Different Explanation, less frustration?

Valorisation

Valorisation has been defined by the Dutch government as "*the process of creating value from knowledge by making knowledge suitable and/or available for economic and/or societal use and translating that knowledge into products, services, processes and entrepreneurial activity*".[198] In other words obtained knowledge from research projects, such as generated within this PhD thesis, becomes especially valuable when it is used in society. For example, results of this PhD thesis can be relevant to patients, (informal) caregivers, (future) health care professionals but also to technology manufacturers, designers, or policy makers. They can use the knowledge in daily life practice (e.g. patients and health care professionals) or the results may deliver input for future projects (e.g. technology manufacturers, designers or researchers) and the development of guidelines (e.g. policy makers). However, the generation of scientific knowledge does not mean that it automatically reaches society.

The following chapter describes how the findings of this thesis are relevant for society. Firstly, the overall relevance of the clinical problem is described. Then the chapter outlines how the findings of this thesis are relevant for different stakeholders and how the findings have already been disseminated. Finally, the future dissemination activities and innovative nature of the PhD project are described

Relevance of the clinical problem

Every year there are many people who suffer from the consequences of an acquired brain injury or from chronic neurological disorders. For example, in the Netherlands alone, there are about 500.000 people who suffer from a stroke and about 50.000 people with Parkinson's disease in a total population of about 17 million inhabitants.[199,200] These conditions can lead to a wide variety of impairments, such as problems with physical, or cognitive functions, which in turn can affect daily life activities. As a consequence, many people need to (re)learn daily life motor skills such as walking, standing up from a chair or taking the stairs. The ability to perform these activities in a safe and independent manner, are important for autonomy and are seen as important factors for discharge from hospitals or rehabilitation facilities.

Health care professionals such as physiotherapists and occupational therapists are constantly searching for the best treatment approaches for their patients. However, the process of motor learning in neurological rehabilitation is dynamic and can be influenced by many factors such as pain, cognition or physical abilities, which can therefore result in challenging and complex situations. To deliver effective and efficient therapy it is important to know which motor learning approaches are feasible and effective within clinical practice. Findings of the current thesis add to this field of research and clinical practice as the developed interventions within this thesis demonstrate how implicit and motor learning can be structured within clinical practice and the results provide insight in the effects and feasibility of the researched motor learning strategies.

Target population and other stakeholders
The findings of this thesis are valuable to a variety of stakeholders as described below.

Patients and (informal) caregivers
The knowledge obtained from this thesis can be of benefit to patients who are in the process of (re)learning motor skills. This knowledge may also be relevant to (informal) caregivers e.g. partners who provide support during this process. Results indicate that individually tailored implicit and explicit motor learning approaches can both be used to facilitate motor skills such as walking in in a feasible and potentially effective manner. Importantly, overall, independent of the cognitive abilities, patients were able to use the instructions, and were satisfied about the received interventions. To avoid confusion and to ensure that everyone is supporting the patient in the same manner, it is alaso necessary to inform the caregiver (and other professionals who treat the patient) about the chosen treatment approach. For example, if an implicit strategy turned out to work well for the patient therapy should not be disturbed with explicit instructions. Simultaneously, if an explicit approach or mix of learning strategies are being used this should be clear for everyone who supports the patient during the (re)learning process of motor skills.

Furthermore, patients who took part in the study may have benefitted from the sensor-feedback system "*Stappy*". The system provides the possibility to practice walking independently at times that are convenient for the patient. Additionally, the system provides the opportunity to receive feedback about their performance also outside the guided therapy sessions. At this moment, the sensor-feedback system with *Stappy* user-interface is not commercially available. However, patients may consider technologies with similar functions such as activity trackers that provide feedback (perhaps less specific compared to "*Stappy*") about walking performance e.g. about the walking distance or walking speed. Feedback about own movement performance can motivate people to practice more.[201]

