLBP: chronic non-specific low back pain. P-values extracted from four individuals unpaired t-tests

3.2. Association of psychological/clinical factors with LRDT outcomes in CNSLBP

The secondary goal of this study was to assess the effect of clinical and psychological factors on the outcomes of the LRJT. To test this, multiple linear regression models were formed by adding factors with bivariate correlations with significance level lower than p 0.2. Bivariate correlations were either performed by using Pearson or Spearman Rho correlation coefficients. Analysis of TSK versus reaction speed context and TSK versus accuracy context were performed using the Pearson correlation, all other parameters did not show normal distribution and therefore were tested by using Spearman Rho correlation. In the correlation analysis, it can be seen that age showed p values lower than p 0.2 in all regression models and was thus added to all models (age and reaction speed vanilla (p=0.008), age and reaction speed context (p=0.01), age and accuracy vanilla (p=0.01), age and accuracy context (p=0.05)). TSK showed p values lower than (p=0.2) but only in the correlation with reaction speed vanilla (p=0.08) and was therefore added to this model. NPRS7D, as well as NPRSNow, showed results with p values beneath p 0.2 in both accuracy conditions (vanilla and NPRS7D (p=0.01), vanilla and NPRSNow (p=0.002), context and NPRS7D (p=0.15) and context and NPRSNow (p=0.16)), as such were added to both models. These correlations are represented in Table 3.

This resulted in the creation of three models of which both vanilla models did not show a normal distribution of residuals. The model for context accuracy did however meet all the criteria. For all models, a least squares fit was performed. As mentioned in the data analysis all models were performed both with and without the correction of outliers. This correction was performed due to the sensitivity of these models to outliers. These three models were tested: reaction speed vanilla with age and TSK; accuracy vanilla with age, NPRSNow and NPRS7D; accuracy context with age, NPRSNow and NPRS7D. As in the model reaction speed context no parameters except for age, had a correlation significance of (p=0.2) or lower this model was not included. The accuracy context model met all assumptions, the reaction speed vanilla model data had to be log-transformed to meet the assumption of normal distribution of residuals. The accuracy vanilla model also violated the assumption of normality of distribution of residuals but no transformation could be performed to change this. After checking all variables for significance two models were fitted. No model was constructed for reaction speed context as there were no significant variables (p<0.2) influencing this outcome.

Table 3

Correlations (Pearson's and Spearman Rho's)

	Speed Vanilla	Speed Context	Accuracy Vanilla	Accuracy context
Age	**0.27 (0.0008)****	**0.20 (0.01)***	**-0.20 (0.02)***	**-0.16 (0.05)***
Sports	-0.04 (0.62)	0.01 (0.89)	0.03 (0.71)	0.10 (0.24)
TSK	**0.14 (0.08)**	-0.07 (0.42)	*0.18 (0.85)*	*0.17 (0.90)*
PCS	0.007 (0.93)	0.003 (0.98)	-0.02 (0.80)	0.06 (0.46)
NPRS7D	-0.03 (0.69)	-0.02 (0.84)	**-0.21 (0.01)***	**-0.12 (0.15)**
NPRSNow	0.02 (0.85)	0.05 (0.55)	**-0.25 (0.002)****	**-0.12 (0.16)**

Table of correlations of each outcome measure with all included variables. Spearman correlations were performed for all analyses except for the ones in italic, pearson correlation was used for those correlations as assumptions were met in these circumstances. Lastly p-values of all correlations are displayed between the parentheses and the correlations presented in bold text were added to the models

3.2.1 Speed vanilla regression model

To ensure normal distribution a log transformation was performed on the reaction speed vanilla data. The reaction speed vanilla regression model contained the variables age and TSK. The model showed a coefficient of determination of R^2 0.05. Age (p=0.004) showed a significant effect on the outcome variable whilst TSK (p=0.55) did not significantly affect it.

