UNIVERSIDADE CATÓLICA PORTUGUESA

MULTISENSORY *SELF*-REFERENTIAL STIMULATION – A CONTRIBUTION FOR THE *CORE-SELF*

Tese apresentada à Universidade Católica Portuguesa
para obtenção do grau de Doutor em Ciências da Saúde - especialidade em Reabilitação Neurológica

por

Ana Isabel Correia Matos de Ferreira Vieira

Instituto de Ciências da Saúde

Julho de 2016

UNIVERSIDADE CATÓLICA PORTUGUESA

MULTISENSORY *SELF*-REFERENTIAL STIMULATION – A CONTRIBUTION FOR THE *CORE-SELF*

Tese apresentada à Universidade Católica Portuguesa
para obtenção do grau de Doutor em Ciências da Saúde - especialidade em Reabilitação Neurológica

Por Ana Isabel Correia Matos de Ferreira Vieira

Sob orientação de:
Professor Doutor Alexandre Castro-Caldas
Professora Doutora Maria Vânia Nunes

Instituto de Ciências da Saúde
Julho de 2016

To Filipe and Beatriz

Because family is the greatest thing in life

“A family is like a circle
the connection never ends
and even if at times it breaks
in time it always mends.
A family is like the stars
somehow they're always there.
Families are those who help,
who support and always care.
A family is like a book
the endings never clear
but through the pages of the book
their love is always near”

Nicole O’Neil

Acknowledgements

Writing this thesis was a journey full of academic, personal and family challenges but now that it is finished, I look back and see all the things I have learned. To overcome the challenges I had to learn how to manage time, to do a more adequate analysis and critical review, to bridge theory and practice in a better reflexive way. This dissertation could not have been completed without the great support that I have received from so many people over the years.

Firstly, I would like to express my deepest gratitude to the main supervisor, Professor Alexandre Castro-Caldas for the continuous support to the PhD and related research, for his patience, motivation, and immense knowledge. I would like to thank him particularly for guiding me through the path of research science.

I am also grateful to my second supervisor, Professor Maria Vânia Nunes for the valuable guidance, for the helpful suggestions, for her perspectives on how to better focus the study and her clarity of mind regarding advice on the methodology.

I thank the financial support of the Institute of Health Sciences - Catholic University of Portugal and of the Alcoitão School of Health Sciences

I thank the Visual Neuroscience Laboratory, Institute for Biomedical Imaging in Life Sciences (IBILI), ICNAS, Faculty of Medicine, University of Coimbra, particularly to Professor Miguel Castelo Branco for the support and counselling during the development of the experimental paradigm and fMRI data analysis.

I would like to acknowledge “Santa Casa da Misericórdia” of Cascais and “Centro Social e Paroquial de São João e São Pedro do Estoril” that guaranteed me a valuable field of work by allowing me to have access to the elderly subjects and providing an excellent partnership.

I’m very grateful to Nádia Canário, from the Institute of Health Sciences - Catholic University of Portugal for the support on the development of the fMRI paradigm, data processing and analysis. This dissertation would not have been possible without her remarkable work.

Also want to acknowledge the participants in the studies developed in this thesis.

I cannot thank enough Jackie and Katie for the English revision and critical review.

I would like to acknowledge Professors Dália Nogueira, Elizabeth Reis and Luís Cavalheiro who worked with me side by side. Their guidance helped me throughout the research phase.

I owe my gratitude to my colleagues of the Physiotherapy department of the Alcoitão School of Health Sciences for standing by me through good times and bad.

Special thanks to my dear friend and colleague Patrícia for her help and encouragement throughout this process. She was an example of friendship, perseverance and courage to accept new challenges.

I am very much indebted to my beloved friend Maria Emilia who supported me in every possible way to see the completion of this work.

I will always be grateful to my parents, my brother and my in-laws for the encouragement and for providing the moral and emotional support I needed to complete my thesis.

I most want to thank my husband Filipe for his love, sacrifice, and kind indulgence. Also for his wisdom, guidance and structured mind that allowed me to build and translate the entire thesis.

I also thank our daughter Beatriz for inspiring and amazing me every day.

My work is finished and now I'm coming home.

Resumo

Sempre que ocorre uma alteração da função sensitiva, quer seja devida a uma doença, a um trauma ou ao processo normal de envelhecimento, surge simultaneamente uma alteração no controlo motor, na perceção do corpo e das emoções, na cognição, nas atividades da vida diária e na participação do individuo enquanto "ser" social. O sentimento que é gerado é de perda de identidade, de ameaça e de desintegração da perceção do indivíduo como um todo. Este fenómeno de consciência pessoal é designado por *Self*. Na literatura são relatados vários conceitos do *Self* mas algumas teorias mais recentes afirmam que existe um único *Self*. O ser humano é um todo e quanto maior for a perceção de unidade pessoal maior funcionalidade física, cognitiva e emocional poderá ser alcançada. O *Self* pode alterar-se de acordo com a exposição a diferentes condições de saúde mas também devido a experiências sensoriais e relacionais que sejam relevantes para o indivíduo, ou ainda devido à falta de estimulação. A estimulação que recebemos através de todas as modalidades sensoriais ajuda a construir a representação que fazemos de nós próprios. No entanto a estimulação unisensorial parece não ser suficiente para promover a perceção do *Self* como um todo, sendo que, a estimulação multissensorial, desde que seja composta por estímulos significativos para o indivíduo e referenciados ao *Self*, parece desencadear uma consciência mais global do *Self*. Os estímulos referenciados ao *Self* são estímulos que estão relacionados fortemente com a própria pessoa, sobretudo com a perceção do seu corpo. O fisioterapeuta é um profissional que se diferencia pela utilização de estratégias de estimulação sensorial que podem ser consideradas referenciadas ao *Self*, tais como a estimulação verbal apelando para sentir partes do corpo e o contacto direto e prolongado das suas mãos com o corpo do utente. No entanto estas estratégias raramente são usadas na Fisioterapia com o objetivo de melhoria das competências sensoriais e percetivas e quando são aplicadas nunca são usadas em simultâneo.

No que se refere a estratégias de avaliação e de intervenção que utilizam o toque, verifica-se também que não existe um cuidado sistemático em avaliar a perceção que os utentes fazem do contacto físico que é estabelecido. No entanto, diferentes significados poderão ser atribuídos a esse contacto físico durante as interações terapêuticas, podendo gerar atitudes e comportamentos de evitamento ao toque. Isto pode inviabilizar a relação terapêutica e afetar os resultados esperados.

Se a perda de função sensorial, nomeadamente a função sensorial tátil pode conduzir a uma desintegração do *Self*, o estudo deste problema torna-se mais relevante nos idosos pois a evidência aponta para a existência de uma perda sensorial importante nesta etapa de vida, com implicações na função motora, nas atividades do dia-a-dia e nas relações interpessoais.

Face ao exposto esta tese possuiu como objetivos gerais (1) aumentar a evidência científica acerca da prática clínica da Fisioterapia; (2) contribuir para uma reflexão acerca da prática clínica da Fisioterapia no que se refere à importância da estimulação sensorial na construção do *Self*; (3) permitir uma melhor compreensão do processo de envelhecimento saudável relacionado com as implicações do declínio da sensibilidade tátil na funcionalidade e nas relações interpessoais; (4) efetuar um conjunto de recomendações para o aumento da qualidade da prestação de serviços prestados pela Fisioterapia, especificamente relacionados com a avaliação da função sensorial e com as estratégias de estimulação sensorial. Para alcançar estes objetivos foram realizados três estudos: (1) "Multisensory *Self-referential* stimulation of the lower limb – an fMRI study on healthy subjects"; (2) "Tactile Discrimination, Social Touch and Frailty criteria in elderly people"; (3) "Reliability and Validity of the European Portuguese version of the Social Touch Questionnaire". Os principais resultados e conclusões dos estudos são: (1) a estimulação unisensorial auditiva-verbal e tátil-manual referenciada ao *Self*, assim como a estimulação multisensorial (auditiva-verbal + tátil-manual) referenciada ao *Self* promovem ativações bilaterais da Junção Temporo Parietal (JTP), do córtex somatosensorial primário (S1), do córtex motor primário (M1)-BA4 e do córtex prémotor-BA6. Estas áreas sensoriomotoras foram localizadas na representação sensoriomotora dos membros inferiores; a estimulação multisensorial referenciada ao *Self*, comparada com a estimulação unisensorial, produz um mapa de ativação cerebral constituído por regiões que, segundo a literatura, são responsáveis pelo processamento multisensorial do *Self*. Este processo poderá representar o *Core-Self (também designado por Eu nuclear)*. O mapa cerebral encontrado é composto por estruturas corticais e subcorticais da linha média do cérebro - BA7 (precuneo), BA9 esquerda (córtex pré-frontal medial), BA30 esquerda (cíngulo posterior), tálamo esquerdo, colículo superior bilateral e cerebelo posterior esquerdo, assim como pelo córtex lateral posterior - JTP bilateral, BA13 (insula posterior bilateral), BA19 esquerda e BA37 esquerda. Em relação a todas estas estruturas, a JTP bilateral foi a que mostrou maior volume de ativação; (2) o declínio da sensibilidade discriminativa da mão está relacionado com o aumento da idade, com a diminuição da força de preensão e com maior quantidade de comportamentos e atitudes de evitamento relacionados com o toque. A sensibilidade discriminativa da mão também constitui uma variável explicativa dos níveis de fragilidade da amostra de idosos selecionada para o estudo, ou seja, os idosos frágeis possuem maior perda da sensibilidade discriminativa da mão do que os idosos pré frágeis. De acordo com estes resultados recomendamos que a sensibilidade discriminativa da mão seja usada nos protocolos de avaliação e de intervenção em idosos frágeis ou em risco de se tornar frágeis; (3) produzimos uma versão Portuguesa-Europeia do "Social Touch Questionnaire" e demonstrámos que é um instrumento de medida confiável, válido e de fácil compreensão. É um instrumento que avalia uma variedade de comportamentos e atitudes relacionados com o toque social e que poderá ser utilizado por diferentes profissionais de saúde, tanto na prática clínica como na investigação.

Tendo em conta as conclusões gerais dos estudos e tomando como suporte a evidência científica recolhida, tais como: (1) as áreas cerebrais ativadas com a estimulação multisensorial realizada neste trabalho (auditiva-verbal + tátil-manual) são as relacionadas com o processamento do *Self*, (2) a diminuição da sensibilidade tátil da mão no idoso tem implicações na força da mão e nos comportamentos e atitudes face a toque podendo conduzir a dificuldades nas atividades funcionais, a uma diminuição nas relações interpessoais e à desorganização do *Self*; (3) no caso dos idosos, apesar do declínio dos sistemas sensoriais, existe evidência que o processamento multisensorial cerebral estabiliza ou pode mesmo aumentar; propomos que no planeamento da intervenção para um envelhecimento saudável, cujos objetivos sejam a manutenção ou o aumento da funcionalidade e a manutenção da integridade do *Self*, seja contemplada a estratégia de estimulação multisensorial referenciada ao *Self* proposta nesta tese. De acordo com as conclusões obtidas nos estudos desenvolvidos são feitas algumas recomendações para um raciocínio clínico mais adequado e abrangente que possa conduzir a uma prática clínica em Fisioterapia mais eficaz.[1]

[1] Por se apresentar a tese na língua Inglesa, foi decidido não fornecer palavras-chave para o resumo em português por não permitir uma busca consentânea com o texto principal.

Abstract

Whenever there is a decrease of the sensory function, whether due to a disease, trauma or to the normal aging process, a change occurs at the same time in the motor control, in body and emotions perception, in cognitive processing, in the functional activities and in the interpersonal relationships. The feeling that is generated is of loss of identity, of threat, and *Self* disintegration. This phenomenon of consciousness and identity is called the *Self*. There are many concepts of the *Self* but some more recent theories claim that there is only one *Self*. The human being is a whole and the greater this perception of the personal unit the greater physical, cognitive and emotional functionality can be reached.

The *Self* may change when exposed to various health conditions but also due to sensory and relational experiences or due to the lack of stimulation. The stimulation we get through all sensory modalities helps build the representation we make of ourselves. However unisensory stimulation does not seem to be sufficient to promote perception of the *Self* as a whole. Multisensory stimulation, that it comprises meaningful and *Self-referential* stimuli, seems to trigger a more global consciousness of the *Self*. *Self-referential* stimuli are stimuli that are experienced as strongly related to one's own person.

The physiotherapist is a professional who distinguishes himself by the use of sensorial stimulation strategies, considered *Self-referential* stimulation, i.e., auditory-verbal stimulation liked to body parts and direct and prolonged manual contact with the patient´s body. But these approaches are rarely used in neurological Physiotherapy, for sensory and perceptual competences improvement and they are never used simultaneously. In reference to touch there is no concern to assess the perception that clients have about touch. Different meanings can be attributed to physical contact during therapeutic and social interactions and they may generate bonding or avoidant behaviours.

If the loss of sensory function, namely the tactile sense, may lead to the disintegration of the *Self*, the study of this problem becomes more relevant in the elderly because it is proven that in this stage of life there is an important tactile sensory loss with implications in the motor function, in the activities of daily living and in interpersonal relationships.

In this sense this thesis has as general objectives (1) to increase scientific evidence about the clinical practice of Physiotherapy; (2) to contribute to a reflection of clinical practice in Physiotherapy as it regards to the importance of sensory stimulation for the construction

of the *Self*; (3) to allow for further understanding of the healthy aging process related to the functional and interpersonal relationships implications of tactile sensory decrease; (4) to make recommendations for enhancing the quality of provision of Physiotherapy services, specifically with regard to sensory assessment and sensory stimulation strategies. To achieve these objectives three studies were developed: (1) “Multisensory *Self-referential* stimulation of the lower limb – an fMRI study on healthy subjects”; (2) “Tactile Discrimination, Social Touch and Frailty criteria in elderly people”; (3) “Reliability and Validity of the European Portuguese version of the Social Touch Questionnaire”.

The results and conclusions of the studies are: (1) unisensorial auditory-verbal and tactile-manual *Self-referential* stimulation and multisensory *Self-referential* stimulation elicits bilateral activations of the temporoparietal junction (TPJ), of the primary somatosensory cortex (S1), of the primary motor cortex (M1)-BA4 and of the premotor cortex (BA6). These sensorimotor areas were located in the lower-limb sensorimotor representation; *Self-referential* multisensory stimulation related to the body, more than unisensory one, produce a brain activation map in regions that are responsible for multisensory *Self-processing*. This process may represent the *Core-Self*. This brain map is composed of cortical and subcortical midline structures - BA7 (precuneus), left BA9 (medial prefrontal cortex), left BA30 (posterior cingulated), left thalamus, bilateral superior colliculum and left posterior cerebellum) and posterior lateral cortex (such as bilateral TPJ, bilateral posterior BA13 (insula), left BA19 and left BA37). Regarding all these structures, bilateral TPJ is the one that showed the biggest activation volume; (2) the decline of sensorial tactile discrimination of the hand is related to increasing age, to the decrease in grip strength and to higher avoidance behaviours and attitudes towards social touch. Sensorial tactile discrimination of the hand also explains frailty levels in the sample evaluated in the current study, i.e. frail elders have greater loss of sensorial discrimination then pre-frail elders. According to these results hand tactile discrimination should be used in assessment and intervention protocols in pre-frail and frail elders; (3) we produced an European Portuguese version of the Social Touch Questionnaire and is a reliable, valid and comprehensive measurement tool. It is an instrument that evaluates a range of behaviours and attitudes towards the touch and can be used by different health professionals, in clinical practice and for research purposes. Regarding the general conclusions of the studies supported by scientific evidence collected, such as: (1) brain areas activated by the multisensory stimulation performed in this study (auditory-verbal + tactile-manual) are

those related to the *Self* processing; (2) decreased tactile sensitivity of the hand in the elderly has implications in the hand strength and in behaviour and attitudes towards social touch and can lead to difficulties in functional activities, decrease in interpersonal relations and the disorganization of the *Self*; (3) in case of elderly people, despite the deterioration of the sensory systems there is evidence of stabilization or increase of the multisensory integration processing; we recommend to contemplate multisensory *Self-referential* stimulation composed of unisensory auditory-verbal stimulus requesting to feel specific body parts and unisensory tactile-manual stimulation of the same body parts, when planning intervention strategies for healthy aging with the aim of maintaining the integrity of the elderly *Self*.

According to the conclusions obtained in the developed studies some recommendations are presented for a more appropriate and comprehensive clinical reasoning that can lead to a more effective clinical practice in Physiotherapy.

Keywords: brain activity, *Self*, multisensory *Self-referential* stimulation, verbal stimulation, tactile stimulation, Frailty Syndrome, elderly, hand tactile discrimination, Social Touch Questionnaire.

List of abbreviations and acronyms

APA - American Psychiatric Association

ASHT – American Society of Hand Therapists

BA - Brodmann Area

BATST - Behaviours and Attitudes Towards Social Touch

BMI - Body Mass Index

BOLD - Blood Oxygen Level Dependent

ICC - Intraclass Correlation Coefficient

CMS - Cortical Midline Structures

CoM - Centre of Mass

fMRI - Functional Magnetic Resonance Imaging

FOV - Field of View

GS - Grip Strength

IBILI - Institute for Biomedical Imaging and Life Sciences

ICNAS - Instituto de Ciências Nucleares Aplicadas à Saúde

LPFC - Lateral Prefrontal Cortex

M1- Primary Motor Cortex

MMSE - Mini Mental State Examination

MPRAGE - Magnetization Prepared Rapid Acquisition Gradient Echo

MTPSD - Minimal Two Points Stimuli Detected

OR - Odds Ratio

QMI - Questionnaire upon Mental Imagery

RFX - Random Effects Analysis

S1- Primary Somatosensory Cortex

SACMOT - Scientific Advisory Committee of the Medical Outcome Trust

SIPAAS - Social Interaction and Performance Anxiety and Avoidance Scale

STAI - State Trait Anxiety Inventory

SLUMS- Saint Louis University Mental Status

STQ - Social Touch Questionnaire

TE - Echo Time

TD - Tactile Discrimination

TPJ - Temporoparietal Junction

TR - Repetition Time

WFQ-R - Waterloo Footedness Questionnaire-Revised

WHQ-R - Waterloo Handedness Questionnaire-Revised

Tables index

Figures index

Table of Contents

CHAPTER 1

1 INTRODUCTION

This thesis has sensory function as its central theme. It is intended to: (1) increase scientific evidence about the clinical practice of Physiotherapy; (2) contribute to a reflection of clinical practice in Physiotherapy as it regards to the importance of sensory stimulation for the construction of the *Self*; (3) allow for further understanding of the healthy aging process related to the functional and interpersonal relationships implications of tactile sensory decrease; (4) make recommendations for enhancing the quality of provision of Physiotherapy services, specifically with regard to sensory assessment and sensory stimulation strategies.

Whenever there is a decrease of the sensory function, whether due to a disease, trauma or to the normal aging process, a change occurs at the same time in the motor control, in body and emotions perceptions, in cognitive processing, in the functional activities, and in the participation of the individual as a "social being", particularly in interpersonal relationships. The feeling that is generated is that of loss of identity, of threat, and loss or *Self* disintegration as a whole.