Health care professionals and clinical practice
The current PhD thesis focused on improving walking performance and findings are therefore relevant to health care professionals that support patients during this specific activity. However, the knowledge that we have generated may also be useful during the execution of other daily life motor skills such as taking the stairs, dressing or for example during any sports related activities. Findings, may therefore be useful to a wide variety of disciplines such as physiotherapists, occupational therapists, nurses, and sports coaches. The motor learning framework as developed by Kleynen et al[4] provided a potential structure for motor learning strategies that can be viewed on an implicit-explicit continuum. The current project builds on this framework through providing more knowledge on how implicit (mainly analogy learning) and explicit motor learning

approaches can be applied within clinical practice. Results have led to knowledge regarding the feasibility and potential effects of implicit and explicit motor learning within clinical practice. For health care professionals, it is especially important to know 'how' and 'when' these motor learning approaches can be applied. The interventions presented in the pilot studies (chapters 2 and 3) and in the trial (chapters 4 to 6) provide concrete examples of how implicit and explicit motor learning can be applied to facilitate walking performance. The process evaluation of the trial presents example instructions (chapter 6) that have been used within the interventions and provides insight in the factors that play a role in the application of implicit or explicit motor learning in practice. This concrete knowledge and information can be used by health care professionals as a guidance and source of inspiration.

Education (students)

Evidence Based Practice (EBP) plays a central role in education and clinical practice. Students learn to make decisions based on the available evidence, their own experiences and the preferences and backgrounds of the client. However, students generally lack experience and expertise in clinical practice, which makes it hard to make decisions based on earlier experiences or to recognize certain patterns. Therefore, especially in the beginning, they mainly fall back on the available scientific evidence that is published in (peer-reviewed) journals or summarised in evidence-based guidelines. Current guidelines in neurological rehabilitation describe the importance of motor learning principles such as sufficient dose, intensity, task and context specific training e.g. see[128]. However, generally these guidelines do not describe "how" and "when" implicit and explicit motor learning can best be applied. Kleynen et al[4] developed a motor learning framework that presents a potential structure and insights in different motor learning strategies and how these can be viewed on an implicit-explicit continuum. Through the scientific publications with descriptions and examples of the interventions, this study adds extra knowledge for students on especially how implicit and explicit motor learning can be applied in clinical practice.

Education (Lecturers)

Results of this thesis are relevant for lecturers as the generated knowledge and materials provide extra tools to structure lectures and practical lessons. Various materials have been developed such as video's with patient and therapist experiences, knowledge clips about motor learning and workshops (see dissemination). The use of such materials may perhaps contribute to more enjoyable and engaging teaching and learning environments.

Researchers

The findings of this thesis contribute to the overall body of knowledge with regard to motor learning in neurological rehabilitation. Results are relevant to researchers as they bring new implications and directions for future research. From this PhD project several research questions for future research have emerged. For example, both interventions seemed equally effective, however it would be interesting to explore which patient(s) (characteristics and preferences) benefit most from which motor learning intervention (implicit or explicit). Furthermore, the project also provided insights in the complexity that goes accompanied with research in real life settings, complex tasks and a representative sample. Looking back on the lessons learned, researchers may consider studying these patient characteristics in relation to motor learning in more controlled environments. Ultimately it would be interesting to map all patient characteristics and identify their relationship to (e.g. implicit and explicit) motor learning so that in the end therapists can make better informed decisions regarding their chosen motor learning approaches.

If future research projects would consider randomised controlled trials to assess the effects of implicit motor learning for stroke survivors, more insight is needed in the patient characteristics and preferences of the patient. Furthermore, researchers should carefully consider the research setting i.e. laboratory or clinical practice and potential factors that can influence the contrast between the intervention. Researchers may also consider different research designs to gain insights in the application and effects of implicit motor learning such as cohort studies in which many potential influencing factors are measured over time or using multiple baseline study designs.

This PhD project was part of a larger project "*the power of implicit motor learning 2.0*" and currently the research on this topic will be continued in the form of two new follow-up projects. One project will focus on creating instruction and example material for (informal) caregivers, whereas the other project will focus on gaining more insight in the factors that play a role during the process of motor learning.