3.2.2 Accuracy context regression model

All assumptions regarding the linear regression model were met with the accuracy context model. Variables included in the model are age, NRPSNow and NRPS7D. The model showed a fit of R^2 0.05. Age showed a significant effect (p=0.02), while both NRPSNow (p=0.15) and NRPS7D (p=0.72) did not show a significant difference. Parameter estimates of all models can be found in Table 4.

Table 4

Individuals parameters estimates

Model		Unstandardized coefficients		Standardized coefficients	t	Sign.	CI 95%	
		Beta	Std. Error	Beta			Lower bound	Upper bound
Vanilla reaction speed	Intercept	0.19	0.15		1.32	0.19	-0.10	0.49
	Age	0.006	0.002	0.24	2.95	0.004**	0.002	0.01
	TSK	0.002	0.004	0.05	0.60	0.55	-0.005	0.009
Context accuracy	Intercept	78.65	5.24		15.00	<0.0001**	68.29	89.01
	Age	-0.22	0.09	-0.20	-2.37	0.02*	-0.41	-0.03
	NPRS7D	-1.32	0.90	-0.16	-1.46	0.15	-3.10	0.46
	NPRSNow	0.28	0.77	0.04	0.36	0.72	-1.24	1.79

Beta (β) values, standard error, Standard beta (Stβ) value, significance, t-value and confidence intervals of each individual independent variable per model

4. Discussion

4.1 CNSLBP Vs. healthy participants

The main hypothesis of this study states that people with CNSLBP have impaired motor imagery performance, more specifically measured by the LRJT.

As stated in the results section the data collected in this study shows a significantly slower reaction speed in the CNSLBP group compared to the healthy participants.

This slower reaction speed was observed both in the vanilla and in the context condition.

The CNSLBP group also showed significantly lower accuracy on the LRJT in both the vanilla and context conditions compared to the healthy group. These findings do not relate to other studies researching the effect of CNSLBP on the LRJT. Bowering et al. and Linder et al. observed no significant effect on the outcomes of the LRJT (Bowering et al., 2014; Linder et al., 2016). Bray & Moseley found that back pain did not result in slower reaction speed but found that bilateral back pain led to lower accuracy (Bray & Moseley, 2011). In summary, current evidence suggests that there is no influence of back pain on reaction speed but there could be an effect on the accuracy of the LRJT which is in contrast to the results found in this study. The difference between this study and previous research could be explained due to the fact that in this study only people with CNSLBP and other strict inclusion criteria were included and no distinction was made based on the location of back pain (unilateral or bilateral). In other studies inclusion criteria for participants were not limited to CNSLBP. This means that participants included in the studies could also have specific lower back pathologies (Linder et al., 2016). This means that in these studies it is much harder to rule out any confounding variables. It is known that low back pain has a lot of psychological and clinical factors that play an important role in the progression of the disease that could also affect the participants' motor imagery performance, combined with the inclusion of participants with both chronic and acute pain can lead to varying results. Thus results in these studies are subject to high levels of potentially yet unknown influencing factors. There was also a big difference in sample size between this study and others, an example of this would be: 21 in the study of Bray et al., 1189 in the study of Bowering et al., and 30 in the study of Linder et al. whilst the current study had 150 (Bowering et al., 2014; Bray & Moseley, 2011; Linder et al., 2016). Studies with a lower number of participants lead to less clinical relevance. Another difference was found in the practice trials, in the current study participants performed two practice trials, one before the vanilla condition test and one before the context condition test that consisted of 10 pictures. Bray et al. used one practice trial of 80 pictures, Linder et al. used 60 pictures with a maximum picture time of 5 seconds whilst this study only used 40 pictures with a maximum picture time of seven seconds during the test. This difference in practice trials could have an impact on the participants' motivation, this combined with the learning effect, could influence their results.