This phenomenon of consciousness and identity is called the *Self*. In fact every individual is the result of what he inherits genetically but he is also the result of the perception that he makes of his own emotional feelings throughout life, especially those who arise from sensorial experiences.

In literature we find many concepts of the *Self* but some recent theories claim that there is only one *Self*. The human being is a whole and the greater this *Self-perception* is, the greater physical, cognitive and emotional functionality can be achieved.

In situations of disability the first dimension of the *Self* that is affected is the bodily *Self*-consciousness. The body becomes an obstacle to the achievement of life projects and, the desired *Self* conflicts with the weakness of the perceived *Self*. In fact, consciousness of feelings and perception of the body are essential for reassuring construction of function and personal identity.

On the other hand, the *Self* rises and builds up from the social relations that the individual establishes for himself. In fact, we build these relationships socially and assuming various roles that differentiate us from other individuals and identify us. In this sense another dimension of the *Self* that may be affected is the Social-*Self*.

The *Self* may change when exposed to various health conditions but it changes also due to sensory and relational experiences that are relevant to the individual or due to the lack of stimulation.

The stimulation we get through all sensory modalities helps us build the representation we make of ourselves, i.e. when we feel the touch of someone in our body, when we feel the smell of someone else, when we look at our own body or at the body of another, when someone speaks of our body, or when the movement we make triggers a sound. All these stimuli are provided in unissensorial modalities.

However unisensory stimulation does not seem to be sufficient to promote perception of the *Self* as a whole. Multisensory stimulation, as long as it encompasses meaningful and *Self-referential* stimuli, seems to trigger a more global consciousness of the *Self*. *Self-referential* stimuli are stimuli that are strongly related to one's own person.

In Physiotherapy clinical practice the use of sensory stimulation is crucial to increase the sensory function and motor function.

Alongside other important therapeutic strategies, the physiotherapist is a professional who distinguishes himself by the use of two different *Self-referential* stimulation strategies, the auditory-verbal stimulation and the tactile-manual stimulation (direct and prolonged manual contact with the patient´s body).

Verbal and visual hints are often used but they are focussed on the task itself and the role of the body parts in the proposed activity. Rarely is there an appeal to the conscience of the body parts. As for tactile stimulation, regarding the majority of intervention strategies, manual contact is used to provide a sensorimotor input, stabilizing or guiding the movement of the relevant body part.

The auditory-verbal stimulation (appealing to the conscience body) and the tactile-manual stimulation are rarely used in neurological Physiotherapy, for the sole purpose of sensory and perceptive stimulation. The only area in which these approaches are used is in mental health but there are no protocols based on scientific evidence, and it is not known which brain areas are activated with this specific strategies.

Concerning the body approach trough physical contact, the perception that users make of touch is a variable and as such may impair the therapeutic relationship and influence expected results.

An unexpected touch on an individual's body, even in the therapeutic context, can generate attitudes and behaviours of avoidance to the touch. It is further noted that there is no systematic assessment to the perception that clients have, regarding physical contact. In this sense it is fundamental to previously evaluate this variable. However no instruments to measure touch perception adapted to the Portuguese culture were found.

Another emerging concern is the quality of the delivery of Physiotherapy care to elderly people. During the normal aging process the individual gets confronted with threats or losses related to physical, social and affective functions. The therapeutic support that the elderly can receive to reduce functional losses, the way they become aware of their situation, their acceptance of those changes and the strategies they use to maintain a relationship with oneself and with others are important to ensure their personal balance, the acceptance of themselves as a whole, their identity redefinition and the restructuring of the *Self*.

Considering that the sensory experiences contribute to the integrity of the *Self*, and that there is a progressive loss of sensory function in elderly people, we can assume that this loss can lead to a deterioration of the integrity of the *Self*.

Concerning the study of sensorial function in elderly people, one of the least studied functions is the tactile sensory function. To intervene in an appropriate way it is essential to know if there is indeed tactile sensory loss and what are the implications in the other functional dimensions, particularly the motor function, activities and interpersonal relationships.

Based on the reading of scientific evidence and reflecting on the authors´ professional experience, some assumptions related to the clinical practice were assumed:

(1) there is little concern with regard to the promotion of the clients *Self*-consciousness as a body, emotional and social whole; (2) two of the sensory stimuli that most define

Physiotherapy (verbal and tactile-manual sensory stimuli) are the least studied and applied, and probably they are the ones that could constitute a significant and *Self-referential* stimuli; (3) there are no brain activation studies using the tactile-manual stimulus and the auditory-verbal stimulus (related to sensing the body), applied in this study, either alone or simultaneously. In that sense we do not know what are the areas that process this sensory information; (4) sensory stimulation is used only for the purpose of increasing the sensory and motor function; (5) multisensory stimulation strategies are rarely used; (6) Physiotherapy is a profession that stands out because of touch but there is no concern to assess the perception that users have about being touched; (7) in clinical practice the implications on interpersonal relationships due to loss or tactile sensory decrease are not addressed.

During the course of the study all the above-mentioned assumptions were confirmed. Some of these assumptions are indeed enduring problems related to the practice of the Physiotherapy profession.

To address those problems that the author has identified over twenty five years of clinical practice as a physiotherapist and to make valid recommendation on the proper way to deal with them, three different but relevant studies were conducted.

The starting point was an exploratory study related to the theme of the thesis entitled "Multisensory *Self-referential* stimulation of the lower limb – an fMRI study on healthy subjects". The objectives of this study were (1) to analyse the somatotopic activation during three *Self-referential* stimuli on healthy old adults subjects (a unisensory *Self-*referential stimulus with auditory-verbal stimulus requesting to feel specific body parts, a unisensory *Self-referential* stimulus with tactile-manual stimulation of the same body parts and a third *Self-referential* stimulus comprising of the two previous stimuli applied simultaneously); (2) to understand if the areas activated by multisensorial stimulation are the ones described in the literature as responsible for multisensorial *Self-processing.*

The second study, under the theme "Tactile Discrimination, Social Touch and Frailty criteria in elderly people", was meant (1) to analyse the relationship between tactile discrimination of the hand, avoidance behaviours and attitudes towards social touch and phenotype frailty criteria (unintentional weight loss, self-perception of exhaustion, decrease grip strength, slow walking speed, low level of physical activity) in a sample of institutionalized elderly people; (2) to explore if other variables could also contribute to explain de differences between pre-frail and frail elders.

We have studied some variables related to the sensory, motor and mental functions (sensory tactile discrimination, unintentional weight loss, self-perception of exhaustion, grip strength), with the activity (walking speed, level of physical activity) and with social participation (behaviours and attitudes towards social touch) in an attempt to perceive the individual as a whole, i.e., as a unique *Self*. In fact, according to the literature it seems that the Frailty Syndrome is the condition that poses more serious challenges to the stability of the *Self*.

For the two studies mentioned above, we used convenience samples selected from a population of older adults. This decision was related to three important facts: (1) older adults have a higher incidence of health changes that can lead to loss of sensory and motor functions; (2) it is at this stage of life that the process of sensory tactile deterioration begins or increases and this fact can contribute to the deterioration of the *Self*.

Finally we developed a methodological study entitled "Reliability and Validity of the European Portuguese version of the Social Touch Questionnaire (STQ)" and the purpose was to produce a valid and reliable European Portuguese version of the STQ.

The development of this methodological study was very important for the authors because there was a need to find a tool adapted to the reality of the Portuguese culture to evaluate a very comprehensive range of behaviours and attitudes towards touch and that could be applied in various contexts and by different professionals in health, social and education areas. After the adaptation and validation of the European Portuguese version of the STQ, the questionnaire was applied in both the first and the second studies. The reasons for this were because in the first study attitudes and behaviours towards social touch could affect brain activation and in the second because social touch worked as a variable under study.

The thesis is organized in five chapters. The current Chapter 1 is dedicated to a generic introduction where we present the scope and the aims of the dissertation. Chapters 2 to 4 are dedicated to the presentation of the three studies developed, including findings from the data collected alongside with relevant conclusions and recommendations per study that can be used as potential lines for future research and clinical practice. In Chapter 5 we present a final conclusion of the overall study.

CHAPTER 2

2 Multisensory *Self-referential* stimulation of the lower limb – an fMRI study on healthy subjects

The following study is a version of an article that has been submitted to an international journal with peer review and is currently under revision.

2.1 Introduction

The phenomenon of consciousness and identity, known as the *Self* (Damásio, 2010; Northoff & Bermpohl, 2004; Northoff et al., 2006), is influenced by an individual's life experiences and is relatively stable. One of the life experiences that may constitute a threat to the stability of the *Self* is the presence of a health condition. The sensation that is generated is that of loss of emotional consciousness and loss of consciousness of the body. This holistic view of the person may provide a novel insight for the clinical reasoning in Physiotherapy.
In recent years there has been a major concern amongst philosophers, psychologists and neuroscientists about the *Self*. Many authors have categorized different perceptions and distinct concepts of the *Self* (*Physical-Self, Mental-Self, Spiritual-Self, Proto-Self, Autobiographical-Self, Bodily Self-consciousness*, etc) (Damásio, 1999, 2003, 2010; Ghallager, 2000; Panksepp & Northoff, 2009).

Despite the existence of all these concepts of the *Self*, Damásio conceived the "*Core-Self*" (Damásio, 1999) as a continuous conjunction of interoceptive and exteroceptive stimuli leading to the continuous representation of the experience of the *Self* as a unit.

However, in order to achieve a continuous *Self* representation as a whole, the internal and external stimuli should be *Self-referential*. *Self-referential* stimuli are experienced by the individual himself and are strongly related to one's own person (Northoff & Bermpohl, 2004; Northoff et al., 2006).

If the stimuli are *Self-referential*, the *Self-referential* processing in the brain is common to different components of the *Self* and in different cognitive and sensory domains (Gillihan & Farah, 2005; Lloyd, 2002; Northoff et al., 2006; Yaoi, Osaka, & Osaka, 2009).

Some authors claimed that the "*Core-Self*" is where *Self-referential* processing takes place in the brain (Northoff & Bermpohl, 2004) and is essential to create a model of the *Self.*

This theory is supported by other researchers (Damásio, 1999, 2003, 2010; LeDoux, 2003; Panksepp, 2005) that established a relationship between sensory inputs and *Self-referential* processing. They claim that this relationship takes place in specific brain regions: (1) in the cortical midline structures (CMS), the neural activity, particularly in the anterior region, is essential for transforming simple sensory information into more complex *Self-referential* processing (Mahy, Moses, & Pfeifer, 2014; Northoff et al., 2006); (2) in the lateral prefrontal cortex (LPFC) a higher-order processing occurs, in relation to the autobiographical, emotional, spacial and verbal Selves; (3) in the lateral parietal cortex, bilateral temporal poles, insula, temporoparietal junction (TPJ) and subcortical structures, including brain stem and colliculum (Geng & Vossel, 2013; Northoff et al., 2006), during *Self-referential* cognitive, motor, imagery and unisensory tasks; (4) in medial pre-frontal cortex, the precuneus, the temporal lobes and the inferior frontal gyrus. These brain areas also seem to have an important role in *Self-consciousness* and in tasks that involve thinking about the mental states of other persons (Schurz, Radua, Aichhorn, Richlan, & Perner, 2014).

However, unisensory stimulation may not be sufficient to invoke the perception of a holistic *Self* (Manos Tsakiris, Costantini, & Haggard, 2008; Vignemont, 2006). In fact, everyday life perceptual activities often appear in multiple sensory modalities at once, and our brain is prepared and has the ability to integrate multisensory information related to the body into a unique and coherent perception (Freiherr, Lundström, Habel, & Reetz, 2013; Shams & Seitz, 2008).

In reality, one of the constraints is that many of the studies related with *Self-referential* stimulation developed until now, are focused on single sensory modalities alone (frequently vision) (Beauchamp, 2005a).

Some of the studies that reference multisensory stimulation highlight TPJ as an important multisensory area capable of integrating inputs from different modalities (Blanke, 2012) and containing an internal model of the body that enables the brain to maintain a consistent representation of one's body (Manos Tsakiris et al., 2008). Activation of the

TPJ has also been identified in a variety of Theory of Mind studies[2] (Aichhorn et al., 2009).

On a global basis, the TPJ is characterized as a region between the temporal and parietal lobes surrounding the ends of the sylvian fissure. TPJ is also referred to as the superior temporal gyrus, posterior inferior parietal lobe, ventral parietal cortex and angular gyrus. TPJ is the region that includes BA 22, 37, 39, 40, 42 (Geng & Vossel, 2013; Matsuhashi et al., 2004; Schurz et al., 2014).

However, outside of TPJ, it remains unclear all of the brain regions that are activated by multisensory *Self-referential* stimuli and which ones support the constitution of the *Self*.

Our exploratory whole-brain functional magnetic resonance imaging (fMRI) study is based on the brain activity of lower limbs during three *Self-referential* stimuli on healthy older subjects: (1) a unisensory *Self-referential* stimulus that involves an auditory-verbal stimulus requesting to feel specific body parts (hip, thigh and knee); (2) a unisensory *Self-referential* stimulus with tactile-manual stimulation of the same body parts, according to the Haptonomie science (also known as the science of affectivity) (Veldman, 2001); (3) a third *Self-referential* stimulus, applied according to the principles of multisensory stimulation (Freiherr et al., 2013) and comprising the two previous stimuli applied simultaneously.

The tactile-manual and auditory-verbal (spoken words) stimuli were selected because (1) they have never been performed in any study of brain activity and in particular their application in the lower limbs; (2) of the need to understand their effect on brain activity, with the purpose of a suitable therapeutic decision-making; (3) they originally define Physiotherapy (alongside with Motion); (4) they are rarely used in neurological Physiotherapy clinical practice; (5) they can be considered a *Self-referential* stimuli because they are directly related to the person's own body (Northoff et al., 2006).

As a matter of fact, the unisensory stimulation strategies that have been most used and studied in neurological Physiotherapy are pressure stimulation with objects, thermal stimulation for recovery of sensation, intermittent pneumatic compression intervention for improving tactile and kinesthetic sensation, electrical stimulation, magnetic stimulation, tensive mobilizations of the peripheral nerves, acupuncture and stimulation with cotton,

[2] Theory of Mind is the cognitive capacity to attribute mental states to *Self* and others (Goldman, 2012).

soft brush or with different textures (Chen & Shaw, 2014; Flor & Diers, 2009; Johansson, 2012). Nevertheless, they cannot be considered as *Self-referential* stimulus. Moreover, the most commonly used multisensory strategies are motor imagery, action observation, music therapy, and training with a mirror or in a virtual environment. These multisensory stimulation strategies are more focused on movement than on body perception and consciousness (Johansson, 2012).

The selection of the lower limb is due to the fact that there is extensive research on brain activity during sensory stimulation of the upper limbs but not on lower limbs, especially in their proximal segments. Lower limb activation patterns during sensorial stimulation are still not well understood. More recently, attention has turned to the role of the lower limb proximal structures and current evidence shows that these core muscles are essential in controlling hip abduction and internal rotation of the femur, thereby promoting a more functional distal movement. On the other hand, core instability leads to the development of lower extremity injury (Chuter & Janse de Jonge, 2012).

Two main goals have been elected for the study: (1) to analyse the somatotopic activation during auditory-verbal and tactile-manual unisensory *Self-referential* stimuli and multisensorial *Self-referential* stimulus, comprising the two previous stimuli, applied simultaneously; (2) to understand if the areas activated by multisensorial *Self-referential* stimulation are the ones that are described in literature as responsible for multisensorial *Self- processing.*

We have established the hypothesis that multisensory *Self-referential* stimulation compared with unisensory *Self-referential* stimulation elicits brain activity in regions responsible for multisensory *Self-referential* processing and for that reason these regions could form the *Core-Self.*

2.2 Methodology

All the experimental procedures conducted in this study and described below were approved by the Ethical Committee of Health Sciences Institute at the Portuguese Catholic University.

2.2.1 Participants

Our study is based on a sample of normal older subjects because (1) the knowledge of normal brain activity during several stimulations allows us to understand the normal and abnormal behaviour. It also allows us to provide more appropriate forms of intervention in aging and in neurological disorders (Kolb & Whishaw, 1998); (2) little is known about the processing of multisensory *Self-referential* stimuli in older adults.

As we can see in table 1, ten healthy subjects (5 male/5 female), between 52 and 84 years old (average age of 60.3 ± 9.1 years), were recruited to the study and were given a written informed consent to sign in accordance with the Declaration of Helsinki.

All subjects were screened to ensure that they were in compliance with fMRI safety requirements. All participants were right-handed and right-footed, assessed with the Waterloo Handedness Questionnaire-Revised (WHQ-R) and the Waterloo Footedness Questionnaire-Revised (WFQ-R) (Elias, Bryden, & Bulman-Fleming, 1998). Inclusion criteria included non-brain lesioned subjects, not having psychiatric, motor-sensorial or cognitive disorders or touch avoidance behaviour, and all participants had to be Portuguese native speakers. Anxiety indicators were assessed according to the State Trait Anxiety Inventory (STAI) scale (Kvaal, Ulstein, Nordhus, & Engedal, 2005), cognitive disorders were assessed according to Portuguese version of the Saint Louis University Mental Status scale (SLUMS) (Tariq, Tumosa, Chibnall, Perry, & Morley, 2006), touch avoidance was assessed according to the Social Touch Questionnaire (STQ) (Wilhelm, Kochar, Roth, & Gross, 2001) and clarity and vividness of the ability of mental imagery was assessed applying the Questionnaire upon mental imagery (QMI - auditory and kinaesthetic domains) (Sheehan, 1967) (table 1).

Table 1 - Subjects Characteristics

Subjects	Age	Gender	Handedness and Footedness	QMI - auditory and kinaesthetic domains	STAI Y1	SLUMS	STQ
1	84	F	Right	24	34	25	23
2	57	M	Right	18	28	26	24
3	60	M	Right	17	32	30	14
4	63	F	Right	24	26	28	18
5	56	F	Right	20	28	25	19
6	55	M	Right	10	25	30	9
7	52	F	Right	21	43	25	15
8	64	F	Right	24	34	27	14
9	56	M	Right	16	25	30	17
10	56	M	Right	20	41	30	20
Average	60.3	-	-	19.4	31.6	27.6	17.3

QMI - auditory and kinaesthetic domains (min. 10; max. 70); STAI Y1- State-Trait Anxiety Inventory (min. 20; max. 80); SLUMS-Saint Louis University Mental Status (min 1; max. 30); STQ-Social Touch Questionnaire (min. 0; max. 80);

2.3 Procedures for Brain Activity Acquisition

2.3.1 fMRI Scanning

The fMRI can be considered a major breakthrough in medicine regarding the knowledge of brain functioning. It is a technique that measures the hemodynamic response of neural activity of the brain, based on focal metabolic changes. Thus it is possible to determine the role of different brain areas and map different cortical areas

There is a contrast mechanism which depends on the level of oxygenation of the blood and which has a key role in fMRI called BOLD (blood oxygen level dependent).