Technology manufacturers and designers

Today there are many supportive technologies that can be used by patients during their rehabilitation, for example activity trackers, smartphone apps or e-health platforms. However, even though (supportive) technologies generally function and operate perfectly on a 'technical' level, they are not always used as regularly as intended. There are many factors that determine the actual level of use of the (supportive) technologies[174]. For example, one of the reasons may be that technologies are not inviting to use for example because the user-interface is too complex, boring or because the users lack proficiency in the English language. The current PhD thesis (chapter 7) demonstrates how user-interfaces can be designed using a user-centered approach. Using this approach in design processes

will hopefully lead to developments of user-interfaces that will lead to a more meaningful user experience. Furthermore, the systematic description of the user-centred approach and the associated deliverables may hopefully act as a guidance to future projects that (re)design or develop products for the stroke population.

Policy makers

The knowledge obtained within this PhD thesis can be relevant to policy makers who are active in the development of guidelines in neurological rehabilitation. The knowledge of this thesis adds to current guidelines as it provides more evidence and insight in 'how' and 'when' implicit and explicit motor learning can be applied. This current PhD project delivered knowledge in terms of 1) scientific evidence for implicit and explicit motor learning and 2) the practical application and feasibility of these motor learning strategies in neurological rehabilitation. The trial (chapter 3 to 6) showed 'how' tailored implicit and explicit motor learning can be applied in an effective and feasible manner to people after a stroke. However, in order to determine who benefits most from which intervention more insight is needed in the patient characteristics and working mechanisms of implicit motor learning. The process evaluation of the trial (chapter 6) also provides insight in a variety of factors that may play a role during implicit and explicit motor learning. Furthermore, this PhD project also showed that even people after stroke who are in the chronic phase of recovery (> six month after stroke) still have the ability to obtain meaningful improvements in short 'boost' sessions as presented within this trial.

Dissemination

Tables 1 to 4 describe the dissemination activities performed so far for patients and society, health care professionals and clinical practice, education and the research community.

Table 1. Overview of dissemination activities for patients and society

Knowledge transfer to patients and society	
Factsheets 	Dutch: Onderzoeksbeschrijving "De kracht van het onbewuste leren 2.0" English: Research description "The Power of Implicit Motor Learning 2.0" *To read the factsheets scan the QR code.*
Symposia 	The project end symposium. June 2019. *To watch the aftermovie of the symposium scan the QR code.*
Dissemination through client representatives 	Else de Bont, Anja Minheere and Nathalie Sieben. *Participerende patiënten aan het woord.* Workshop op eind-symposium van het project. June 2019 Anja Minheere. *Het is alleen zinvol als het goede participatie is.* Publication in burgkracht. May 2019. *To read the article scan the QR code.* Else de Bont, Anja Minheere Nathalie Sieben. *Cliëntenparticipatie, de waarde van ervaringsdeskundigheid*. Publication in Zorgbelang. December 2015
Newspaper reports	De Limburger. "*Zuyd Hogeschool wint landelijke prijs voor onderzoek naar revalidatie na een beroerte*". November 2019 Sittard-Geleen nieuws. "*Onderzoeken Zuyd Hogeschool vallen in de prijzen*". November 2019 1limburg. "*Opnieuw publieksprijs voor Zuyd: leren lopen met beeldspraak*". November 2019
Radio appearances 	RTV Maastricht. 'Station Maastricht'. 12 November 2019. *To watch the episode scan the QR code.*

Table 2. Overview of dissemination activities for health care professionals and clinical practice