These findings have important implications as they can pose a baseline for future research regarding the subject. Due to the clearly defined target population, the usage of a strict protocol, the combination of data from two different conditions and the significant results on all dependent variables, the hypothesis that CNSLBP could be responsible for disruption in motor imagery performance can be interpreted with more confidence. These results could prove to be an important finding for the entire chronic pain population as it would imply that chronic pain is linked to disruption in motor imagery performance. In the current research, longer than normal response times are thought to reflect delayed neural processing or decreased cortical weighting of a given body part or spatial zone and poor accuracy is thought to indicate disrupted cortical proprioceptive representation of the body part (Breckenridge et al., 2019). This would therefore imply that chronic pain leads to a decreased cortical weighting, delayed neural processing or disrupted cortical proprioceptive representation. Due to the large variance in protocols of the previous studies discussed above, it is difficult to draw a conclusion regarding the findings. However, if this protocol is repeated in future studies and similar findings are presented, these results could imply impaired motor imagery performance in participants with CNSLBP and in other chronic pain populations.

4.2 Regression models

The second aim of this study is to research the association between psychological and clinical factors in the CNSLBP population and the outcomes of the LRJT.

4.2.1 Regression model: reaction speed vanilla

In this model both age and TSK score were added to the model. Age seemed to have a significant effect on the LRJT and will be discussed in more detail at the end of the analyses of the different models. TSK did not seem to affect the outcomes of the LRJT. This would suggest that kinesiophobia or the fear of pain due to movement does not influence the reaction speed while performing the LRJT.

In Pedler et al. small effects were found when comparing the chronic whiplash-associated disorder group with healthy controls using a LRJT with neck and foot pictures and the post-traumatic stress diagnostic scale (PDS). More specifically, the whiplash group scored higher on domains such as avoidance, arousal and re-experiencing the traumatic event that caused their injury and a negative correlation was found for both neck and foot reaction speed outcomes on the LRJT. A different population was recruited, namely persons with chronic whiplash-associated disorders instead of CNSLBP and in addition to this a different LRJT was used as well as the PDS which measures avoidance, arousal and re-experiencing the traumatic event instead of the TSK which also measures pain-related fear of movement. These differences might lead to different findings in this study compared to the previous study of Pedler et al. Nonetheless this research is in alignment with the data of this study as the data showed small yet not significant effects (Pedler et al., 2013).

Moseley et al. hypothesized that a positive correlation between reaction speed and duration of symptoms was a consequence of prolonged disuse on the body schema, as is often the case in people with kinesiophobia. This hypothesis cannot be confirmed by the data collected in this study although correlation analysis results were nearly significant in the reaction speed vanilla analysis (Moseley, 2004).

4.2.2 Regression model: accuracy context

The accuracy context model included age, NRPSNow and NPRS7D. A significant effect of age on the accuracy in the context condition of the LRJT was presented. Both NPRSNow and NPRS7D did not seem to affect the LRJT, however, the NPRSNow came close to statistical significance. The intensity of low back pain in CNSLBP was not researched yet so these findings are important to better understand the underlying reasons for a decline in motor imagery performance.

The studies of Bray et al., Heerkens et al., Pedler et al., Pelletier et al., Schmid et al., and Stanton et al. all found no differences in LRJT performance when compared with pain intensity (Bray & Moseley, 2011; Heerkens et al., 2018; Pedler et al., 2013; Pelletier et al., 2018; Schmid & Coppieters, 2012; Stanton et al., 2013). However, there are multiple differences between these previously mentioned studies and the current study which might make it difficult to generalize the findings. An example would be that the study of Bray et al. only recorded pain values of the participants two days prior to the LRJT whilst the current study recorded the average pain values from the past week and at the moment of testing which might have led to different results when looking at how pain intensity might affect the outcomes of the LRJT and participants could experience more or less pain on the day of testing (Bray & Moseley, 2011).
The study of Heerkens et al., found no differences in LRJT performance when compared with pain intensity but used a different LRJT with shoulder and hand pictures and had a population with complaints of arms, neck and shoulder compared to a LRJT with back pictures and CNSLBP population in this study. These differences in population and LRJT might explain the different findings in the present study (Heerkens et al., 2018). When comparing the LBP group with healthy controls, a significant negative association between accuracy of trunk laterality judgments and LBP intensity was found but no significant association was found for reaction speed (Linder et al., 2016). Seeing as this study also included participants with LBP and found significant results, similar to this study. In contrast to all other previous studies in this section, this might imply that LBP intensity could affect the accuracy of motor imagery performance. Considering previous and current research of pain on accuracy, no conclusions can be made related to the accuracy of the LRJT. Due to the conflicting evidence