There are certain advantages associated with the use of fMRI: (1) discloses short-term physiological changes associated with active brain functioning, enabling assessment of different parts of the brain where mental processes occur and allowing the characterization of activation patterns; (2) is a sensitive and specific method also for the evaluation of perceptual phenomenon and function related to higher-order cognitive networks; (3) is a non-invasive method; (4) does not require injection of contrast; (5) provides a good spatial resolution.

A limitation of fMRI is its poor temporal resolution. This method does not allow temporal sequences of activation and relation between areas (Kim & Ogawa, 2002; Shah, Anderson, Lee, & Wiggins, 2010).

2.3.2 fMRI data collection

Functional images, based on a whole-brain approach, were acquired with a 3 Tesla Scan Siemens Magnetom Trio at the Portuguese Brain Imaging Network.

The experiment started with one 3D anatomical T1-weighted MPRAGE sequence, voxel size 1x1x1, repetition time (TR): 2.530 ms, echo time (TE): 3.42 ms, field of view (FOV): 256 x 256 mm, and a matrix size of 256 x 256. The anatomical sequence was composed of 176 slices. The fMRI experiment was acquired in 2 functional runs: RUN 1 - right lower limb and RUN 2 - left lower limb, in the same session, sensitive to BOLD signal sequences, a TR: 2500 ms, TE: 30 ms, voxel size 3x3x3 mm, FOV: 256 x 256, and a matrix size of 86 x 86. For each run 200 volumes were acquired with 45 slices.
This procedure was also used in a previous study (Almeida, Vieira, Canário, Castelo-Branco, & Castro Caldas, 2015).

2.3.3 Experimental Paradigms

Before stepping into the fMRI machine, the subjects were informed that they would be required to lie down in the scanner with their eyes closed and should experience the various stimulations passively. Headphones were placed on subjects in order to protect them from scanner noise and to hear the verbal commands more clearly.

All subjects were submitted to a single session which included one structural scan and one functional scan with two runs. Each run consisted of 3 stimulation blocks and 1 fixation block (Table 2). For the 3 stimulation blocks the goal was to create a somatotopic activity map according to:

- *Block 1 - auditory-verbal stimulus* requesting to feel specific body parts - *"feel your hip, feel your thigh, feel your knee"* - recorded with a sound recorder using a female voice and translated into Windows media audio (wma) format. It should be noted that, up to this moment, in embodied cognition studies[3] simulation tasks and action words related to the body have only been used, much like imagining body movements or the use of tools (Esopenko, Borowsky, Cummine, & Sarty, 2008; Gabbard, 2012; Hauk, Davis, Kherif, & Pulvermüller, 2008; Kemmerer &

[3] The theory is that many of the dimensions of cognition (language, memory, attention, and reasoning) are embodied, i.e., they are dependent and are influenced by characteristics of the body, how that body collects the information of the environment, the way the body interacts with the brain and how the brain processes this information and raises awareness (Anderson, 2003; Hauk & Tschentscher, 2013)environment, the way the body interacts with the brain and how the brain processes this information and raises awareness (Anderson, 2003; Hauk & Tschentscher, 2013).

Gonzalez-Castillo, 2010; Pulvermüller, Kherif, Hauk, Mohr, & Nimmo-Smith, 2009; Rueschemeyer, Pfeiffer, & Bekkering, 2010; Van Dam, Rueschemeyer, & Bekkering, 2010).

- *Block 2 - Tactile-manual stimulus* based on Haptonomy (Veldman, 2001) performed by a specialized physiotherapist. This particular form of touch was applied with both hands simultaneously around the subject´s relevant body part. Once the hands were in complete contact with the subject´s skin, a slight pressure was exerted and then both hands were gently removed. The choice of type of tactile stimulus was due to the fact that there is limited information about how the brain responds to skin-to-skin contact in a pleasant way (Essick et al., 2010; Guest et al., 2009; Lindgren et al., 2012; Löken, Evert, & Wessberg, 2011; McCabe, Rolls, Bilderbeck, & McGlone, 2008; Olausson, Wessberg, Morrison, McGlone, & Vallbo, 2010; Sliz, Smith, Wiebking, Northoff, & Hayley, 2012).

- *Block 3 – Multisensory simultaneous stimulus* involving auditory-verbal and tactile-manual stimulation. For this block, multisensory integration principles (Freiherr et al., 2013) were considered: (1) unimodal sensory stimuli have to be applied within a certain temporal sequence; (2) sensory stimuli of different modalities have to match in time and space, i.e., there should be spatial concordance between stimuli; (3) contextual and semantic congruency is fundamental; (4) multisensory integration is most effective when less ambiguous individual stimuli are applied. When the conditions set out in the principles are satisfied, the sensory stimuli seem to come from the same object and one can achieve optimal integration results. The congruence of the stimuli was assured by intensive training of the person who applied them, by the visual and auditory feedback received during the experiment so that the stimuli were applied simultaneously and by the presence of an external evaluator that oversaw and validated the congruence of multisensory stimulation.

Each stimulation block (3 per run) included 5 trials lasting 7 seconds each, with 15 seconds of rest time between each trial (totalling 105 seconds of stimulation per run). The fixation blocks lasted 30 seconds, and were applied before the first stimulation trial and after the last stimulation trial per run (2 runs total as described above). The total time for each run came to 495 seconds. The overall functional acquisition lasted 990 seconds for each subject.

The fixation blocks were used for baseline purposes, and the participants were asked to lay at rest and not to make any intentional movement. Carey (2012) states that in order to obtain a brain map of sensory responses it is sufficient to compare de bold signal measured during the stimulation with a baseline "rest". However, some authors claim that when cognitive tasks are performed, a different design may be required with the purpose of isolating the specific cognitive process. In fact the auditory-verbal stimulus used in this study could be considered a cognitive task because it requires proper phonological and semantic processing. Also, the areas responsible for this processing are very similar to the human brain "default network". This network is active during the conscious resting state and many studies demonstrate that these areas are deactivated during cognitive tasks and therefore authors should not make comparisons between cognitive tasks and the baseline "rest".

At first glance this could be observed out as a methodological weakness in this study. However, deactivation only occurs when the stimulus (or task) makes little or no demands to the semantic system. When the stimulus (or task) itself engages the semantic system, deactivation does not occur, i.e., words with meaning (not pseudo-words) do not deactivate the "default network" when compared to the baseline "rest" (Binder, Desai, Graves, & Conant, 2009).

The functional acquisition started with the right lower limb and the sequence of the following stimulation blocks was the same for all subjects. This sequence was previously randomised on Matlab R2013a (Mathworks). Three different image codes were displayed on a computer screen regarding each block, only visible accessible to the physiotherapist. This procedure allowed the physiotherapist to identify the different blocks and to assess their duration.

Table 2 - Experimental paradigm

	495 seconds per RUN (990 seconds per subject)				
	Fixation Block Baseline 1	Block 1 	Block 2 	Block 3 	Fixation Block Baseline 2
RUN 1 - Right Lower Limb Stimulation	30 seconds	Pseudo-randomized sequence, with 5 repetions of each block (7 secondes of stimuli per repetition) and 15 seconds of rest, in between each repetition.			30 seconds
RUN 2 - Left Lower Limb Stimulation	30 seconds	Pseudo-randomized sequence, with 5 repetions of each block (7 secondes of stimuli per repetition) and 15 seconds of rest, in between each repetition			30 seconds

2.4 Image Processing and Data Analysis

BrainVoyager™ QX version 2.3 software (Brain Innovation B.V., The Netherlands; http://www.brainvoyager.com) was used to process images and analyse data.

The anatomical images were re-oriented into a space where the anterior and the posterior commissures were aligned in the same plane (AC-PC) and were then mapped using the Talairach reference system.

Functional images were intensity-adjusted and all slice scans were time- and 3D motion-corrected, temporal-filtered and subsequently coregistered to the structural image. In order to attain signal equilibrium, the first three functional volumes were discarded. The effects of stimulation blocks vs. baseline were determined by performing, for each functional run, a one-way repeated ANOVA measure to identify significant clusters for each contrast. A whole-brain mask was included in order to eliminate voxels located outside of the boundaries of the brain. We considered the presence of significant clusters at the 0.05 threshold, corrected for multiple comparisons using a cluster threshold estimator (based on Monte Carlo simulations [1,000 interactions]). The cluster-size thresholding allowed us to define multi-subject volumes of interest (VOIs), according to the clusters' centre of mass (CoM), and to measure their activation volumes. We also examined the surrounding areas that were included in the identified clusters using the Brain Voyager-Brain Tutor atlas.

These areas were properly identified according to the location of their CoM and peak voxel, but no activation volume was recorded due to the intrinsic limitations of using a brain atlas in order to segment those areas. The VOIs were obtained using particular contrasts. The contrast of separate auditory-verbal, tactile-manual and simultaneous auditory-verbal and tactile-manual stimulus with the baseline was used to provide a *Self-referential* processing map for each type of stimulation.

In literature we can find different criteria for detecting brain areas responsible for multisensory processing, such as criterion is superadditivity, max criterion, mean criterion, etc. However this degree of sensitivity is dependent on the sensory modality of the stimuli or on the type of tasks involved in sensory stimulation. As such, certain limitations have been identified in these criteria and so far a suitable consensus has not been reached yet (Beauchamp, 2005b; Doehrmann & Naumer, 2008; Goebel & Atteveldt, 2009).

For example, if there is the involvement of an auditory stimulus and the appropriate semantic processing, Doehrmann & Naumer (2008) suggest an alternative analysis that allows for the identification of multisensory processing areas. However they still refer the need of the stimuli involved to be significant and for their implementation to be congruent in time and space. In this analysis two conditions are contrasted (congruent vs. incongruent), eliminating the contrast with the unisensorial condition.

Taking into account (1) the limitations on the criteria for detecting brain areas identified in literature; (2) that there is an increasing recommendation for the use of more liberal criteria fitted to the topic at study; (3) the fact that this is an exploratory study that uses for the first time an audio-verbal stimulus combined with tactile-manual stimulation; (4) that the interest in not to eliminate the contrast with the unisensory stimuli, but the comparison between stimuli applied simultaneously with each one individually, because they embodie three distinct intervention strategies used in Physioterapy; (5) that the experimental protocol was built on the principles of multisensory stimulation, in which one of the requirements is the semantic and spatial-temporal coherence of stimuli;

we make the option to perform the following contrasts:

Multisensory stimulation (Unisensory Tactile-Manual + Unisensory Auditory-Verbal) > Unisensory auditory-verbal stimulus; Multisensory stimulation (Unisensory Tactile-Manual + Unisensory Auditory-Verbal) > tactile-manual stimulus, in order to understand if the brain regions activated are the ones described in the literature as responsible for multisensorial *Self- processing*.

2.5 Results

The participants did not reveal high levels of anxiety, cognitive impairment and touch avoidance, which could affect the study results. They also revealed very good mental imagery ability in the sensory modalities addressed in the study

2.5.1 Unisensory Auditory-Verbal stimulation vs Baseline

For both lower limbs, auditory-verbal stimulation elicits a statistically significant (RFX, p = 0.05, corrected) cortical and sub cortical activation, especially in the bilateral sensorimotor areas (S1, primary motor cortex (M1)-BA4, and premotor cortex-BA6), left BA44, bilateral thalamus and bilateral anterior and posterior cerebellum.

For the right lower limb, two of the seven clusters found, stand out due to the high activation volume, both at the right and left TPJ (see Figure 1a, Table 3, Annex B). The cluster 1 has its CoM and Peak Voxel level at BA22 (No. voxels = 22477; t (36) = 8.03; p<0.000001 for the right hemisphere) and includes BA 39, 40 and 41. The cluster 7 has its CoM and Peak Voxel level at BA42 (No. voxels = 33197; t (36) = 7.81; p<0.000001 for the right hemisphere) and includes BA22, 39, 40 and 41.

For the left lower limb, two of the six clusters also revealed a high activation volume (see Figure 1a, Table 3).

The cluster with the greatest volume is the number 6 and has both its CoM and Peak Voxel level at left BA44 (No. voxels = 62346; t (36) = 6.64; p<0.000001 for left hemisphere) and includes left TPJ, left insula and left BA45 and 46.

The other one (number 1) corresponds to the activation of the right TPJ and has both its CoM and Peak Voxel level at BA22 (No. voxels = 12249; t (36) = 5.14; p<0.000011) and extends to right BA39, 40, 41, 42 (see Figure 1a, Table 3, Annex B).

S1 and M1 activations are located in the lower-limb representation (sensorimotor homunculus).

2.5.2 Unisensory Tactile-manual Stimulation vs Baseline

For the right lower limb, tactile-manual stimulation elicits a statistically significant (RFX, p = 0.05, corrected) activation in bilateral TPJ, thalamus, contralateral BA4 (extending to hipsilateral BA4, bilateral S1 and bilateral BA6, located in the lower-limb sensorimotor representation) and BA44 and BA6 (near Broca’s area).

The cluster 5 is the one with the greatest volume of activation has its CoM at left BA44 and Peak Voxel level at left BA6 (No. voxels = 14594; t (36) = 5.69; $p<0.000003$) and includes the left BA13 - anterior insula (see Figure 1b, Table 3, Annex B).

For the left lower limb, tactile-manual stimulation elicits a statistically significant (RFX, p = 0.05, corrected) bilateral TPJ and contralateral BA6. The cluster with the greatest activation volume is the number 3 and was detected in left TPJ, with the CoM in left BA13 – posterior insula and Peak Voxel at left BA40 (No. voxels = 152836; t (36) = 8.77; $p<0.000001$) and includes left BA18, 19, 22, 39, 41, 42, 44, 45, 46 (see Figure 1b, Table 3, Annex B).

2.5.3 Multisensory Tactile-Manual + Auditory-Verbal stimulation vs Baseline

For the right lower limb, multisensory stimulation with tactile-manual and auditory-verbal stimulus elicits a statistically significant (RFX, p = 0.05, corrected) activation in bilateral TPJ, contralateral thalamus (extending to bilateral superior coliculus) and bilateral S1, M1-BA4 and BA6 (located in the lower-limb sensorimotor representation).

The two clusters with the greatest activation volume (number 1 and 4) were found in the TPJ and have their CoM at BA41 and Peak Voxel at BA22 (No. voxels = 29815; t (36) = 8.76; $p<0.000001$ for the right hemisphere and No. voxels = 44650; t (36) = 9.41; $p<0.000001$ for the left hemisphere). Those clusters also include bilateral BA39, 40, 41 and 42 activations (see Figure 1c, Table 3, Annex B).

For the left lower limb we have detected activations in bilateral TPJ, ipsilateral Thalamus and bilateral S1, M1 M1–BA4 and BA6 (located in the lower-limb sensorimotor representation).

The two clusters with the greatest activation volume (number 1 and 4) were found in the TPJ and have their CoM at BA41 and Peak Voxel at BA22 (No. voxels = 13158; t (36) = 5.97; $p<0.000002$ for the right hemisphere and No. voxels = 98687; t (36) = 8.93; $p<0.000001$ for the left hemisphere). Those clusters also include, respectively, right BA39, 40 and left BA18, 19, 39, 40, 41, 42 (see Figure 1c, Table 3, Annex B).

2.5.4 Multisensory stimulation vs. Unisensory stimulation

Compared with auditory-verbal stimulus, multisensory stimulation for the right lower limb elicits a statistically significant (RFX, p = 0.05, corrected) activation in bilateral TPJ and contralateral BA7 (precuneus), BA13 (insula) and BA19 (extending to BA37).

The two clusters with the greatest activation volume (number 1 and 4) were found in the TPJ.

The cluster 1 has its CoM at BA13 and Peak Voxel level at BA22 (No. voxels = 3782; t (36) = 4.47; p<0.000075 for the right hemisphere) and includes BA 39, 40, 41 and 42. The cluster 4 has its CoM at BA13 and Peak Voxel level at BA22 (No. voxels = 4965; t (36) = 4.22; p<0.000157 for the left hemisphere) and includes BA22, 39, 40, 41 and 42. (see Figure 1d, Table 3, Annex B).

For the left lower limb, elicits a statistically significant (RFX, p = 0.05, corrected) activation in ipsilateral TPJ, BA9, BA30 (posterior cingulate), posterior cerebellum, contralateral BA13 (insula) and bilateral BA7 (precuneus) (see Figure 1d, Table 3, Annex B).

The cluster 1 is the one with the greatest activation volume and has both CoM and Peak Voxel level at BA39 (No. voxels = 41592; t (36) = 5.28; p<0.000007 for the left hemisphere) and includes BA 18, 19, 22, 40 and 42.

Compared with tactile-manual stimulus, multisensory stimulation for the right and left lower limb, elicits a statistically significant (RFX, p = 0.05, corrected) activations at bilateral TPJ. Specifically for the right lower limb, we detected activation at bilateral superior colliculus and contralateral posterior cerebellum (see Figure 1e, Table 3, Annex B).

For the right lower limb we detect four clusters and the two clusters with the greatest activation volume (number 1 and 4) were found in the TPJ.

The cluster 1 has its CoM at BA41 and Peak Voxel level at BA22 (No. voxels = 16221; t (36) = 8.63; p<0.000001 for the right hemisphere) and includes BA 38, 39 and 40. The cluster 4 has its CoM at BA41 and Peak Voxel level at BA22 (No. voxels = 16035; t (36) = 7.15; p<0.000001 for the left hemisphere) and includes BA38, 39 and 40.

For the left lower limb we detect two clusters with the greatest activation volume in the TPJ.

The cluster 1 has its CoM at BA41 and Peak Voxel level at BA22 (No. voxels = 7.679; t (36) = 5.11; $p<0.000012$ for the right hemisphere) and includes BA39 and 42. The cluster 2 has its CoM at BA41 and Peak Voxel level at BA22 (No. voxels = 16.369; t (36) = 7.55; $p<0.000001$ for the left hemisphere) and includes BA39 and 42.