Knowledge transfer to health care professionals and clinical practice	
Presentations at national conferences and symposia	Jie LJ, Kleynen M, Meijer K, Beurskens AJ, Braun SM. *Implicit and explicit motor learning in gait rehabilitation of people after stroke: A randomized controlled single blind trial.* (Poster presentation at the Dag van de Fysiotherapeut, Den Bosch, the Netherlands, November 2019). Jie LJ, Kleynen M, Meijer K, Beurskens AJ, Braun SM. (2019) *Implicit and explicit motor learning in gait rehabilitation of people after stroke: a randomized controlled single blind trial* (Poster presentation at de dag voor de fysiotherapeut, Den Bosch November 2019) Jie LJ. *Impliciet motorisch leren met behulp van analogieën.* (Oral presentation at the symposium 'Motorisch leren in de neurorevalidatie: van theorie naar therapie'. Wijk aan zee, Februari 2019) Jie LJ. *Looptraining bij mensen na een beroerte: de toepassing van impliciet motorisch leren en het gebruik van een sensoren feedback systeem.* (Oral presentation at the Jubileum conference of Key Point neurorevalidatie. Utrecht, October 2019) Jie JL. *Nooit meer expliciet?* (Oral presentation at the Afscheidsreceptie Frank van Hartingsveld. Amsterdam, November 2019) Jie JL. *Impliciet motorisch leren bij het verbeteren van de loopvaardigheid bij mensen na een beroerte. Hoe doe je dat?* (Oral presentation at the Symposium *"*Motorisch leren in sport en revalidatie: wat kunnen we van elkaar leren?". Maastricht, April 2018)
Publications in national professional journals	Jie LJ, van den Heuvel R, Braun SM, Kleynen M. Looptraining met behulp van technologie; ervaringen van CVA-patiënten en therapeuten met het sensoren-feedback systeem 'Stappy'. *Keypoint Tijdschrift voor behandelaars in de neurorevalidatie.* 2020;43E(3):16-19.
Implementation in routine care through workshops for health care professionals	Workshops on implicit motor learning and the application of the sensor-feedback system Stappy within neurological rehabilitation. For physiotherapists working within neurological rehabilitation. At Zuyd University of Applied Sciences • Workshop 1: 03-09-2018 • Workshop 2: 20-09-2018 At Adelante Rehabilitatie Centre. • Workshop 1: 01-11-2018 • Workshop 2: 24-11-2018
Intervention guideline of the trial	Kleynen M, Jie LJ, Theunissen K, Halfens J, Kurvers J. *Raamwerk voor de toepassing van impliciet en expliciet motorisch leren*. Januari 2017
Video clips	One instruction video of the sensor-feedback system has been developed for healthcare professionals.

Table 3. Overview of dissemination activities within education

Knowledge transfer to education	
Lectures	Learning strategies for gait rehabilitation in course. Lecture at the Master track Human Movement Sciences. Maastricht University. 2017, 2018, and 2019. Technologie in de zorg. Lecture at the bachelor track Physiotherapy. Zuyd University of Applied Sciences. 2017 Motorisch leren binnen de neurorevalidatie. Lecture at the minor "growing older". Zuyd University of Applied Sciences. 2015 and 2016.
Video clips	In total 13 short video clips on the topic of (implicit) motor learning have been recorded and made available to students and staff from Zuyd University of Applied Sciences. One video clip with patient experiences on implicit motor learning has been developed One video clip with patient experiences of the sensor-feedback system Stappy has been developed
Inclusion of students in graduation projects	A total of 48 students from different disciplines such as physiotherapy, communication multimedia design and human movement sciences were involved in 18 thesis projects.

Table 4. Overview of dissemination activities within the research community

Knowledge transfer to research community	
Publications in peer-reviewed journals	Four out of six articles included in this thesis have been published in international, peer-reviewed journals. Two articles have been submitted for publication.
Presentations at (inter)national scientific conferences	The project results have been presented and discussed at (inter)national conferences e.g. Dutch Congress of Rehabilitation Medicine (2016), Congress on Neurorehabilitation and Neural Repair (2015 & 2019), and the ISPGR World Congress (2019).
Follow-up grants	**Top-Up project**: A project that aims to translate the knowledge into instruction and example material for (informal)caregivers to provide better support to the patient during the process of (implicit)motor learning process. **The ACTIE project**: ACTIE stands for an approach for the complexity of in neurological rehabilitation (in Dutch: Aanpak van Complexiteit neurorevalidaTIE). The project aims to identify which factors play an important role during the process of successful motor learning.
Multimedia	**ResearchGate:** • Project "The-power-of-implicit-motor-learning-20"(58 Followers) • Personal account "Li-Juan_Jie" (133 Followers) **Twitter accounts:** • Project @zuyd_mind (169 Followers) • Personal account @lijuanjie (305 Followers) **Project website**: www.m-i-n-d.org

Future dissemination and implementation activities

The following chapter describes the future dissemination and implementation activities per target population.