and the near significant association found in the current study, it cannot be ruled out that that pain intensity could reflect in the disrupted cortical proprioceptive representation of the body part.

Age was added to all models primarily as a control variable as previous research regarding the influence of age on the LRJT concluded that age has a clear influence on LRJT performance. However bivariate analyses were performed and age reached the inclusion significance of ($p<0.2$) in all models. The results of this study support the hypothesis that age influences the outcomes of the LRJT but an important observation must be taken into consideration. The researchers noticed that younger adults seemed more comfortable with the use of the iPad and made fewer technical errors such as accidental double-tapping.

This could imply that the difference in results is not only attributable to worse motor imagery performance but also a better understanding of newer technologies. Other similar studies also used computer programs or apps to test this hypothesis and as such could have experienced the same problems (Breckenridge et al., 2017; Wallwork, Butler, Fulton, et al., 2013). These studies both reach the same conclusion as is reached in this study, namely that an increase in age results in a decrease in accuracy and an increase in reaction speed.

In all models, the included factors accounted for only 5% of explained variance (R^2 adjusted) which strengthens the conclusion that in the CNSLBP population factors such as kinesiophobia and intensity of pain do not seem to be associated with altered motor imagery performance. Considering the bivariate analyses, other factors such as pain catastrophizing and the amount of exercise have little to no influence on the outcomes of the LRJT. However, more research regarding CNSLBP and its influencing factors on impaired motor imagery performance is needed to support this conclusion.

4.3 Bivariate correlations

For reaction speed context and accuracy vanilla, no models were built due to two reasons. The first reason is associated with the vanilla accuracy model, in this model three significant correlations were found. However, after transformations, this model still violated the model assumptions and therefore would be too unreliable to discuss. The second reason is associated with the reaction speed context model, in this model there simply weren't enough significant parameters to form a model with.

Pairwise correlations can be discussed. However, for both reaction speed context and accuracy vanilla, the factor age resulted in a significant effect strengthening the conclusion that age is related to the outcomes of the LRJT. As is also seen in other research (Breckenridge et al., 2017; Wallwork, Butler, Fulton, et al., 2013). Regarding pain intensity, both NPRS7D and NPRSNow show significant correlations with the accuracy vanilla condition. This could imply that pain intensity is correlated to the accuracy and as such the disrupted cortical proprioceptive representation of the body part, and not the reaction speed. This data conflicts with the data regarding the accuracy context model. Although the factors of NPRS7D and NPRSNow were added to these models, no significant association could be discovered. This conflicting data could be due to the difference in the difficulty of both settings. Meaning that once the task gets more difficult, the influence of pain diminishes. The results also suggest a larger correlation of NPRSNow in comparison to NPRS7D. This could prove that the time of questioning NPRS could have an influence on the correlation between motor imagery performance and pain intensity. This however contradicts the model accuracy context where the opposite was true.

The PCS shows no significant correlations with any of the dependent variables. This would imply that pain catastrophizing is not an important factor when investigating motor imagery performance. The TSK only showed significant correlations in the reaction speed vanilla condition. This could imply that kinesiophobia could be associated with delayed neural processing or a decreased cortical weighting of the body part. However, the benchmark for statistical significance was not reached in this condition so the effect of kinesiophobia cannot be confirmed by significant data. Combining the conclusion from both psychological factors it might be possible that psychological factors have little influence on motor imagery performance.