Table 3 - Clusters of Activations

Contrast	Run	Center of Mass*						Peak Voxel*								
		Cluster	x	Y	z	Region Area	BA	x	y	Z	Region Area	BA	Other BA included in the cluster	Nº Voxels	t-test	p-value
Verbal vs Baseline	Right	1	52,13	-7,25	4,22	R. Superior Temporal Gyrus-Temporoparietal Junction	R 22	50	-17	6	R. Superior Temporal Gyrus-Temporoparietal Junction	R 22	R 39,40,41	22.477	8.03	P < 0. 000001
		2	37,23	-53,17	-28,12	R. Cerebellum – Anterior lobe – Culmen (IV&V)	-	32	-44	-27	R. Cerebellum – Anterior Lobe – Culmen (IV&V)	-	-	5.825	6.11	P < 0.000001
		3	3,44	-78,30	-24,66	R. Cerebellum – Posterior Lobe – Pyramis (VIII)	-	17	-80	-30	R. Cerebellum – Posterior Lobe – Pyramis (VIII)	-	-	3.623	4.15	P < 0.000193
		4	0,08	-5,37	56,31	L. Medial Frontal Gyrus	L 4	2	-5	57	R. Medial Frontal Gyrus	R 4	R&L S1 R& L 6	7.089	5.59	P < 0.000003
		5	-0,10	-19,21	9,08	L. Thalamus – Medial Dorsal Nucleus	-	2	-11	12	R. Thalamus – Medial Dorsal Nucleus	-	-	3.621	4.28	P < 0.000130
		6	-36,48	-53,19	-27,76	L. Cerebellum – Anterior lobe – Culmen (IV&V)	-	-31	-53	-30	L. Cerebellum – Anterior lobe – Culmen (IV&V)	-	-	4.332	6.03	P < 0.000002
		7	-53,33	-11,91	13,13	L. Superior Temporal Gyrus-Temporoparietal Junction	L 42	-58	-29	12	L. Superior Temporal Gyrus-Temporoparietal Junction	L 42	L 22,39,40,41	33.197	7.81	P < 0.000001
	Left	1	51,74	-14,23	4,90	R. Superior Temporal Gyrus - Temporoparietal Junction	R 22	44	-26	-3	R. Superior Temporal Gyrus-Temporoparietal Junction	R 22	R 39,40,41,42	12.249	5.14	P < 0.000011
		2	38,98	-46.91	-27,51	R. Cerebellum– Anterior lobe-Culmen	-	50	-38	-30	R. Cerebellum – Anterior lobe - Culmen	-	-	2.575	4.52	P < 0.000065
		3	-18,67	-62,19	-26,62	L. Cerebellum-Anterior Lobe-Culmen (IV&V)	-	-34	-50	-30	L. Cerebellum-Anterior Lobe-Culmen (IV&V)	-	-	7.098	5.52	P < 0.000004
		4	-2,55	-7,07	57,15	L. Medial Frontal Gyrus	L 4	-1	-17	66	L. Medial Frontal Gyrus	L 4	R&L S1 R 4 R&L 6	5.643	5.42	P < 0.000005
		5	-14,34	-2,16	12,67	L. Thalamus-Anterior Ventral Nucleus		-13	-8	21	L. Caudado	-	-	2.883	5.05	P < 0.000014
		6	-51,09	-9,63	15,09	L. Inferior Frontal Gyrus	L44	-52	10	24	L. Inferior Frontal Gyrus	L44	L 45,46, L. Ínsula L TPJ	62.346	6.64	P < 0.000001

Center of Mass*								Peak Voxel*									
Contrast	**Run**	**Cluster**	**x**	**y**	**z**	**Region Area**	**BA**	**x**	**y**	**z**	**Region Area**	**BA**	**Other BA included in the cluster**	**Nº Voxels**	**t-test**	**p-value**
Manual vs Baseline	**Right**	1	52,13	-33,32	27,21	R. Inferior Parietal Lobule- Temporoparietal Junction	R 40	56	-26	18	R. Parietal Postcentral Gyrus- Temporoparietal Junction	R 40	R 7, 39	6.425	4.81	P < 0.000028
		2	43,74	11.85	14,22	R. Ínsula	R 13	50	25	12	R. Inferior Frontal Gyrus	R 45	R. 44	8.976	4.75	P < 0.000032
		3	-2,90	-8,26	55,66	L. Medial Frontal Gyrus	L 4	-4	-2	60	L. Medial Frontal Gyrus	L 4	L&R S1 R 4 L&R 6	6.269	4.60	P < 0.000051
		4	-9,89	-19,25	10,74	L. Thalamus-Medial Dorsal Nucleus	-	-16	-17	15	L. Thalamus-Ventral Lateral Nucleus	-	-	1.678	4.22	P < 0.000155
		5	-48,60	11,95	14,03	L. Inferior Frontal Gyrus	L 44	-58	1	30	L. Frontal Precentral Gyrus	L 6	L Anterior Ínsula	14.594	5.69	P < 0.000003
		6	-55,40	-36,48	26,33	L. Inferior Parietal Lobule- Temporoparietal Junction	L 40	-55	-38	33	L Supramarginal Gyrus- Temporoparietal Junction	L 40	L 7, 39	10.490	4.84	P < 0.000025
	Left	1	51,88	-29,74	23,61	R. Inferior Parietal Lobule- Temporoparietal Junction	R 40	50	-32	24	R. Inferior Parietal Lobule- Temporoparietal Junction	R 40	R 39,41,42	2.986	4.42	P < 0.000088
		2	48,33	7,21	28,52	R. Inferior Frontal Gyrus	R 44	45	-5	51	R. Frontal Precentral Gyrus	R 6	-	3.163	4.55	P < 0.000059
		3	-37,52	-19,48	15,59	L. Posterior Ínsula	L13	-64	-32	21	L. Superior Temporal Gyrus- Temporoparietal Junction	L 40	L 18, 19,22,39,41 ,42,44,45, 46	152.836	8.77	P < 0.000001

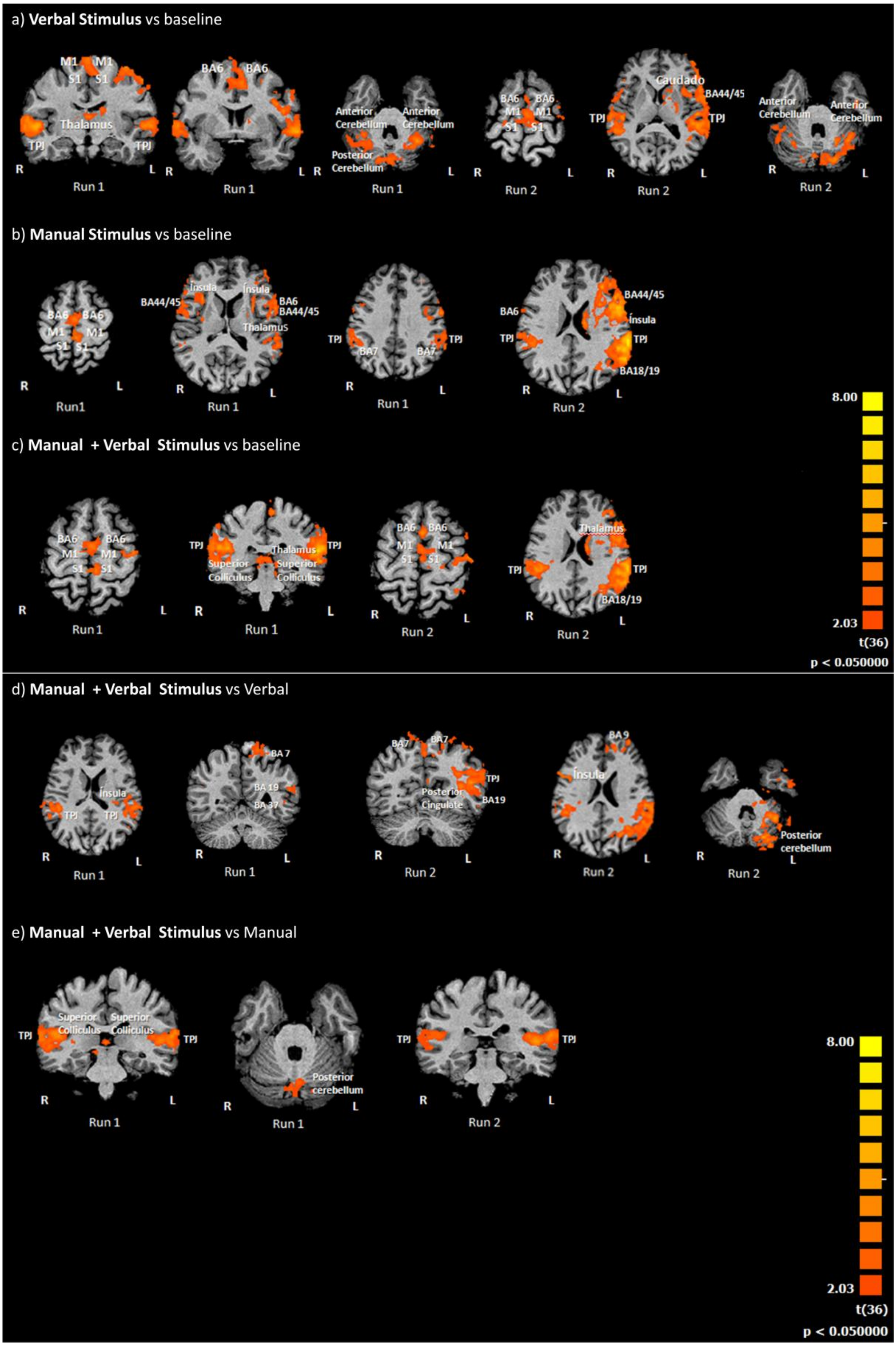
Center of Mass*								Peak Voxel*								
Contrast	**Run**	**Cluster**	**x**	**y**	**z**	**Region Area**	**BA**	**x**	**y**	**z**	**Region Area**	**BA**	**Other BA included in the cluster**	**Nº Voxels**	**t-test**	**p-value**
Manual + Verbal vs Baseline	Right	1	52,49	-17,44	9,56	R. Superior Temporal Gyrus- Temporoparietal Junction	R 41	53	-20	12	R. Superior Temporal Gyrus- Temporoparietal Junction	R 22	R 39,40, 41,42	29.815	8.76	P < 0.000001
		2	-2,00	-13,46	60,56	L.Medial Frontal Gyrus	L 4	2	-5	57	R.Medial Frontal Gyrus	R 4	R & L S1 R & L 6	6.600	4.85	P < 0.000025
		3	-5,60	-23,80	2,98	L. Thalamus	-	-16	-17	15	L. Thalamus-Ventral Lateral Nucleus	-	L & R Superior Colliculus	2.753	5.25	P < 0.000008
		4	-52,75	-20,28	14,19	L. Superior Temporal Gyrus- Temporoparietal Junction	L 41	-58	-29	12	L. Superior Temporal Gyrus- Temporoparietal Junction	L 22	L 39,40,41,42	44.650	9.41	P < 0.000001
	Left	1	52,07	-21,74	12,09	R. Superior Temporal Gyrus - Temporoparietal Junction	R 41	50	-11	6	R. Superior Temporal Gyrus- Temporoparietal Junction	R 22	R 39,40	13.158	5.97	P < 0.000002
		2	-1,26	-9,09	58,45	L Medial Frontal Gyrus	L 4	-1	-17	66	L Medial Frontal Gyrus	L4	R & L S1 R&L 6 R & L 4	4.914	5.30	P < 0.000007
		3	-15,13	-7,06	11,15	L. Thalamus-Ventral Lateral Nucleus	-	-13	-14	3	L. Thalamus-Ventral Lateral Nucleus	-	-	4.363	4.90	P < 0.000021
		4	-47,66	-24,72	12,45	L Superior Temporal Gyrus - Temporoparietal Junction	L 41	-58	-29	12	L. Superior Temporal Gyrus- Temporoparietal Junction	L 22	L 18,19,39,40 ,41,42	98.687	8.93	P < 0.000001

Center of Mass*								Peak Voxel*								
Contrast	Run	Cluster	x	y	z	Region Area	BA	x	y	z	Region Area	BA	Other BA included in the cluster	Nº Voxels	t-test	p-value
Manual + Verbal vs Verbal	Right	1	51,16	-30.72	20,22	R. Ínsula	R 13	53	-20	12	R. Superior Temporal Gyrus-Temporoparietal Junction	R 22	R 39, 40,41,42	3.782	4.47	P < 0.000075
		2	-15,64	-49,25	58,41	L. Superior Parietal Lobe	L 7	-16	-47	57	L. Parietal Lobe-Precuneus	L 7	-	1.428	5.69	P < 0.000003
		3	-38,86	-12,24	4,13	L. Ínsula	L 13	-37	-17	0	L. Ínsula	L 13	-	1.491	4.48	P < 0.000074
		4	-54,86	-35,88	19,47	L. Ínsula	L 13	-58	-29	15	L. Superior Temporal Gyrus-Temporoparietal Junction	L 22	L 39, 40,41,42	4.965	4.22	P < 0.000157
		5	-50,88	-61,51	-6,13	L. Midle Occipital Gyrus	L 19	-52	-65	-12	L. Temporal Fusiform Gyrus	L 19	L 37	1.535	4.13	P < 0.000202
	Left	1	46,91	-29,61	19,48	R. Ínsula	R 13	47	-35	21	R. Ínsula	R 13	-	2.156	4.02	P < 0.000278
		2	1,65	-49,35	57,52	R. Medial Parietal Lobe-Precuneus	R 7	20	-50	66	R. Parietal Postcentral Gyrus-Precuneus	R 7	L 7	3.342	6.33	P < 0.000001
		3	-9,55	49,94	26,61	L. Medial Prefrontal Cortex	L 9	-4	52	30	L. Medial Prefrontal Cortex	L 9	-	4.000	4.24	P < 0.000148
		4	-12,25	-95,32	-14,79	L. Occipital Lingual Gyrus	L 17	-13	-95	-21	L. Cerebellum Posterior Lobe-Uvula (IX)	-	-	1.934	4.42	P < 0.000087
		5	-2,50	-49,17	5,80	L. Posterior Cingulate	L 30	-1	-47	15	L. Posterior Cingulate	L 30	-	1.409	4.40	P < 0.000093
		6	-48,36	-40,37	17,89	L. Superior Temporal Gyrus- Temporoparietal Junction	L 39	-46	-56	12	L. Middle Temporal Gyrus-Temporoparietal Junction	L 39	L 18,19,22,40,42	41.592	5.28	P < 0.000007
		7	-25,20	-74,01	-33,82	L. Cerebellum Posterior Lobe-Pyramis (VIII)	-	-28	-65	-42	L. Cerebellum-Posterior/Inferior - Semi-Lunar Lobe (HVII)	-	-	3.241	4.50	P < 0.000068

Center of Mass*								Peak Voxel*								
Contrast	**Run**	**Cluster**	**x**	**y**	**z**	**Region Area**	**BA**	**x**	**y**	**z**	**Region Area**	**BA**	**Other BA included in the cluster**	**Nº Voxels**	**t-test**	**p-value**
Manual + Verbal vs Manual	**Right**	1	53,61	-16,26	4,93	R. Superior Temporal Gyrus-Temporoparietal Junction	R 41	53	-14	3	R. Superior Temporal Gyrus-Temporoparietal Junction	R 22	R 38,39,40	16.221	8.63	P < 0.000001
		2	2,17	-35,05	-2,32	R. Midbrain-Superior Colliculum	-	8	-29	0	R. Midbrain-Superior Colliculum	L Superior Colliculum	-	1.572	4.06	P < 0.000247
		3	-1,06	-71,94	-24,15	L. Cerebellum-Posterior Lobe-Vermis - Pyramis (VIII)	-	-1	-74	-30	L. Cerebellum-Posterior Lobe-Vermis - Pyramis (VIII)	-	-	2.074	3.62	P < 0.000899
		4	-56,52	-22,84	5,53	L. Superior Temporal Gyrus-Temporoparietal Junction	L 41	-58	-29	12	L. Superior Temporal Gyrus-Temporoparietal Junction	L 22	L 38,39,40	16.035	7.15	P < 0.000001
	Left	1	54,27	-19,29	7,15	R. Superior Temporal Gyrus-Temporoparietal Junction	R 41	47	-14	6	R. Superior Temporal Gyrus-Temporoparietal Junction	R 22	R 39,42	7.679	5.11	P < 0.000012
		2	-55,59	-24,13	5,86	L. Superior Temporal Gyrus-Temporoparietal Junction	L 41	-46	-23	3	L. Superior Temporal Gyrus-Temporoparietal Junction	L 22	L 39,42	16.369	7.55	P < 0.000001

*Talairach coordinates; BA: Brodmann area; R: right hemisphere; L: left hemisphere; S1: primary somatosensory cortex.

Figure 1: Statistical maps of activation for lower-limb stimulation



BA: Brodmann area; R: right hemisphere; L: left hemisphere; Run 1: right leg; Run 2: left leg.

2.6 Discussion and conclusions

Common brain map for unisensory and for multisensorial Self-referential stimulation

As we can infer from our results, cortical and subcortical midline structures were activated by the tactile-manual and auditory-verbal unisensory stimuli and by the multisensorial stimuli provided. This fact is supported by other studies (LeDoux, 2003; Northoff et al., 2006) that also claim that if *Self-referential* processing is supported by sensory processing and linked to it, we should observe activations in both subcortical and cortical midline regions.

There is also a predominance of activations in the left cerebral hemisphere. Literature points out some reasons for this such as: (1) the left-hemisphere lateralization for the phonological and semantic processing (Binder et al., 2009); (2) the right handedness and footedness of the subjects (Jirak, Menz, Buccino, Borghi, & Binkofski, 2010). In the case of this study, all subjects are right handed and right footed.

In our study, unisensory auditory-verbal *Self-referential* stimulation, unisensory tactile-manual and multisensory *Self-referential* stimulation elicits strong and significant activation of bilateral TPJ.

Studies relating unisensory stimuli, similar to those applied in this investigation, with the *Self*, concluded that: (1) in touch experiences, the differentiation between *Self* and other is based on a network of brain regions that supports a sense of the *Bodily-Self*, comprising TPJ, precentral gyrus and posterior parietal cortex (Ebisch et al., 2011); (2) faced with a tactile stimulus, TPJ, alongside with other structures, helps to promote the consciousness of this stimulus (Gallace & Spence, 2008); (3) there is a convergence of somatosensory, auditory and visual responses in this region (Matsuhashi et al., 2004); (4) unisensory processing of *Self-referential* stimulation provide an input to the multisensory processes in TPJ (Gallace & Spence, 2008; Serino et al., 2013).

In fact, TPJ is responsible for multisensory processing. Several functional imaging studies, performed with normal subjects and patients with perceptive problems, reported the involvement of this region in multisensory stimulation, in cognitive and behavioural tasks related to the *Self*. They conclude that TPJ: (1) is essential for *Self-location*, for maintaining a coherent sense of one’s body and for visuo-spatial perspective, because it receives visual, tactile, auditive, proprioceptive and vestibular signals of the body orientation within the environment (Serino et al., 2013); (2) encodes a map of auditory information crucial for articulatory representations, kept in premotor cortex (Josse, Joseph, Bertasi, & Giraud, 2012); (3) possess an internal model of the body, that is capable of determining whether sensory events belong to one's own body (Orlov, Makin, & Zohary, 2010); (4) is involved in the attention process, responding to significant stimuli or tasks (Geng & Vossel, 2013); (5) is activated during mental state reasoning in adults, in Theory of Mind and in mental imagery of one's own body (Blanke et al., 2005); (6) is involved in vestibular processing and in the perception of human bodies or body parts (Blanke & Arzy, 2005).

We found also that unisensory *Self-referential* stimulation and multisensory *Self-referential* stimulation trigger bilateral activation of sensorimotor areas (S1, BA4, and BA6) located in the lower-limb sensorimotor representation.

All investigations agree that the S1 area has a prominent contralateral response. Nevertheless, recent evidence (Tamè et al., 2012) revealed that S1 contributes to the spatial coding of touch by discriminating between different body parts and integrates the somatosensory input coming from the two sides of the body. These findings also corroborate the fact that body parts are not perceived per se, but they imply a sense of the whole body system (Borghi & Cimatti, 2010). Several studies (Bao et al., 2012; Davis, Kwan, Crawley, & Mikulis, 1998; Fabri et al., 2005; Tamè et al., 2012) also demonstrated that unilateral stimulation of the human lower limb can elicit activations in bilateral S2, and, in a recent one (Almeida, Vieira, Canário, Castelo-Branco, & Castro Caldas, 2015), activations were detected in bilateral S1, BA4 and BA6 for the lower limb movement with tactile-manual and auditory-verbal stimulation.