Knowledge transfer to patients and society

Dissemination of results towards society will continue through the start of a new project (Top-Up grant from Nationaal Regieorgaan Praktijkgericht Onderzoek SIA). This project aims to develop instruction and example material that is specifically focused on informal caregivers e.g. partners or family members. This material can be used to improve the process of (implicit) motor learning at home and in their social environments and may strengthen the overall rehabilitation trajectory. Furthermore, results of this PhD thesis will be disseminated through press releases at Zuyd University of Applied Sciences and Maastricht University. The PhD thesis will be freely accessible through the research repository of Maastricht University (https://cris. maastrichtuniversity.nl/portal/).

Knowledge transfer to health care professionals and clinical practice

Knowledge may be transferred through presentations at national conferences and symposia targeted at health care professionals. In 2020, an article about the results of this PhD project will be published in the Journal of Physiotherapy of the Royal Dutch Society for Physical Therapy. Through this publication, project results will be communicated to a wide range of physiotherapists in the Netherlands.

Knowledge transfer to education

Various materials have already been developed in the form of scientific publications and developed materials (e.g. video clips) and are currently integrated in a variety of courses at Zuyd University of Applied Sciences e.g. the Physiotherapy, and Occupational Therapy tracks. Results are also being taught within other tracks of other (inter)national universities such as the University of Exeter, Waikato University and Fontys University of Applied Sciences. Future dissemination to education will continue in this manner and the development of new material (e.g. through the Top-Up grant) may lead to a larger database of educational resources on the topic of motor learning.

Knowledge transfer to the research community

Knowledge transfer to the research community will continue through setting up new research projects. In 2020 one research project will start to explore and identify which factors play a role during the process of motor learning of movements in people after stroke. Furthermore, knowledge will be transferred to the research community through a research visit (through the YERUN mobility award) that will take place in April 2020. Through this visit, knowledge on motor learning and research methodologies will be exchanged between Brunel University London, Maastricht University and Zuyd

University of Applied Sciences, which may lead to new collaborations. Finally, there are plans to start new research projects that focus on gaining a better understanding of the specific patient characteristics and their relationship to motor learning.

Innovative aspects

At the start of my PhD in 2015, evidence for implicit motor learning was almost exclusively based on studies in cognitive psychology and sports populations. However, the application and potential benefits of implicit learning seemed also promising for neurological rehabilitation. Therefore, findings are innovative of nature. The project contributed to bridging the knowledge from sports towards rehabilitation and clinical practice. Through pilot studies the application of different implicit motor learning strategies to facilitate walking in people after stroke and people with Parkinson's were explored (chapters 2 and 3). Based on these studies the first randomised controlled trial to examine the effects of an implicit compared to explicit motor learning walking intervention to improve walking performance in people after stroke was developed, conducted and evaluated (chapters 4 to 6). The results provide new insights in the application, effects and feasibility of implicit motor learning within neurological rehabilitation. Furthermore, findings seem reflective for clinical practice as the trial took place within a real-life setting (the home environments of the patients), were focused on a common daily life task (that is walking) and a representative sample was included.

Additionally, this thesis innovative of nature as we re-designed and optimized an existing technology rather that developing a new product from scratch (which seems way more efficient). Everyday new (supportive) technologies get developed, however many of these new innovative systems or programs are not being used as regular as intended. One reason may be that often engineers develop a technology that functionally operates perfectly but is not attractive or inviting to use. Designing products and user interfaces as described within this thesis, may contribute to the creation of products that lead to a more meaningful user experience.