4.4 Strengths and weaknesses

First, the study is part of a larger research project meaning that both the questionnaires and testing protocol were standardized which resulted in as little as possible influence of differences in methods of testing which could influence the results of the study. Furthermore, the study managed to recruit a large number of participants despite the specific inclusion criteria e.g. no surgeries, no infiltrations and no sensorimotor training. The inclusion criteria were very well defined which resulted in a clearly defined target population. Lastly, previous studies examined the effect on the LRJT outcomes by using images of people in static positions as was the case in the current vanilla condition. However, this study also included a more difficult trial namely the context condition, in this condition the participants had to judge pictures of the backs of people who were either sporting or working and without a neutral background. This provides a more functional analysis of motor imagery performance that hasn't been researched yet. Additionally the use of the context condition, in addition to the vanilla condition used in current research, resulted in more information regarding the motor imagery performance of each participant. Despite the strengths of this study, the interpretation of the results must take some limitations into consideration. Other studies excluded response times less than 500ms as this was considered too short a time to make a judgement response and therefore would likely represent a guess or accidental button press (Wallwork, Butler, Fulton, et al., 2013). This correction was not performed in the present study, this way errors attributable to technical problems such as double-tapping or tapping just as the seven second timer ran out resulting in two errors, were not excluded from the results. Furthermore, the testing of participants was performed by two researchers, and although the protocol and testing method were well defined, this could have resulted in lower reliability.

4.5 Future research

The results of this study support the hypothesis that CNSLBP influences motor imagery performance. For future research on this subject, it might be important to consider other chronic pain conditions as well as other influencing factors that were not researched in this study (e.g. level of disability, duration of chronic pain onset). Furthermore, the influence of the NPRS and the influence of investigating current pain or a mean of the last seven days needs to be researched further as well as the influence of psychological factors such as the Tampa Scale for Kinesiophobia to clearly understand its association with delayed neural processing or decreased cortical weighting of a given body part or spatial zone. Lastly, It is also important to clearly define inclusion criteria for these populations to minimize the influence of possible variables.

5. Conclusion

In this study population results showed a significantly higher reaction speed and lower accuracy in participants with chronic non-specific low back pain compared to healthy individuals. The amount of sports practiced and pain catastrophizing did not seem to influence the outcomes of the LRJT in vanilla and context conditions. Older age resulted in a significantly worse accuracy in the vanilla and context conditions and a slower reaction speed in the context condition. Pain intensity proved to be significantly correlated to accuracy vanilla and nearly significant in accuracy context. Lastly, kinesiophobia seemed not to influence the outcomes of the LRJT except for a nearly significant correlation with reaction speed vanilla. Further research is needed to clearly examine all possible factors of CNSLBP that could have an influence on altered motor imagery performance.

6. Conflict of interest

The authors declare that they had no conflict of interests.

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Appendix

UHASSELT
KNOWLEDGE IN ACTION

Inschrijvingsformulier verdediging masterproef academiejaar 2020-2021,
Registration form jury Master's thesis academic year 2020-2021,

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O behouden - *keep*

O wijzigen - *change to:* JOREN DEMULDER AND MAXIM VAN ROMPUY

LUIK B - VERPLICHT - IN TE VULLEN DOOR DE PROMOTOR(EN)
PART B - MANDATORY - TO BE FILLED OUT BY THE SUPERVISOR(S)

Wijziging gegevens masterproef in luik A/*Change information Master's thesis in part A:*

X goedgekeurd - *approved*

O goedgekeurd mits wijziging van - *approved if modification of:*

Scriptie/*Thesis:*

X openbaar (beschikbaar in de document server van de universiteit)- *public (available in document server of university)*