One of the reasons that explains bilateral activations in S1 and S2 is that there are direct projections from somatosensory inputs to ipsilateral S1 (besides contralateral projections) and also that thalamic projections and contralateral S1 and S2 information are sent through the corpus callosum to ipsilateral S1 and S2 (Blankenburg et al., 2008; Tamè et al., 2012). Another reason linked specifically with lower limbs and supported by literature (Selzer, Clarke, Cohen, Duncan, & Gage, 2006) could be related to the Central Pattern Generators, i.e., gait is the lower limbs´ main function and the rhythmic movement between the two legs is managed by a Central Pattern Generator that corrects imperfect sensory feedback and adapts central input to the peripheral input.

Movement is critical for developing the sense of our own body. Nevertheless, the sense of body is previously grounded in sensations rather than in agency. Literature about embodied cognition is only focused on action and less on *Self-sensing* the body (Borghi & Cimatti, 2010) and unfortunately, according to the most radical interpretation of embodied cognition theory, action is the core of embodied cognition.

The most significant embodied theory of cognition is the mirror neuron theory, which claims that the motor system is automatically activated when conceptual and perceptual tasks are performed, i.e. when processing auditory-verbal stimuli (action verbs), when observing another person's body performing actions or manipulating objects (Mahon & Caramazza, 2008) and also when performing tasks that comprise words or verbs related to the body parts (Jirak et al., 2010).

However, the motor system (BA4 and BA6) is also engaged in mental operation tasks that do not involve any movement (Georgopoulos, 2000; Hanakawa et al., 2002). These areas are considered the key to associate symbolic cues and responses in both motor and non-motor behaviours, such as deciphering the meaning of words, introspection and thoughts (Clark, 2006; Hanakawa et al., 2002). In fact, thinking allows us to have *Self-consciousness*, and this is linked to *Self-representation*, i.e., we observe our physical or mental state, thus obtaining an internal image of ourselves (Legrand, 2007).

Other authors (Rochat & Striano, 2000; Ruby & Legrand, 2007) claim that sensory stimulation related to the body is crucial to explain our intuitive perception of being located where the body is felt.

The most important dimension of the *Self* is the feeling of one's body. The interconnections of different modalities of sensory information with proprioception and with the motor system provide a solid and lasting signature of the *Self*. In particular, sensorimotor cortices code for some abstract and global representation of the boundary between the *Self* and the external world (Ruby & Legrand, 2007; Manos Tsakiris, 2010).

Specific brain map for unisensory Self-referential stimulation

The unisensory tactile-manual and auditory-verbal stimulus related to felling the body elicits strong activation in BA44. The most recent literature confirms the interaction between semantic knowledge and sensorimotor processes. Embodied cognition theory also proposes that in order to understand a sentence, we simulate the perceptual processes that sustained the task meaning (Caramazza, Anzellotti, Strnad, & Lingnau, 2014). In fact, BA44 is involved in non-verbal functions, such as working memory, attention in speech, mirror neuron system and object manipulation, but also in a variety of language tasks including production, comprehension, processing, syntactic information as well as word and sentence processing (Bedny, Hulbert, & Thompson-Schill, 2007; Bookheimer, 2002; Embick et al., 2000)

BA 44 also seems to be responsible for the congruence of the words related to the body and respective movement (Josse, Joseph, Bertasi, & Giraud, 2012) because some aspects of semantic knowledge about words are stored in the form of motor representations (Caramazza et al., 2014) and body schema is reflected in lexical–semantic representations (Rueschemeyer, Pfeiffer, & Bekkering, 2010)

Findings from other studies (Borghi & Cimatti, 2010; Gianelli, Scorolli, & Borghi, 2013; A. Goldman & de Vignemont, 2009; Schaefer, Heinze, & Rotte, 2012) suggest that the body is always an acting body, and that language is also a form of action.

Bernal, Ardila, & Rosselli (2015) also confirmed that the BA44 is part of a language functions network, along with anterior insula, BA6 and BA4, with connections to cerebellum. In fact, for auditory-verbal stimulus we observed the involvement of the anterior and posterior cerebellum, and for the tactile-manual stimulus, the activation of the anterior insula.

Specific brain map for multisensory Self-referential stimulation

Due to lack of consensus in literature of the most appropriate criteria for the detection of regions of multisensory integration, Goebel & Atteveldt (2009) recommend that whatever the options, the results should all be presented, described and analyzed in the greatest detail possible.

Compared with tactile-manual unisensory *Self-referential* stimulation, multisensory *Self-referential* stimulation elicits activity: (1) bilateral TPJ; (2) bilateral superior colliculum and (3) left posterior cerebellum. Literature shows that the left cerebellar hemisphere is engaged in language processing (Jirak et al., 2010) and that the posterior lobe is involved in higher-level tasks with an important role in language, spatial and cognitive functions (implicated in prefrontal-cerebellar loops), and in emotional processing associated with the cerebellar-limbic circuit (Stoodley, Valera, & Schmahmann, 2012). The cerebellum is also an interface between motor and sensory events, and the sensory inputs from different modalities reach the cerebellum through the superior colliculum (Glickstein, Sultan, & Voogd, 2011; Manni & Petrosini, 2004). The posterior cerebellum is also responsible for the homunculus representation of the lower limb in the posterior lobe (Manni & Petrosini, 2004).

Compared with auditory-verbal unisensory Self-referential stimulation, multisensory Self-referential stimulation elicits activity:

(1) In cortical and subcortical midline structures - BA7 (precuneus), left BA9 (medial prefrontal cortex), left BA30 (posterior cingulated) and left posterior cerebellum. BA7, BA9 and BA30 are regions that are repeatedly activated in studies related to the *Self*.

(2) In posterior lateral cortexes (such as bilateral TPJ, bilateral posterior BA13 (insula), left BA19 and left BA37). Regarding all these structures, bilateral TPJ is the one that showed the biggest activation volume. Posterior bilateral insula activations were also detected in multisensory *Self-referential* stimulation compared with unisensory auditory-verbal stimulation. This result is in line with previous studies (Manos Tsakiris, Hesse, Boy, Haggard, & Fink, 2007) that claim that the posterior insula is responsible for attribution of body parts to oneself in the absence of motor action (thus, insular activity may reflect body-ownership rather than reflecting agency). The posterior insula also belongs to a sensorimotor network for body-ownership, transforming sensory inputs into feelings (Craig, 2003; Ferri, Frassinetti, Ardizzi, Costantini, & Gallese, 2012; Manos Tsakiris, 2010). Some authors (Björnsdotter, Löken, Olausson, Vallbo, & Wessberg, 2009) state that gentle touch is processed in the posterior insular cortex, and one of the stimuli used in multisensory stimulation is based on gentle touch. Also a surprising finding is the activation of left BA19 and BA37 with multisensory *Self-referential* stimulation compared to baseline and compared with unisensory auditory-

verbal stimulation. Some researchers (Dehaene, Clec'H, Poline, Bihan, & Cohen, 2002; Gardini, De Beni, Cornoldi, Bromiley, & Venneri, 2005; Olivetti Belardinelli et al., 2009) suggest that these areas are involved in sensory mental imagery experiences, supported by different brain networks, depending on the type of image that needs to be generated, which involves also the frontal (BA9), parietal (BA13) and temporal regions (mostly BA40).

Many studies (Ebisch et al., 2011; Ferri et al., 2012; Fu et al., 2006; Jirak et al., 2010; Kuehn, Trampel, Mueller, Turner, & Schütz-Bosbach, 2012; Northoff & Bermpohl, 2004; Ruby & Legrand, 2007; Sperduti, Delaveau, Fossati, & Nadel, 2011; Suzuki, Garfinkel, Critchley, & Seth, 2013; Tamè et al., 2012; M Tsakiris, Longo, & Haggard, 2010; Yaoi et al., 2009) which investigated the cerebral correlations of a common and unique *Self* link all the above-mentioned structures to several dimensions of the *Self* , especially a brain network comprising medial prefrontal cortex (BA9), precuneus (BA7), posterior cingulate gyrus (BA30) and temporoparietal junction (Ciavarro et al., 2012; Ruby & Legrand, 2007).

Can we consider these regions Self-specific?

On one hand, Ruby & Legrand (2007) state that that the previous stated brain network cannot be considered *Self-specific* because the activation of the regions that form the network could be explained also by the reasoning involved in the evaluation of the sensory inputs using the information stored in memory. They also argued that sensorimotor integration may also play an important role in the construction of the *Self*. On the other hand Northoff et al. (2006) demonstrated that there is a consistent activity in the cortical-subcortical midline system that underlies the human *Self*. They have also pointed out that *Self-referential* processing in those regions constitutes the Core of our *Self* and their activation is observed in *Self-referential* tasks across all domains and sensory modalities. Other investigations (Blanke et al., 2005) also state that TPJ is a crucial region for conscious experience of the normal *Self*.

In fact, until now there is no clear picture of the neuroimage of the *Self*. However, in our study it appears that *Self-specificity* may be supported by somatosensory information and by multisensory integration and processing because the results demonstrate the activation of a possible network constituted by sensorimotor areas, by cortical and subcortical midline structures (BA7, BA9, BA30, superior colliculum and posterior cerebellum) and by TPJ, posterior BA13, BA19 and BA37.

Our experiment seems to indicate that *Self-referential* multisensory inputs related to the body, more than unisensory ones, produce an activation map in regions that are responsible for multisensory *Self-processing*. Actually we live in a multisensory environment, and the interaction between our genetic heritage and this environment defines and reorganizes our brains at every moment. Our brain has a large capacity for automatic and simultaneous integration and processing of multisensory information (Johansson, 2012).

For these reasons, in order to achieve a *Self* adjusted to reality, there has to be a constant updating of sensory and motor representations (Manos Tsakiris, Schütz-Bosbach, & Gallagher, 2007). Recent research in older adults (Freiherr et al., 2013) has shown that there is a stabilization or an increase of brain multisensory processing, despite the decline in unisensory systems during aging, and our sample seems to demonstrate the integrity of multisensory processing. It is important to highlight that this process is very important for body perception, for the processing of emotions and for the stability of the aging *Self* (Coleman, Ivani-Chalian, & Robinson, 1999).

Sensory stimuli (visual, auditive, tactile and proprioceptive) are perceived through sensory organs distributed on the body surface. Nevertheless, the body is perceived as a unique entity and not as a set of fragmented parts (Tessari, Tsakiris, Borghi, & Serino, 2010). When the stimuli are addressed to a particular body part, sensory information is processed in sensorimotor brain areas related to that body part. However there is a process that transforms sensation of the body parts in a single and unique body perception. Some facts support this process: (1) throughout our body there are neurons with large visual, auditory, tactile and proprioceptive receptive fields; 2) there is a multisensory interplay in low level cortical structures, considered until recently as unisensory areas (primary sensory cortices); (3) neuronal populations exist in specific high level multisensory brain areas that process multisensory information provided by the body (Cappe, Rouiller, & Barone, 2009; Driver & Noesselt, 2008; Gazzola et al., 2012; Keysers, Kaas, & Gazzola, 2010; Petkova et al., 2011; Schroeder & Foxe, 2005).

Implications for Physiotherapy practice

The results of this study may guide new clinical reasoning because, if we apply the multisensory *Self-referential* stimulation with tactile-manual and auditory-verbal stimuli (appealing to feel body parts), we can contribute to the *Self-Consciousness* and Identity, helping to maintain the stability of the Self or its reorganization (Tajadura-Jiménez, Grehl, & Tsakiris, 2012). Furthermore, the results may represent an effective strategy for promoting better perceptual learning. In fact, perceptual learning allows a cerebral reorganization and has an important impact in different dimensions, such as cognitive and motor dimensions (Cuppini, Magosso, & Ursino, 2011; Shimojo & Shams, 2001).

We also highlight the need for the use of meaningful stimuli for the subject because some brain areas responsible for the multisensory processing are activated strongly in response to meaningful stimuli (Beauchamp, 2005a; Doehrmann & Naumer, 2008). Also, it is essential to take into account the principles of multisensory stimulation (Freiherr et al., 2013), particularly the principle of congruence. In addition to the parameters of time and space, multisensory integration can also be influenced by the semantic congruence of the stimuli (Calvert & Thesen, 2004).

It is important to notice that the unisensory stimuli applied in this study provide a direct relationship between the physiotherapist and the subject, through touch and speech. This statement needs to be considered thoroughly because not all stimuli promote a therapeutic relationship, which is a very important factor for the success of each health-related intervention. And because the way we talk and how we touch may have a negative or positive influence on the emotional condition of the individuals, the physiotherapist, when planning research studies or in clinical context, should be trained in voice projection and in affective touch. On the other hand, we have to be aware that multisensory experiences shared between ourselves and others can change the mental representation of our own identity (Tajadura-Jiménez et al., 2012).

Research Implications

It is recommended to continue to study the impact of multisensory *Self-referential* stimulation with unisensory stimuli performed in this study in other body parts and on different outcomes, such as body Self-consciousness, postural control, upper and lower limb motor control, sensorial system, quality of life, gait, emotions, cognitive function, etc., both on healthy and non healthy subjects, on young adults and children, as well as with larger samples. It is advisable also to use other analysis criteria to validate the brain map found, as responsible for the multisensory processing related with the *Self*, and in particular the Congruent vs. Incongruent.

For future reference, fMRI research studies, using the same type of stimuli that was used for the current experiment, should set the procedures for functional sequences in the same run to minimize instrumental bias in order to allow for direct comparisons between right and left stimulation and to consolidate the validity of the results.

Conclusions

Taking into account the objectives of this study, we conclude that the somatotopic map of activation for unisensory auditory-verbal, for tactile-manual *Self-referential* stimulation and for multisensory *Self-referential* stimulation, related to body parts of the lower limb in healthy subjects, elicits bilateral activations of sensorimotor areas (S1, BA4, BA6), of BA44 and of the TPJ. Specific for auditory-verbal stimulus, we found significant activation on left thalamus and on bilateral anterior and posterior cerebellum, and specific to tactile-manual stimulus, we detect significant activation in bilateral BA13 (insula) and bilateral BA44.

Moreover, the results of the multisensory *Self-referential* stimulation presented in our experiment offer a contribution to both the theory that *Self-referential* multisensory processing is the core of the *Self* and to the Damásio theory of a unique *Self*. In fact, besides the TPJ, already defined as a region of multisensorial processing related to the *Self*, some of the structures that belong to the cortical and subcortical midline structures also seem to be responsible for the multisensorial processing of this particular multisensorial *Self-referential* stimulus. This multisensory processing is supported by sensorimotor integration.

These findings seem to indicate that multisensory *Self-referential* processing of multisensorial *Self-referential* stimuli is mediated by (1) sensorimotor areas; (2) TPJ; (3) cortical and subcortical midline structures. This processing in these structures may represent the *Core-Self*.

2.7 References

Aichhorn, M., Perner, J., Weiss, B., Kronbichler, M., Staffen, W., & Ladurner, G. (2009). Temporo-parietal Junction Activity in Theory-of-Mind Tasks: Falseness, Beliefs or Attention. *Journal Cognitive Neuroscience*, *21*(6), 1179–1192.

Almeida, P., Vieira, A. I., Canário, N., Castelo-Branco, M., & Castro Caldas, A. (2015). Brain Activity during Lower-Limb Movement with Manual Facilitation : an fMRI Study. *Neurology Research International*, 1–14.

Anderson, M. L. (2003). Embodied Cognition: A field guide. *Artificial Intelligence*, *149*(1), 91–130. doi:10.1016/S0004-3702(03)00054-7

Bao, R., Wei, P., Li, K., Lu, J., Zhao, C., Wang, Y., & Zhang, T. (2012). Within-limb somatotopic organization in human SI and parietal operculum for the leg: an fMRI study. *Brain Research*, *1445*, 30–39. doi:10.1016/j.brainres.2012.01.029

Beauchamp, M. S. (2005a). See me, hear me, touch me: multisensory integration in lateral occipital-temporal cortex. *Current Opinion in Neurobiology*, *15*(2), 145–153. doi:10.1016/j.conb.2005.03.011

Beauchamp, M. S. (2005b). Statistical criteria in FMRI studies of multisensory integration. *Neuroinformatics*, 93–113. doi:10.1385/NI

Bernal, B., Ardila, A., & Rosselli, M. (2015). Broca's area network in language function: a pooling-data connectivity study. *Frontiers in Psychology*, *6*, 1–8. doi:10.3389/fpsyg.2015.00687

Binder, J. R., Desai, R. H., Graves, W. W., & Conant, L. L. (2009). Where Is the Semantic System? A Critical Review and Meta-Analysis of 120 Functional Neuroimaging Studies. *Cerebral Cortex*, *19*(12), 2767–2796. doi:10.1093/cercor/bhp055

Björnsdotter, M., Löken, L., Olausson, H., Vallbo, A., & Wessberg, J. (2009). Somatotopic organization of gentle touch processing in the posterior insular cortex. *The Journal of Neuroscience*, *29*(29), 9314–9320. doi:10.1523/JNEUROSCI.0400-09.2009

Blanke, O. (2012). Multisensory brain mechanisms of bodily self-consciousness. *Nature Reviews - Neuroscience*, *13*(8), 556–571. doi:10.1038/nrn3292

Blanke, O., & Arzy, S. (2005). The out-of-body experience: disturbed self-processing at the temporo-parietal junction. *The Neuroscientist*, (1992), 16–24. doi:10.1177/1073858404270885

Blanke, O., Mohr, C., Michel, C. M., Pascual-Leone, A., Brugger, P., Seeck, M., Thut, G. (2005). Linking out-of-body experience and self processing to mental own-body imagery at the temporoparietal junction. *The Journal of Neuroscience*, *25*(3), 550–557. doi:10.1523/JNEUROSCI.2612-04.2005

Blankenburg, F., Ruff, C. C., Bestmann, S., Bjoertomt, O., Eshel, N., Josephs, O., Driver, J. (2008). Interhemispheric effect of parietal TMS on somatosensory response confirmed directly with concurrent TMS-fMRI. *The Journal of Neuroscience, 28*(49), 13202–13208. doi:10.1523/JNEUROSCI.3043-08.2008

Borghi, A. M., & Cimatti, F. (2010). Embodied cognition and beyond: acting and sensing the body. *Neuropsychologia*, *48*(3), 763–773. doi:10.1016/j.neuropsychologia.2009.10.029

Calvert, G. A., & Thesen, T. (2004). Multisensory integration : methodological approaches and emerging principles in the human brain. *Journal of Physiology*, *98*, 191–205. doi:10.1016/j.jphysparis.2004.03.018

Cappe, C., Rouiller, E. . M., & Barone, P. (2009). Multisensory anatomical pathways. *Hearing Research*, *258*(1-2), 28–36. doi:10.1016/j.heares.2009.04.017

Carey, L. M. (2012). *Stroke Rehabilitation: Insights from Neuroscience and Imaging*. New York: Oxford University Press.

Chen, J.-C., & Shaw, F.-Z. (2014). Progress in sensorimotor rehabilitative physical therapy programs for stroke patients. *World Journal of Clinical Cases*, *2*(8), 316–26. doi:10.12998/wjcc.v2.i8.316

Chuter, V. H., & Janse de Jonge, X. A. K. (2012). Proximal and distal contributions to lower extremity injury: A review of the literature. *Gait & Posture, 36*, 7–15. doi:10.1016/j.gaitpost.2012.02.001

Ciavarro, M., Ambrosini, E., Tosoni, A., Committeri, G., Fattori, P., & Galletti, C. (2012). A Meta-Analysis of Functional Neuroimaging Studies of Self and Other Judgments Reveals a Spatial Gradient for Mentalizing in Medial Prefrontal Cortex. *Journal of Cognitive Neuroscience*, *24*(8), 1742–1752. doi:10.1162/jocn

Clark, A. (2006). Language, embodiment and the cognitive niche. *Trends in Cognitive Sciences*, *10*(8), 370–4. doi:10.1016/j.tics.2006.06.012

Coleman, P. G., Ivani-Chalian, C., & Robinson, M. (1999). Self and identity in advanced old age: validation of theory through longitudinal case analysis. *Journal of Personality*, *67*(5), 819–849. doi:10.1111/1467-6494.00074

Craig, A. D. (2003). Interoception: The sense of the physiological condition of the body. *Current Opinion in Neurobiology*, *13*, 500–505. doi:10.1016/S0959-4388(03)00090-4

Cuppini, C., Magosso, E., & Ursino, M. (2011). Organization, maturation, and plasticity of multisensory integration: insights from computational modeling studies. *Frontiers in Psychology*, *2*(7), 1–21. doi:10.3389/fpsyg.2011.00077

Damásio, A. (1999). *The Feeling of What Happens: Body and Emotion in the Making of Consciousness*. (H. Brace, Ed.). New York.

Damásio, A. (2003). Mental self: The person within. *Nature*, *423*. doi:doi:10.1038/423227a

Damásio, A. (2010). *Self comes to mind : constructing the conscious brain*. (W. Heinemann, Ed.) (1 edition.). New York: Pantheon Books.

Davis, K., Kwan, C., Crawley, A., & Mikulis, D. (1998). Functional MRI study of thalamic and cortical activations evoked by cutaneous heat, cold and tactile stimuli. *The American Physiological Society*, 1533–1546.

Dehaene, S., Clec'H, G. Le, Poline, J., Bihan, D. Le, & Cohen, L. (2002). The visual word form area: a prelexical representation of visual words in the fusiform gyrus. *Brain Imaging*, *13*(3), 321–325.

Doehrmann, O., & Naumer, M. J. (2008). Semantics and the multisensory brain: how meaning modulates processes of audio-visual integration. *Brain Research*, *1242*, 136–150. doi:10.1016/j.brainres.2008.03.071

Driver, J., & Noesselt, T. (2008). Multisensory Interplay Reveals Crossmodal Influences on "Sensory-Specific" Brain Regions, Neural Responses, and Judgments. *Neuron*, *57*(1), 11–23. doi:10.1016/j.neuron.2007.12.013

Ebisch, S. J. H., Ferri, F., Salone, A., Perrucci, M. G., D'Amico, L., Ferro, F. M., Gallese, V. (2011). Differential involvement of somatosensory and interoceptive cortices during the observation of affective touch. *Journal of Cognitive Neuroscience*, *23*(7), 1808–1822. doi:10.1162/jocn.2010.21551

Elias, L. J., Bryden, M. P., & Bulman-Fleming, M. B. (1998). Footedness is a better predictor than is handedness of emotional lateralization. *Neuropsychologia*, *36*(1), 37–43. doi:10.1016/S0028-3932(97)00107-3

Esopenko, C., Borowsky, R., Cummine, J., & Sarty, G. (2008). Mapping the semantic homunculus: A functional and behavioural analysis of overt semantic generation. *Brain Topography*, *21*, 22–35. doi:10.1007/s10548-008-0043-8

Essick, G. K., McGlone, F., Dancer, C., Fabricant, D., Ragin, Y., Phillips, N., Guest, S. (2010). Quantitative assessment of pleasant touch. *Neuroscience and Biobehavioral Reviews*, *34*(2), 192–203. doi:10.1016/j.neubiorev.2009.02.003

Fabri, M., Del Pesce, M., Paggi, A., Polonara, G., Bartolini, M., Salvolini, U., & Manzoni, T. (2005). Contribution of posterior corpus callosum to the interhemispheric transfer of tactile information. *Brain Research*, *24*(1), 73–80. doi:10.1016/j.cogbrainres.2004.12.003

Ferri, F., Frassinetti, F., Ardizzi, M., Costantini, M., & Gallese, V. (2012). A sensorimotor network for the bodily self. *Journal of Cognitive Neuroscience*, *24*(7), 1584–1595. doi:10.1162/jocn_a_00230

Flor, H., & Diers, M. (2009). Sensorimotor training and cortical reorganization. *NeuroRehabilitation*, *25*(1), 19–27. doi:10.3233/NRE-2009-0496

Freiherr, J., Lundström, J. N., Habel, U., & Reetz, K. (2013). Multisensory integration mechanisms during aging. *Frontiers in Human Neuroscience*, *7*(863), 1–6. doi:10.3389/fnhum.2013.00863

Fu, C., Vythelingum, G., Brammer, M., Williams, S., Amaro, E., Andrew, C., McGuire, P. (2006). An fMRI study of verbal self-monitoring: neural correlates of auditory verbal feedback. *Cerebral Cortex*, *16*(7), 969–977. doi:10.1093/cercor/bhj039

Gabbard, C. (2012). The role of mental simulation in embodied cognition. *Early Child Development and Care*, *1*(8), 37–41. doi:10.1080/03004430.2012.681649

Gallace, A., & Spence, C. (2008). The cognitive and neural correlates of “tactile consciousness”: a multisensory perspective. *Consciousness and Cognition*, *17*(1), 370–407. doi:10.1016/j.concog.2007.01.005

Gardini, S., De Beni, R., Cornoldi, C., Bromiley, A., & Venneri, A. (2005). Different neuronal pathways support the generation of general and specific mental images. *NeuroImage*, *27*, 544–552. doi:10.1016/j.neuroimage.2005.04.032

Gazzola, V., Spezio, M. L., Etzel, J. A., Castelli, F., Adolphs, R., & Keysers, C. (2012). Primary somatosensory cortex discriminates affective significance in social touch. *Proceedings of the National Academy of Sciences*, *109*(25), E1657–1666. doi:10.1073/pnas.1113211109

Geng, J., & Vossel, S. (2013). Re-evaluating the role of TPJ in attentional control: Contextual updating? *Neuroscience & Biobehavioral Reviews*, *37*, 2608–2620.

Georgopoulos, A. P. (2000). Neural aspects of cognitive motor control. *Current Opinion in Neurobiology*, *10*, 238–241.

Ghallager, S. (2000). Philosophical conceptions of the self: implications for cognitive science. *Trends in Cognitive Sciences*, *4*(1), 14–21.

Gianelli, C., Scorolli, C., & Borghi, A. M. (2013). Acting in perspective: the role of body and language as social tools. *Psychological Research*, *77*(1), 40–52. doi:10.1007/s00426-011-0401-0

Gillihan, S. J., & Farah, M. J. (2005). Is self special? A critical review of evidence from experimental psychology and cognitive neuroscience. *Psychological Bulletin*, *131*(1), 76–97. doi:10.1037/0033-2909.131.1.76

Glickstein, M., Sultan, F., & Voogd, J. (2011). Functional localization in the cerebellum. *Cortex*, *47*(1), 59–80. doi:10.1016/j.cortex.2009.09.001

Goebel, R., & Atteveldt, N. Van. (2009). Multisensory functional magnetic resonance imaging : a future perspective. *Experimental Brain Research*, *198*, 153–164. doi:10.1007/s00221-009-1881-7

Goldman, A., & de Vignemont, F. (2009). Is social cognition embodied? *Trends in Cognitive Sciences*, *13*(4), 154–159. doi:10.1016/j.tics.2009.01.007

Goldman, A. I. (2012). Theory of Mind. In E. Margolis, R. Samuels, & S. Stich (Eds.), *Oxford Handbook of Philosophy and Cognitive Science* (E-reader., p. 402). Retrieved from http://philosophy.rutgers.edu/

Guest, S., Essick, G., Dessirier, J. M., Blot, K., Lopetcharat, K., & McGlone, F. (2009). Sensory and affective judgments of skin during inter and intrapersonal touch. *Acta Psychologica*, *130*(2), 115–126. doi:10.1016/j.actpsy.2008.10.007

Hanakawa, T., Honda, M., Sawamoto, N., Okada, T., Yonekura, Y., Fukuyama, H., & Shibasaki, H. (2002). The role of rostral Brodmann area 6 in mental operation tasks: an integrative neuroimaging approach. *Cerebral Cortex*, *12*, 1157–1170. doi:10.1093/cercor/12.11.1157

Hauk, O., Davis, M. H., Kherif, F., & Pulvermüller, F. (2008). Imagery or meaning? Evidence for a semantic origin of category-specific brain activity in metabolic imaging. *The European Journal of Neuroscience*, *27*(7), 1856–66. doi:10.1111/j.1460-9568.2008.06143.x

Hauk, O., & Tschentscher, N. (2013). The Body of Evidence: What Can Neuroscience Tell Us about Embodied Semantics? *Frontiers in Psychology*, *4*(February), 50. doi:10.3389/fpsyg.2013.00050

Jirak, D., Menz, M. M., Buccino, G., Borghi, A. M., & Binkofski, F. (2010). Grasping language - a short story on embodiment. *Consciousness and Cognition*, *19*(3), 711–720. doi:10.1016/j.concog.2010.06.020

Johansson, B. B. (2012). Multisensory stimulation in stroke rehabilitation. *Frontiers in Human Neuroscience*, *6*(60), 1–11. doi:10.3389/fnhum.2012.00060

Josse, G., Joseph, S., Bertasi, E., & Giraud, A. (2012). The Brain ’s Dorsal Route for Speech Represents Word Meaning : Evidence from Gesture. *Plos One*, *7*(9). doi:10.1371/journal.pone.0046108

Kemmerer, D., & Gonzalez-Castillo, J. (2010). The Two-Level Theory of verb meaning: An approach to integrating the semantics of action with the mirror neuron system. *Brain and Language*, *112*, 54–76. doi:10.1016/j.bandl.2008.09.010

Keysers, C., Kaas, J. H., & Gazzola, V. (2010). Somatosensation in social perception. *Nature Reviews - Neuroscience*, *11*(6), 417–428. doi:10.1038/nrn2919

Kolb, B., & Whishaw, I. Q. (1998). Brain Plasticity and Behavior. *Annual Review of Psychology*, *49*, 43–64. doi:10.1146/annurev.psych.49.1.43

Kuehn, E., Trampel, R., Mueller, K., Turner, R., & Schütz-Bosbach, S. (2012). Judging roughness by sight - a 7-Tesla fMRI study on responsivity of the primary somatosensory cortex during observed touch of self and others. *Human Brain Mapping*, *34*(8), 1882–1895. doi:10.1002/hbm.22031

Kvaal, K., Ulstein, I., Nordhus, I. H., & Engedal, K. (2005). The Spielberger State-Trait Anxiety Inventory (STAI): the state scale in detecting mental disorders in geriatric patients. *International Journal of Geriatric Psychiatry*, *20*(7), 629–634.

LeDoux, J. (2003). The Self - Clues from de Brain. *Annals of the New York Academy of Sciences*, *26*(1001), 295–304.

Legrand, D. (2007). Subjectivity and the body: introducing basic forms of self-consciousness. *Consciousness and Cognition*, *16*(3), 577–582. doi:10.1016/j.concog.2007.06.011

Lindgren, L., Westling, G., Brulin, C., Lehtipalo, S., Andersson, M., & Nyberg, L. (2012). Pleasant human touch is represented in pregenual anterior cingulate cortex. *NeuroImage*, *59*(4), 3427–3432. doi:10.1016/j.neuroimage.2011.11.013

Lloyd, D. (2002). Functional MRI and the study of human consciousness. *Journal of Cognitive Neuroscience*, *14,* 818–831. doi:10.1162/089892902760191027

Löken, L. S., Evert, M., & Wessberg, J. (2011). Pleasantness of touch in human glabrous and hairy skin: Order effects on affective ratings. *Brain Research*, *1417*, 9–15. doi:10.1016/j.brainres.2011.08.011

Mahon, B. Z., & Caramazza, A. (2008). A critical look at the embodied cognition hypothesis and a new proposal for grounding conceptual content. *Journal of Physiology*, *102*, 59–70. doi:10.1016/j.jphysparis.2008.03.004

Mahy, C. E. V, Moses, L. J., & Pfeifer, J. H. (2014). How and where : Theory-of-mind in the brain. *Developmental Cognitive Neuroscience, 9*, 68–81.

Manni, E., & Petrosini, L. (2004). A century of cerebellar somatotopy: a debated representation. *Nature Reviews - Neuroscience*, *5,* 241–249. doi:10.1038/nrn1347

Matsuhashi, M., Ikeda, A., Ohara, S., Matsumoto, R., Yamamoto, J., Takayama, M., Shibasaki, H. (2004). Multisensory convergence at human temporoparietal junction - epicortical recording of evoked responses. *Clinical Neurophysiology*, *115*(5), 1145–

1160. doi:10.1016/j.clinph.2003.12.009

McCabe, C., Rolls, E. T., Bilderbeck, A., & McGlone, F. (2008). Cognitive influences on the affective representation of touch and the sight of touch in the human brain. *Social Cognitive and Affective Neuroscience*, *3*(2), 97–108. doi:10.1093/scan/nsn005

Northoff, G., & Bermpohl, F. (2004). Cortical midline structures and the self. *Trends in Cognitive Sciences*, *8*(3), 102–107. doi:10.1016/j.tics.2004.01.004

Northoff, G., Heinzel, A., Greck, M., Bermpohl, F., Dobrowolny, H., & Panksepp, J. (2006). Self-referential processing in our brain - a meta-analysis of imaging studies on the self. *NeuroImage*, *31*(1), 440–457. doi:10.1016/j.neuroimage.2005.12.002

Olausson, H., Wessberg, J., Morrison, I., McGlone, F., & Vallbo, Å. (2010). The neurophysiology of unmyelinated tactile afferents. *Neuroscience and Biobehavioral Reviews*, *34*(2), 185–191. doi:10.1016/j.neubiorev.2008.09.011

Olivetti Belardinelli, M., Palmiero, M., Sestieri, C., Nardo, D., Di Matteo, R., Londei, A., Romani, G. L. (2009). An fMRI investigation on image generation in different sensory modalities: The influence of vividness. *Acta Psychologica*, *132*(2), 190–200. doi:10.1016/j.actpsy.2009.06.009

Orlov, T., Makin, T. R., & Zohary, E. (2010). Topographic Representation of the Human Body in the Occipitotemporal Cortex. *Neuron*, *68*(3), 586–600. doi:10.1016/j.neuron.2010.09.032

Panksepp, J. (2005). Affective consciousness: Core emotional feelings in animals and humans. *Consciousness and Cognition*, *14*(1), 30–80. doi:10.1016/j.concog.2004.10.004

Panksepp, J., & Northoff, G. (2009). The trans-species core SELF: the emergence of active cultural and neuro-ecological agents through self-related processing within subcortical-cortical midline networks. *Consciousness and Cognition*, *18*(1), 193–215. doi:10.1016/j.concog.2008.03.002

Petkova, V. I., Björnsdotter, M., Gentile, G., Jonsson, T., Li, T.-Q., & Ehrsson, H. H. (2011). From part to whole body ownership in the multisensory brain. *Current Biology*, *21*(13), 1118–1122. doi:10.1016/j.cub.2011.05.022

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *The Behavioral and Brain Sciences, 4*, 515–526.

Pulvermüller, F., Kherif, F., Hauk, O., Mohr, B., & Nimmo-Smith, I. (2009). Distributed cell assemblies for general lexical and category-specific semantic processing as revealed by fMRI cluster analysis. *Human Brain Mapping*, *30*, 3837–3850. doi:10.1002/hbm.20811

Rochat, P., & Striano, T. (2000). Perceived self in infancy. *Infant Behavior & Development*, *23*, 513–530.

Ruby, P., & Legrand, D. (2007). Neuroimaging the self? In Y. Rosseti, P. Haggard, & M. Kawato (Eds.), *Sensorimotor Foundations of Higher Cognition (22nd Attention & Performance Meeting)* (pp. 293–318). Oxford University Press. doi:http://dx.doi.org/10.1037/a0014172

Rueschemeyer, S.-A., Pfeiffer, C., & Bekkering, H. (2010). Body schematics: on the role of the body schema in embodied lexical-semantic representations. *Neuropsychologia*, *48*(3), 774–781. doi:10.1016/j.neuropsychologia.2009.09.019

Schaefer, M., Heinze, H., & Rotte, M. (2012). Touch and personality: extraversion predicts somatosensory brain response. *NeuroImage*, *62*(1), 432–8. doi:10.1016/j.neuroimage.2012.05.004

Schroeder, C. E., & Foxe, J. (2005). Multisensory contributions to low-level, “unisensory” processing. *Current Opinion in Neurobiology*, *15*(4), 454–8. doi:10.1016/j.conb.2005.06.008

Schurz, M., Radua, J., Aichhorn, M., Richlan, F., & Perner, J. (2014). Fractionating Theory of Mind : A meta-analysis of functional brain imaging studies. *Neuroscience and Biobehavioral Reviews*, *42*, 9–34.

Selzer, M. E., Clarke, S., Cohen, L. G., Duncan, P. W., & Gage, F. H. (2006). *Textbook of Neural Repair and Rehabilitation* (Vol. 2). New York: Cambridge University Press. doi:10.1017/CBO9780511545078

Serino, A., Alsmith, A., Costantini, M., Mandrigin, A., Tajadura-Jimenez, A., & Lopez, C. (2013). Bodily ownership and self-location: components of bodily self-consciousness. *Consciousness and Cognition*, *22*(4), 1239–1252. doi:10.1016/j.concog.2013.08.013

Shams, L., & Seitz, A. R. (2008). Benefits of multisensory learning. *Trends in Cognitive Sciences*, *12*(11), 411–417. doi:10.1016/j.tics.2008.07.006

Sheehan, P. W. (1967). A shortened form of Betts' Questionnaire upon Mental Imagery. *Journal of Clinical Psychology*, *23*, 386–389.

Shimojo, S., & Shams, L. (2001). Sensory modalities are not separate modalities : plasticity and interactions. *Current Opinion in Neurobiology*, *11*, 505–509.