O vertrouwelijk (niet beschikbaar in de document server van de universiteit) - *confidential (not available in document server of university)*

Juryverdediging/*Jury Defense:*

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:*

X te verdedigen/*to defend the aforementioned Master's thesis within the aforementioned period of time*

X 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*

LUIK C - OPTIONEEL - IN TE VULLEN DOOR STUDENT, alleen als hij luik B wil overrulen
PART C - OPTIONAL - TO BE FILLED OUT BY THE STUDENT, only if he wants to overrule part B

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 te verdedigen/*to defend the aforementioned Master's thesis within the aforementioned period of time*

LUIK D - VERPLICHT - IN TE VULLEN DOOR DE STUDENT EN DE PROMOTOR(EN)
PART D - MANDATORY - TO BE FILLED OUT BY THE STUDENT AND THE SUPERVISOR(S)

Datum en handtekening student(en)
Date and signature student(s)

28/05/2020

Maxim

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

31/05/2021

UHASSELT
KNOWLEDGE IN ACTION

Inschrijvingsformulier verdediging masterproef academiejaar 2020-2021,
Registration form jury Master's thesis academic year 2020-2021,

GEGEVENS STUDENT - *INFORMATION STUDENT*

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

Stamnummer + naam: **1335513 Van Rompuy Maxim**
Student number + name

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

INSTRUCTIES - *INSTRUCTIONS*

Neem onderstaande informatie grondig door.

Print dit document en vul het aan met DRUKLETTERS.

In tijden van van online onderwijs door COVID-19 verstuur je het document (scan of leesbare foto) ingevuld via mail naar je promotor. Je promotor bezorgt het aan de juiste dienst voor verdere afhandeling.

Vul luik A aan. Bezorg het formulier aan je promotoren voor de aanvullingen in luik B. Zorg dat het formulier ondertekend en gedateerd wordt door jezelf en je promotoren in luik D en dien het in bij de juiste dienst volgens de afspraken in jouw opleiding.
Zonder dit inschrijvingsformulier krijg je geen toegang tot upload/verdediging van je masterproef.

Please read the information below carefully.

Print this document and complete it by hand writing, using CAPITAL LETTERS.

In times of COVID-19 and during the online courses you send the document (scan or readable photo) by email to your supervisor. Your supervisor delivers the document to the appropriate department.

Fill out part A. Send the form to your supervisors for the additions in part B. Make sure that the form is signed and dated by yourself and your supervisors in part D and submit it to the appropriate department in accordance with the agreements in your study programme.
Without this registration form, you will not have access to the upload/defense of your master's thesis.

LUIK A - VERPLICHT - IN TE VULLEN DOOR DE STUDENT
PART A - MANDATORY - TO BE FILLED OUT BY THE STUDENT

Titel van Masterproef/*Title of Master's thesis:* WHATS THE LINK BETWEEN CHRONIC NON-SPECIFIC LOW BACK PAIN AND MOTOR IMAGERY PERFORMANCE

⊘ behouden - *keep*
O wijzigen - *change to:*

/:

O behouden - *keep*
O wijzigen - *change to:*

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

O behouden - *keep*
● wijzigen - *change to:* JOREN DEMULDER AND MAXIM VAN ROMPUY

LUIK B - VERPLICHT - IN TE VULLEN DOOR DE PROMOTOR(EN)
PART B - MANDATORY - TO BE FILLED OUT BY THE SUPERVISOR(S)

Wijziging gegevens masterproef in luik A/*Change information Master's thesis in part A:*

X goedgekeurd - *approved*
O goedgekeurd mits wijziging van - *approved if modification of:*

Scriptie/*Thesis:*

X openbaar (beschikbaar in de document server van de universiteit)- *public (available in document server of university)*
O vertrouwelijk (niet beschikbaar in de document server van de universiteit) - *confidential (not available in document server of university)*