Sliz, D., Smith, A., Wiebking, C., Northoff, G., & Hayley, S. (2012). Neural correlates of a single session massage treatment. *Brain Imaging and Behavior*, *6*(1), 77–87. doi:10.1007/s11682-011-9146-z

Sperduti, M., Delaveau, P., Fossati, P., & Nadel, J. (2011). Different brain structures related to self and external agency attribution: a brief review and meta-analysis. *Brain Structure & Function*, *216*(2), 151–157. doi:10.1007/s00429-010-0298-1

Stoodley, C. J., Valera, E. M., & Schmahmann, J. D. (2012). Functional topography of the cerebellum for motor and cognitive tasks: An fMRI study. *NeuroImage*, *59*(2), 1560–1570. doi:10.1016/j.neuroimage.2011.08.065

Suzuki, K., Garfinkel, S. N., Critchley, H. D., & Seth, A. K. (2013). Multisensory integration across exteroceptive and interoceptive domains modulates self-experience in the rubber-hand illusion. *Neuropsychologia*, *51*(13), 2909–17. doi:10.1016/j.neuropsychologia.2013.08.014

Tajadura-Jiménez, A., Grehl, S., & Tsakiris, M. (2012). The other in me: interpersonal multisensory stimulation changes the mental representation of the self. *PloS One*, *7*(7), e40682. doi:10.1371/journal.pone.0040682

Tamè, L., Braun, C., Lingnau, A., Schwarzbach, J., Demarchi, G., Li Hegner, Y., Pavani, F. (2012). The contribution of primary and secondary somatosensory cortices to the representation of body parts and body sides: an fMRI adaptation study. *Journal of Cognitive Neuroscience*, *24*(12), 2306–2320. doi:10.1162/jocn_a_00272

Tariq, S. H., Tumosa, N., Chibnall, J. T., Perry, M. H., & Morley, J. E. (2006). Comparison of the Saint Louis university mental status examination and the minimental state examination for detecting dementia and mild neurocognitive disorder - A pilot study. *The American Journal of Geriatric Psychiatry*, *14*, 900–910.

Tessari, A., Tsakiris, M., Borghi, A. M., & Serino, A. (2010). The sense of body: A multidisciplinary approach to body representation. *Neuropsychologia*, *48*, 643–644. doi:10.1016/j.neuropsychologia.2009.12.004

Tsakiris, M. (2010). My body in the brain: a neurocognitive model of body-ownership. *Neuropsychologia*, *48*(3), 703–12. doi:10.1016/j.neuropsychologia.2009.09.034

Tsakiris, M., Costantini, M., & Haggard, P. (2008). The role of the right temporo-parietal junction in maintaining a coherent sense of one's body. *Neuropsychologia*, *46*(12), 3014–8. doi:10.1016/j.neuropsychologia.2008.06.004

Tsakiris, M., Hesse, M. D., Boy, C., Haggard, P., & Fink, G. R. (2007). Neural signatures of body ownership: a sensory network for bodily self-consciousness. *Cerebral Cortex*, *17*(10), 2235–2244. doi:10.1093/cercor/bhl131

Tsakiris, M., Longo, M., & Haggard, P. (2010). Having a body versus moving your body : Neural signatures of agency and body-ownership.pdf. *Neuropsychologia*. Retrieved from http://www.sciencedirect.com/science/article/pii/S0028393210002022

Tsakiris, M., Schütz-Bosbach, S., & Gallagher, S. (2007). On agency and body-ownership: phenomenological and neurocognitive reflections. *Consciousness and Cognition*, *16*(3), 645–660. doi:10.1016/j.concog.2007.05.012

Van Dam, W. O., Rueschemeyer, S. A., & Bekkering, H. (2010). How specifically are action verbs represented in the neural motor system: an fMRI study. *NeuroImage*, *53*(4), 1318–1325. doi:10.1016/j.neuroimage.2010.06.071

Veldman, F. (2001). *Haptonomie - Science de l'Affectivité* (8th edn.). Paris: Presses Universitaires de France.

Vignemont, F. (2006). How the Body Shapes the Mind. *Psyche*, *12*(1), 1–7. Retrieved from http://jeannicod.ccsd.cnrs.fr/ijn_00169845/

Wilhelm, F. H., Kochar, A. S., Roth, W. T., & Gross, J. J. (2001). Social anxiety and response to touch: Incongruence between self-evaluative and physiological reactions. *Biological Psychology*, *58*, 181–202. doi:10.1016/S0301-0511(01)00113-2

Yaoi, K., Osaka, N., & Osaka, M. (2009). Is the self special in the dorsomedial prefrontal cortex? An fMRI study. *Social Neuroscience*, *4*(5), 455–463. doi:10.1080/17470910903027808.

CHAPTER 3

3 Tactile Discrimination, Social Touch and Frailty Criteria in Elderly People.

The following study is a version of an article that has been published in Archives of Gerontology and Geriatrics:

Vieira, A. I., Nogueira, D., Reis, E. A., Rosado, M. L., Nunes, M. V., Castro-Caldas, A. (2016). Hand tactile discrimination, social touch and frailty criteria in elderly people: A cross sectional observational study. *Archives of Gerontology and Geriatrics. 66* (73-81). DOI 10.1016/j.archger.2016.04.012**.**

3.1 Introduction

Frailty is currently seen as a major problem in public health. It is a multidimensional syndrome of loss of physical, cognitive and health reserves among the elderly. It leads to great vulnerability and it is a predictor of disability, of the need for institutionalization, of the occurrence of falls, and of death (Malaguarnera et al. 2013; Nowak & Hubbard 2009; Rockwood et al. 2005).

There are several definitions for frailty and over time numerous attempts have been made to create a reliable instrument that can measure it. This reflects uncertainty about the term and its components (Rockwood et al. 2005).

The latest definition (Clegg et al. 2013) portrays frailty as a state of vulnerability and precarious balance in which the response to stress factors is compromised, thus increasing the risk of falls, delirium, disability, long term care needs and death. This contemporary approach attempts to focus attention on a more holistic view of the elderly, their condition and their life contexts.

Frailty is not synonymous with comorbidity or disability because comorbidities are a risk factor for frailty and disability is a result of frailty (Fried et al. 2001; Lang & Michel 2009).

These considerations and findings raise questions about how frailty in the elderly can be reliably detected, how it develops and how it can be prevented (Kan et al. 2008; Morley et al. 2013).

There are several types of evaluation and amongst them the one that contains the largest number of objective criteria is the Phenotype of Frailty (Fried et al. 2001). These criteria have been validated independently and can be used to measure frailty in the context of clinical practice. However, they were selected at random from a cohort study that did not aim to study frailty and does not contain other very important factors for the frailty assessment such as the cognitive level, the presence of depression, or sensory function (Clegg et al. 2013; Lang & Michel 2009).

One aspect that has been little explored, whether regarding frailty evaluation models or therapeutic interventions in older people with frailty, is the sensory function. Furthermore, whenever sensory function related to frailty is discussed, the only sensory modalities that are taken into account are vision and hearing. However data in the literature (Humes et al. 2013; Schumm et al. 2009; Shaffer et al. 2007) shows that other senses, such as smell, taste and touch are also affected with advancing age. Furthermore the sensory decline in all sensory modalities starts with motor decline.

On the other hand, the assessment of sensory function is an important outcome in health and it is essential to take into account that a sensory decrease can constitute a symptom or can be predictive of other health problems (Schumm et al. 2009).

Specifically related to touch, several authors (Brodoehl et al. 2013; Carmeli et al. 2003; Kaneko et al. 2005; Wickremaratchi & Llewelyn 2006) reported that tactile thresholds in healthy elderly are significantly higher than in younger healthy individuals. This fact is probably due to changes in the skin, in central and peripheral nervous system, in the decline in sensory nerve conduction velocity and also in the decrease of the amplitude of the sensory action potential.

For the visually and hearing impaired there are compensation mechanisms through technical aids that minimize these losses, which does not happen in the case of decreased tactile sensibility. With aging there is a sensory decline, and, in most studies related to tactile sensory changes in the elders, only certain body parts are studied, such as the knee and foot region, neglecting sensory changes in the hands (Carmeli et al. 2003).

In this study we will try to emphasize the hand, despite the importance of research in other body parts, including the foot. For instance, related with decreased sensation in the feet, Shaffer et al. (2007) concluded that the structural and functional decline of the somatosensory system that occurs with aging, potentially contributes to the postural instability and may lead to the risk of falls, because in order to maintain a proper and safe postural control we rely primarily on skin and proprioceptive inputs, in addition to visual and vestibular ones.

In the particular case of elderly people's hands, the deterioration of the tactile sensory function occurs due to age-related changes, such as musculoskeletal, vascular and nerve degenerative changes, and changes in the brain centres responsible for unisensorial processing (Brodoehl et al. 2013; Carmeli et al. 2003). There is also a relationship with decreased in grip strength (GS) (Wickremaratchi & Llewelyn 2006), as well as with loss of hand functionality (Guclu-Gunduz et al. 2012; Melchior et al. 2007; Ranganathan et al. 2001; Wickremaratchi & Llewelyn 2006). This loss is also associated with a greater dependence in the performance of daily activities (Kalisch et al. 2008).

Tactile perception, unlike other sensory modalities, always occurs within the personal space and plays a complex holistic role, as it influences and is influenced by emotions and the social context. In fact, the sense of effective touch, in addition to its discriminating function, plays an important role in communication, relationships, sharing of feelings (Craig & Rollman 1999; Dunbar 2010; Gallace & Spence 2010; Morrison et al. 2010) and mediating and regulating emotions (Hertenstein et al. 2006).

This reasoning supports the "Social Touch" hypothesis. This hypothesis proposes that the mechanoreceptors non-myelinated afferents, known as C-Touch (CT), provide a neurobiological basis for the development of the social brain, mediate social behaviour and are responsible for maintaining social relationships as they are as they are involved in coding and processing tactile signals associated with affective touch (Björnsdotter et al. 2009; Gordon et al. 2013; Olausson et al. 2010). Although in order to complete the feeling of pleasant touch, a combination of CT and Aβ afferents is required.

Recent studies (McGlone, Wessberg, & Olausson, 2014; Mcglone et al., 2012) confirmed that CT-afferents are only present in hairy skin and not in the glabrous skin of the palm. However, a touch on the palm can also be perceived as pleasant for two reasons: (1) Aβ-afferents support pleasant sensations (McGlone, Wessberg, & Olausson, 2014); (2) Glabrous skin stimulation might be related to a more cognitive top-down evaluation of touch pleasantness, based on previous tactile experiences (Gordon et al., 2013; McCabe, Rolls, Bilderbeck, & McGlone, 2008; Mcglone et al., 2012).

Touch stimulation on the palm can provide both discriminative and affective input to the brain (Gordon et al., 2013).

Some authors also defend that affective touch may have a unique contribution to the embodied emotional *Self* (Lloyd, Gillis, Lewis, Farrell, & Morrison, 2013; Van Stralen et al., 2013).

However, the relationship between tactile sensory decline of the hand and avoidance behaviours and attitudes towards social touch (BATST) in frail elderly people is not explored in the literature.

In this sense, the first goal of this study is to analyse the relationship between the tactile discrimination (TD) of the hand, avoidance BATST and frailty criteria as defined by Fried et al. (2001) in a sample of institutionalized elderly people. The second goal is to explore whether other variables can contribute to explain the differences between pre-frail and frail elders.

We have studied some variables related to the sensory, motor and mental functions (sensory tactile discrimination, unintentional weight loss, self-perception of exhaustion, grip strength), with the activity (walking speed, level of physical activity) and with social participation (behaviours and attitudes towards social touch) in an attempt to perceive the individual in a holistic way.

Previous studies emphasized the vulnerability of the *Self* in later life; however, some authors have demonstrated the stability of the aging *Self*, at least until the point of frailty (Atchley, 1991; Coleman, Ivani-Chalian, & Robinson, 1999).

3.2 Methodology

3.2.1 Participants

Three urban residential homes agreed to participate in the study. Of the 181 seniors who live in these institutions, a sample of 50 subjects was established after verifying compliance with the inclusion and exclusion criteria. This is a convenience sample and the inclusion criteria established were the following: to be older than 65 years of age, be institutionalized in a residential home, be willing to participate in the study, and sign an informed consent. Exclusion criteria defined were not to present comorbidities that would lead to changes in sensibility (such as stroke, head trauma, degenerative disease or diabetes), to have no medical diagnosis of dementia, not to possess any cognitive impairment that would prevent the evaluation protocol, and not to have any communication or behaviour impairment.

Throughout the planning and during the study some ethical considerations were made; we received prior approval from an institutional review board and subjects gave their written informed consent in accordance with the Declaration of Helsinki (Annex C). We also took into account particular ethical issues related to greater vulnerability, both in the physical and psychosocial point of view of the subjects. Secrecy due of the obligation of professional secrecy was safeguarded, ensuring total confidentiality of the data.

3.2.2 Protocol

After deciding on the sample (participants), on the right procedures and measures to use, the authors felt the need to build an evaluation protocol for this study. This protocol is comprised of (1) a sample characterization questionnaire; (2) an analysis of different risk factors for frailty including: the body mass index (BMI), the number of different medication ingested per day (polypharmacy) and the cognitive level; (3) a self-perception questionnaire of the subjects' sensory difficulties and; (4) the assessment of the three variables that address the main objectives of this study: Phenotype of Frailty (unintentional weight loss, self-perception of exhaustion, decrease grip strength, slow walking speed, low level of physical activity), hand TD and BATST (Annex D). The assessment consisted of hetero-application instruments and some functional tests, such as GS and a walking speed test, and required the active participation of the subjects.

3.2.3 Procedures and Measures

A team of three professionals was organized for data collection (two Physiotherapists and one Speech Therapist, all of which having over 25 years of professional experience). Planning and training sessions were held in order to increase consistency in data collection, as well as reliability. These sessions covered: (1) appropriation of the objectives of the study, (2) creation of the assessment protocol, (3) contact with the institutions and applications for authorization, (4) role playing and problem-solving training. Data collection was carried out at the residential homes, in a single visit to each home that lasted for about 60 minutes.

3.2.4 Sample characterization questionnaire

Sociodemographic data of each subject who participated in the study was collected through a verbally administered questionnaire. This questionnaire requested information about age, gender, level of education and handedness. All participants had-right hand dominance, verified by the Portuguese translated version of the Waterloo Handedness Questionnaire-Revised (WHQ-R) (Elias et al. 1998) (Annex E).

3.2.5 Risk factors for frailty

We have considered as risk factors for frailty the BMI, the number of different medication ingested per day (polypharmacy) and the cognitive level. Beside the fact that BMI is a geriatric risk factor, its calculation was also useful to determine the GS value. To calculate the BMI, weight (kg) and height (cm) were measured according to the recommendations of Task Force BMI (Rockenbach et al. 2010).

According to recent studies, there is a strong association between frailty and having a very low or very high BMI (Hubbard et al. 2010). The same authors proposed cut-off values for frail older adults, i.e. a BMI greater than 30 and lower than 18.50 is indicative of frailty.

Medication data was collected from the subjects’ clinical files. We classified those who took four or more different medication as polymedicated (Denneboom et al. 2006). Since frailty is related to the presence of multiple comorbidities it leads to polymedication (Lang & Michel 2009).

The cognitive level was measured by the Mini Mental State Examination (MMSE). It is considered a valid practical and objective instrument for screening global cognitive functions in clinical practice and in research, especially in studies with elderly people. In addition it is the instrument used to measure cognitive level in the institutions that the subjects belonged to. It can also be applied quickly and it requires about 5-10 minutes for execution, but the actual runtime is not timed. It features 30 questions divided into six cognitive domains: orientation, retention, attention and calculation, recall, language, and constructive ability. Each question is scored either with 0 or 1, and the total score ranges from 0 to 30. A higher score correspond to better performance (Morgado et al. 2009). According to the standardization of the Portuguese population, new cut-off values have been recently recommended relating to literacy levels to allow differentiation between individuals with and without cognitive impairment. A subject with 0 to 2 years of education is considered to have cognitive impairment if the results of his test score are equal to or lower than 22; with 3 to 6 years of education, the subject is considered to have cognitive impairment if he scores are equal to or less than 24; finally, with 7 or more years of education the subject is considered to have cognitive impairment if the score is equal to or less than 27 (Morgado et al. 2009). Several studies have proven the existence of a relationship between cognitive impairment and the presence of frailty in elders (Fried et al. 2001; Kim et al. 2014; Malaguarnera et al. 2013). However, a recent study of older people with frailty concluded that cognition showed no predictive effect for increasing disability (Ament et al. 2014).

3.2.6 Self-perception of sensory difficulties

The subjects were asked several questions in order to understand whether they had difficulties in activities of daily life, due to the impairment of smell, taste, vision, hearing and touch ("Do you have difficulties in your daily life due to diminished smell and taste? Do you have difficulties in your daily life due to lack of vision? Do you have difficulties in your daily life due to lack of hearing? Do you have difficulties in your daily life due to a decrease of sensitivity to touch?).

The use of self-perception measures regarding sensory difficulties, along with objective assessments, should be considered because these may constitute important information about the elderly people's awareness regarding their real abilities (Schumm et al. 2009).

3.2.7 Frailty Assessment (Phenotype of Frailty)

In order to assess frailty, it was used the model described by Fairhall et al. (2008), adapted from the original model (Fried et al. 2001). This decision was made because the authors of that study introduced some simplifications which facilitate its practical application, particularly in institutionalized elders, such as the use of simple and objective questions to assess the level of physical activity. According to the model, each criterion that evaluates frailty is defined by a dichotomous variable (positive / negative criteria).

The five criteria are: (*Criteria 1*) Unintentional weight loss of at least 4.5 kg (not as a result of diet or exercise); (*Criteria 2*) Self-perception of exhaustion evaluated according to the answers given to the following questions taken from the questionnaire of the Centre for Epidemiologic Studies of Depression (Radloff, 1977). Question 1: Have you felt like everything you did in the last week was an effort?; Question 2: Have you felt a lack of energy during the last week? Possible answers are: 0-never / rarely (if for less than 1 day); 1-occasionally (for 1-2 days); 2-with some frequency (for 3-4 days); 3-very often / always (for 5-7 days). If the subject answers at least one of the questions with a value of 2 or with a value of 3, then the criteria is considered positive according to the dichotomous variable explained above. (*Criteria 3*) Muscle weakness assessed by GS, measured with a hydraulic manual dynamometer, J00105 Jamar® model. This is a valuable tool both in research and in clinical practice (Bohannon et al. 2006; Roberts et al. 2011) and is the measurement instrument recommended by the American Society of Hand Therapists (ASHT). We have used ASHT assessment protocol that recommends that the subject should be seated comfortably, shoulder adducted and in extension, elbow flexed at 90°, forearm in neutral position and wrist position extended between 0 and 30°. The final objective is to register the maximum and average value of three alternating measurements recorded in the dominant hand and measured in kilograms (kg). The isometric strength is recorded in three periods of 10 seconds with a 60 second rest period in between, and the final result is cross-referenced with BMI and gender. (*Criteria 4*) Decrease in walking speed measured by evaluating the time spent in seconds to cover a distance of 4.6 meters with regular steps, attuned to sex and height, with or without the use of a walking aid. The criteria was considered positive if the time spent is equal or above 6 seconds; (*Criteria 5*) Low level of physical activity. A subject is considered "inactive" if in the preceding three months he has not carried any weights, has spent more than 4 hours a day sitting and / or conducted a small walking tour only once a month or less.

An elderly person is considered to be "frail" if he has 3 or more positive criteria, "pre-frail" if he has 1 or 2 positive criteria and "not frail" if all criteria are negative.