Juryverdediging/*Jury Defense:*

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:*

X te verdedigen/*to defend the aforementioned Master's thesis within the aforementioned period of time*

- X 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*

LUIK C - OPTIONEEL - IN TE VULLEN DOOR STUDENT, alleen als hij luik B wil overrulen
PART C - OPTIONAL - TO BE FILLED OUT BY THE STUDENT, only if he wants to overrule part B

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 te verdedigen/*to defend the aforementioned Master's thesis within the aforementioned period of time*

LUIK D - VERPLICHT - IN TE VULLEN DOOR DE STUDENT EN DE PROMOTOR(EN)
PART D - MANDATORY - TO BE FILLED OUT BY THE STUDENT AND THE SUPERVISOR(S)

Datum en handtekening student(en)
Date and signature student(s)

Maxim

31/05/2021

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

31/05/2021

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
06/10 2020	Mailcontact rekrutering + informatie schrijfproces	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Van Romphuy Maxim
23/12 2020	Feedback Methodologie + inleiding (4 mails)	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Van Romphuy Maxim
28/01 2021	Vraag ivm rekruteringen (8 mails) (+3 mail of 16/02)	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Van Romphuy Maxim
19-26/02 2021	Feedback Methodologie (7 mails)	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): ~~Demulder~~ Van Romphuy Maxim
11/03 2021	FB Methods	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Van Romphuy Maxim
15/03 2021	FB introduction + 17 maart → Vraag over data	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Van Romphuy Maxim
02/05 2021	Statistische analyse (13 mails) 03/05 → inleren hypothesetesting	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Maxim Van Romphuy
15/05 2021	FB results and discussion	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Maxim Van Romphuy
20/05 2021	FB algemene MP	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Van Romphuy Maxim
26/05 2021	FB algemene MP 2	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Van Romphuy Maxim

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

Naam Student(e): Joren De Mulder **Datum:** 31/05/2021

Titel Masterproef: What's the link between chronic non-specific low abck pain and motor imagery performancece?

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

2) <u>Niet-bindend advies:</u> 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 (sch~~rappen wat niet past) openbaar verdedigd worden.

4) Deze wetenschappelijke stage/masterproef deel 2 mag wel/~~niet (sch~~rappen 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)
31/05/2021	31052021	

www.uhasselt.be
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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
06/10 2020	Mailcontact rekrutering + informatie schrijfproces	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Van Romphuys Maxim
23/12 2020	Feedback Methodologie + inleiding (4 mails)	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Van Romphuys Maxim
28/01 2021	Vraag i.v.m. rekruteringen (8 mails) (+3 mail op 16/02)	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Van Romphuys Maxim
19-26/02 2021	Feedback Methodologie (7 mails)	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): ~~Demulder~~ Van Romphuys Maxim
11/03 2021	FB Methods	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Van Romphuys Maxim
15/03 2021	FB introduction + 17 maart → Vraag over data	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Van Romphuys Maxim
02/05 2021	Statistische analyse (13 mails) 03/05 → indienen hypothesetesting	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Maxim Van Romphuys
15/05 2021	FB results and discussion	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Maxim Van Romphuys
20/05 2021	FB algemene MP	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Van Romphuys Maxim
26/05 2021	FB algemene MP 2	Promotor: [signature] Copromotor/Begeleider: Student(e): Demulder Joren Student(e): Van Romphuys Maxim

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

Naam Student(e): ....Maxim Van Rompuy.................................. **Datum:**..31052021..............

Titel Masterproef: ....What's the link between chronic non-specific low back pain and motor imagery performance?..................................

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

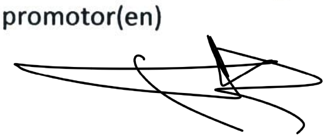
3) Deze wetenschappelijke stage/masterproef deel 2 mag wel/~~niet~~ (schrappen wat niet past) openbaar verdedigd worden.

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)



31/05/2021

31/05/2021