3.2.8 Hand tactile discrimination assessment

Tactile Discrimination (TD) decreases with age and tactile threshold of excitability increases (Kaneko, Asai, & Kanda, 2005). To assess the level of TD within elderly people, the two points' discrimination test has proven to be a valid measurement test (Alsaeed et al. 2014; Bowden and McNulty 2013; Kaneko et al. 2005; Schumm et al. 2009; Shimokata & Kuzuya 1995).

There are some considerations in literature about the psychometric limitations of the two-point discrimination test. These limitations are mainly due to lack of detailed description of the assessment protocol, and especially lack of standardization of applied pressure. One way to solve this problem is to apply a force matching the gravity weight of the assessment tool, the Disk-Criminator ™ (10 to 15 g), or to use a force transducer coupled to a computer with specific software (Tassler & Dellon 1995). This equipment has demonstrated its usability in laboratory context but not in the context of clinical practice or in the field of studies, due to the complexity of the device (Lundborg & Rosen 2004).

The evaluation of TD of the index finger has proven not to be a very sensitive indicator for evaluating age-related sensory loss (Bowden & McNulty, 2013). In a study developed by these authors, the median threshold interval found in elders for two-point discrimination in the hipothenar eminence was 8 mm [6-11 mm]. This value is significantly higher than that on the fingertip (3 mm [3-4 mm]). They concluded that the best region to test tactile discrimination in elderly people is the hypothenar eminence, where the largest and most consistent sensory changes occur with age. Indeed sensory changes on the palm of the hand may cause greater difficulties in motor control than sensory loss at the fingertips, particularly in activities that involve the whole hand.

In most studies related to tactile sensory loss with aging, no relation was found with gender or with manual laterality (Bowden & McNulty 2013; Dunn et al. 2013; Schumm et al. 2009; Shimokata & Kuzuya 1995), and some authors (Dunn et al. 2013) recommend that the test should be applied to the dominant hand.

A calm environment with mild temperatures was selected for the evaluation, with reduced possibility of distractions, and each subject was seated comfortably with the elbow at about 90° and forearm resting on a low table to promote greater stabilization. The wrist and hand were placed on a small cushion with palm facing up. The procedure was explained to every subject and the kind of stimulus that was going to be applied was demonstrated on the forearm while the subjects had their eyes open. The researcher sat in front of the subject, with elbows resting and without touching the subject. The subject was then asked to close his eyes. Two Disk-Criminator™ were used, one with a two-point stimuli variation range between 20 and 9 millimetres and the other between 8 and 2 millimetres. As such, two-point tactile stimulations were successively applied in the distal hypothenar region of the dominant hand, going from the highest to the smallest distance between the two points in the Disk-Criminator™ (Bowden & McNulty 2013). We underline that immediately after the application of the two-point first stimuli, one stimulus was applied with just one point so that the subjects could become aware that the stimuli were not the same throughout (Schumm et al. 2009). This single stimulus test was not considered in the final result. The same question was asked in every stimulation: "Have you felt one or two points?". The minimal two points stimuli detected (MTPSD) by the subject was then recorded (Schumm et al. 2009). *It is paramount to emphasize at this point that throughout the study an increase of the value of MTPSD corresponds to a decrease on the value of TD* (i.e. the bigger the distance felt between two points, the lower the TD). All evaluations were made by the same experienced researcher, in order to assure that the protocol was always applied in the same way, and that the amount of pressure used in the test was as controlled as possible, i.e., always corresponding to the weight of Disk-Criminator™ (Lundborg & Rosen 2004).

3.2.9 Behaviours and attitudes towards social touch (BATST) assessment

To measure BATST we have used a version adapted to the Portuguese culture of the Social Touch Questionnaire (Wilhelm et al. 2001). This questionnaire provides data on a variety of issues related to feelings and attitudes toward social touch. Each subject answered the questionnaire using a rating on a scale from 0 to 4 regarding the accurateness of each statement (0 for "absolutely not" and 4 for "extremely"). The total score is thus obtained by summing the scores for each of the answers and the spectral quantification of the total score is presented on a scale from 0 (lowest avoidance of social touch) to 80 (highest avoidance of social touch). In the original study (Wilhelm et al. 2001) internal consistency (Cronbach's α) of the overall questionnaire was 0.89, with a 0.29 average item intercorrelation. No study has been found involving frailty in the elderly and BATST.

3.3 Statistical analysis

The analysis starts with a series of descriptive statistics to characterize the sample (frequency distributions, means and standard deviations) and to identify linear associations between metric variables (Pearson correlation coefficient) such as age, MTPSD, phenotype frailty criteria (unintentional weight loss, self-perception of exhaustion, decrease grip strength (GS), slow walking speed, low level of physical activity) and BATST. Parametric hypothesis tests, more specifically the t-test for equality of two population means, is then applied to measure the effect of gender on MTPSD, phenotype frailty criteria and BATST whenever the assumption of normal population group distributions was met; in case of violation of the last assumption, a non-parametric alternative was used, i.e., the Mann-Whitney test for equality of two population distributions based on two independent samples. To test for population distributions, the Shapiro-Wilk test was applied because it is more appropriate for small sample dimensions.

The statistical analysis continues with a multivariate inferential approach to estimate an explanatory model of the degree of frailty. A multiple linear regression approach was first applied to the total score of frailty and a number of different predictor variables were considered in this analysis – age, gender, years of education, polypharmacy, MTPSD and BATST.

Multiple linear regression modelling assumptions included: linearity of the relationship between the dependent and the independent variables, normality of the random error, null mean and constant variance of the random errors, independence of random errors, and absence of collinearity between independent variables. However, violation of some of the previous assumptions was verified which might result in biased and inefficient estimates, so an alternative logistic regression model was applied to explain the probability of frailty (1) over pre-frailty (0) (Agresti, 2002).

Logistic regression can in many ways be seen to be similar to ordinary regression. It models the relationship between a dependent and one or more independent variables by estimation of the probability of an event occurring. What we want to predict from a knowledge of relevant independent variables is not a precise numerical value of a dependent variable, but rather the probability (p) that it is 1 (event occurring) instead of 0 (event not occurring). This means that regarding linear regression the relationship between the dependent and the independent variables is linear but this assumption is not the same for logistic regression. For that, the logistic regression function is used. An important concept in logistic regression is the Odds Ratio (OR), which measures the ratio of the odds that an event or result will occur to the odds of the event not happen. Logistic regression does not make many of the key assumptions of ordinary linear regression, particularly regarding linearity, normality, homoscedasticity, and measurement level. (Agresti, 2002).

Firstly, logistic regression does not need a linear relationship between the dependent and independent variables. Logistic regression can handle all sorts of relationships, because it applies a non-linear log transformation to the predicted OR. Secondly, the independent variables do not need to be multivariate normally distributed. Also the error terms (residuals) do not need to be multivariate normally distributed. Thirdly, homoscedasticity is not needed. Lastly, it can handle ordinal and nominal data as independent variables. The independent variables do not need to be metric (interval or ratio scaled).

However, some other assumptions still apply. Binary logistic regression requires the dependent variable to be binary. Reducing an ordinal or even metric variable to dichotomous level leads to the loss of some information, which makes this model inferior compared to multiple linear models. Secondly, for a binary regression, the factor level 1 of the dependent variable should represent the desired outcome. Thirdly, the model should be fitted correctly, only the meaningful variables should be included. Fourthly, the error terms need to be independent, that is the observations should be independent. Also the model should have no multicollinearity, meaning the independent variables should be independent from each other. However, there is the option to include interaction effects of categorical variables in the analysis and in the model itself. Fifthly, logistic regression assumes linearity of independent variables and log odds, but it does not require the dependent and independent variables to be related linearly. Lastly, it requires quite large sample sizes. Because maximum likelihood estimates are less powerful than ordinary least squares, it needs a larger number of cases for each parameter to be estimated.

The logistic regression coefficients (B) indicate the relationship between the independent variables and the dependent variable, the latter being in a logit scale. Their estimates tell the amount of variation in the predicted log odds of the dependent variable if the dependent variable varies 1 unit, holding all other predictors constant. Being in log odds units makes the interpretation of the regression coefficients estimates quite difficult. So, they are often converted into OR by exponentiation [Exp(B)], meaning the predicted change in odds for 1 unit increase in the corresponding independent variable, keeping all the other constant. OR less than 1 correspond to decreases and higher than 1 to increases. The Wald chi-square statistic and test can be used to evaluate the effect of each independent variable. This is a significance test for the effect of the independent variable on the dependent one and it tests the null hypothesis that each parameter is equal to 0.

Another difference from ordinary least squares regression is that there is no overall measure, such as the determination coefficient R2, or the adjusted R2, to assess the overall model fit. Different measures of pseudo-R2 have been proposed for logistic regression, which basically measure the proportionate reduction in deviance of the current model over the null model (which is the model with no predictors, just the constant). Cox & Snell R Square and Nagelkerke R Square are examples of pseudo-R2, the latter being easier to interpret because it takes values between 0 and 1. There are, however, other measures of goodness of fit for logistic regression models. The most straightforward is to simply evaluate how accurate the model is at predicting, by comparing the number of cases the model predicts in each group, with the observed number in each group (percentage of correctly classified cases). As there is no absolute cut-off point, the best is to analyse the extent to which the model is better able to predict group membership than a model with no independent variables, just the constant. (Agresti, 2002).

The objective of our analysis is to explore the determinants of frailty and the effect of the some demographic and sensorial independent variables on the likelihood of frailty when compared to situations of pre-frailty. Logistic regression models of the form below will be fitted to the data:

$$logit(P_i) = log\left(\frac{P_i}{1-P_i}\right) = x_i^{'}\beta$$

Where Pi is the predicted probability of the binary outcome variable yi, assuming the codes 1 - frail and 0 - pre-frail; xi is the vector of predictor variables and β is the vector of regression coefficients. A number of different predictor variables were considered in this analysis.

Binary logistic regression was adopted to model the effect of several independent variables on the likelihood of being frail. The variable to be explained was whether an elderly person has reached a frail situation or can still be considered as pre-frail. This dependent variable is understood as a dichotomous binary variable. Regression coefficients were estimated using the Maximum Likelihood method and the model included the following explanatory variables: (1) Gender - having two categories (1-Male, 0-Female); (2) Education - which represents the number of years of education with three categories (1=0 years; 2=3 to 6 years; 3=12 or more years); (3) MTPSD – on a discrete metric scale, from 5 to 13; (4) BATST – on a discrete metric scale, from 15 to 52. SPSS version 22 was used for all statistical analysis.

3.4 Results

The average age of the sample is 84.4 years ± 6.8 (min=68; max=99), 58% of the subjects are female, the average education level is 5.2 years ± 5 (min=0; max=16), mean BMI is 26.6 Kg/m^2 ± 5.5 (min=16.8; max=45.3); MMSE average score is 25.6 ± 4.6 (min=11; max=30). It is noteworthy that 80% of the sample takes more than four different types of medications (Table 1).

Table 1: Sample characteristics and risk for factors for frailty (n=50)

Age (years)	84,4* ± 6, 8**; 68-99***
Gender (m:f)	42%:58%
Education (years)	5,2* ± 5**; 0-16***
BMI (Kg/m^2)	26,6* ±5,5**; 16,8-45,3***
Polypharmacy (four or more different medications) (%)	80%
MMSE (Portuguese-European version)	25,6* ± 4,6**; 11-30***

*Mean **Standard Deviation ***Minimum-Maximum
BMI – Body mass index; MMSE – Mini mental state examination

In this sample, elderly people report that they feel interference in their daily tasks due to degradation of smell, taste, vision and hearing. However there is no perception that there is change of tactile sensibility (100% of the sample).

Table 2: Sample distribution of Self perception of sensory impairment (% without self perception) (n=50)

No Self-perception of visual impairment %	48%
No Self-perception of hearing impairment %	46%
No Self-perception of smell and taste impairment %	66%
No Self-perception of touch impairment %	**100%**

In Table 3 we can see that 56% of the sample is frail and 44% is pre-frail. As for the frailty criteria, 92% had decreased GS, 16% lost at least 4.5 kg in weight unintentionally (not due to diet or exercise), 70% had decreased walking speed, 46% reported a perception of exhaustion, and 56% had a low level of physical activity. The MTPSD average, i.e., the minimal two points stimuli detected on the distal hypothenar area of the palm was 8.6 ± 2.5 millimetres (min=5; max=13). The average of the BATST was 32.9 ± 9.3 (min=15; max=52).

Table 3: Sample distribution of Frailty - Physical Phenotype and Criteria, MTPSD and BATST (n=50)

Frailty Phenotype (Pre-frail: Frail)	44%:56%
Weakness - Grip strength %	92%
Unintentional weight loss %	16%
Slow walking speed %	70%
Self-reported exhaustion %	46%
Low physical activity level %	56%
MTPSD (millimetres)	8.6* ± 2.5**;5-13***
BATST	32.9* ± 9.3**; 15-52***

*Mean **Standard Deviation *** Minimum-Maximum; MTPSD - Minimal two points stimuli detected; BATST - Behaviours and attitudes towards social touch

We have also tried to understand gender effects in MTPSD, phenotype frailty criteria and BATST. Within the phenotype frailty criteria the only one with statistically significant effect (Table 4) was the GS (p=0.001), with women being the group that presents the weaker values of GS. (Table 4)

Table 4: Effect of Gender on MTPSD, GS and BATST *(n=50)*

	Means		
	Males	Females	p-value
MTPSD **	8.2	8.8	.939
GS*	18.7	12.1	**.001**
BATST*	31.3	34	.313

* t-test for equality of two means; ** K-S test for equality of two distributions
MTPSD - Minimal two points stimuli detected; GS - Grip strength;
BATST - Behaviours and attitudes towards social touch

As it can be seen in Table 5, age is a factor positively and significantly correlated with MTPSD (r=0.29; p=0.021) but not with BATST. Once again, the only phenotype frailty criterion with statistically significant effect was GS. In this case, age is a factor negatively correlated with GS (r=0.28; p=0.025).

Because of the negative correlation between MTPSD and TD (i.e. to a greater value of MTPSD corresponds a decrease in TD) it is fair to state that, in this study sample, older people present a decrease in TD values and there is a decrease in GS.

Table 5: Correlation between Age, MTPSD, GS and BATST (n=50)

		MTPSD	GS	BATST
Age	Pearson Correlation	.290*	-.279*	.000
	p-value	**.021**	**.025**	.499

MTPSD - Minimal two points stimuli detected; GS - Grip strength;
BATST - Behaviours and attitudes towards social touch

Regarding the purpose of the study, in Table 6 we correlated the variables TD (using MTPSD values), phenotype frailty criteria and BATST. From all the frailty criteria, the only one with statistically significant effect was, once again, GS. As it can be seen in Table 6, MTPSD is linear and positively correlated with avoidance BATST (r=0.80; p=0.000), i.e, elderly with lower levels of TD have higher levels of avoidance BATST (negative correlation between TD and BATST); MTPSD is negatively correlated with

GS (r=-0.49; p=0.000), i.e. elderly with lower levels of TD have lower levels of GS (positive correlation between TD and GS). Lower levels of GS corresponds to more avoidance BATST (r=-0.38; p=0.003) (negative correlation between GS and BATST).

Table 6: Correlations between MTPSD, GS and BATST (n=50)

		GS	BATST
MTPSD	Pearson Correlation	-.491**	.808**
	Sig. (1-tailed)	**.000**	**.000**
GS	Pearson Correlation		-.380**
	Sig. (1-tailed)		**.003**

MTPSD - Minimal two points stimuli detected; GS - Grip strength;
BATST - Behaviours and attitudes towards social touch

Table 7 presents the estimates of regression coefficients and respective standard errors, and the p-value of the Wald Chi-Square test for all independent variables. The table also shows the exponential of the model coefficients which estimates the ratio of the changes of the dependent variable by unit of the independent variable.

The percentage of cases correctly classified by the model is high (68%) although the goodness of fit Nagelkerke R^2 indicator is low (less than 21.8%) thus indicating that the likelihood of frailty might be influenced by other factors not included in the model. But 68% of the cases are well predicted by the model, whereas 56% are well predicted just with a constant, so accuracy of prediction has improved over the null model, but only by 12%; the Hosmer and Lemeshow test shows an adequate fit (p-value=0.389), meaning that the model prediction is not significantly different from the observed values. Although all measures suggest an improvement of the logistic model over the null model (with no predictors, just a constant), they also allow to conclude that the adequacy of the model is not optimal.

The results show that the probability of being frail: (1) Is lower for males, when compared to females, but the difference is not significant; (2) Is higher for those with no education or with 3 to 6 years of education, when compared to those with more education (12 or more years), but these differences are not significant; (3) Decreases when the level of avoidance BATST decreases, again with no significant difference;(4) Increases for each unit increase of MTPSD. This is the only significant coefficient. The chance of being frail increases 76.5% when the minimum distance perceived between two points increases one unit, i.e., when the level of TD decreases.

Table 7: Results for the binary logistic model for frailty (n=50)

	B	S.E.	Wald	df	Sig.	Exp(B)
Gender(1) †	-.592	.638	.863	1	.353	.553
MTPSD	.568	.265	4.582	1	.032	1.765
BATST	-.088	.064	1.867	1	.172	.916
Education‡			1.834	2	.400	
Education(1)	1.258	.962	1.712	1	.191	3.519
Education(2)	.888	.822	1.168	1	.280	2.431
Constant	-2.184	1.494	2.138	1	.144	.113

† Gender reference category: Female
‡ Education reference category: 12 or more years
(a) Nagelkerke R^2=0.218
MTPSD - Minimal two points stimuli detected;
BATST - Behaviours and attitudes towards social touch

3.5 Discussion and conclusions

As stated before, the first goal of this study was to analyse the relationship between TD of the hand, avoidance BATST, and frailty criteria, as defined by Fried et al. (2001), in a sample of institutionalized elderly people. A second goal was to explore whether other variables could contribute to explaining the differences between pre-frail and frail elders.

Throughout the study we have tried to elevate tactile sensibility for three main reasons: (1) it is proven to be a sensory modality that degrades with age; (2) because research studies regarding assessment, consequences and intervention in Frailty Syndrome have not taken tactile sensibility into account and (3) considering that sensory experiences contribute to the integrity of the *Self*, and that in the elderly there is a progressive loss of sensory function, then this deterioration could lead to a disruption of the *Self*.

Many authors (Brodoehl et al. 2013; Carmeli et al. 2003; Kaneko et al. 2005; Kuzuya & Shimokata 1995) have reported the existence of tactile sensory deterioration with increasing age. The results of our sample confirm these findings and the minimum average distance felt between two points is consistent with what has been reported in the literature (Bowden and McNulty 2013) for the same age group, with data collected from the hipotenar region.

The same authors found significant statistical differences between genders in the tactile threshold of excitability. Men showed a higher threshold, denoting greater sensory loss.

But in other studies that difference has not been identified (Ranganathan et al. 2001). In our sample we also found that there were no differences between genders in terms of the tactile threshold of excitability. Some authors point out some causes for this finding and argue that men have lower density of Meissner's corpuscles in comparison with women but tactile acuity is not different between genders (Dillon et al. 2001).

Tactile information extracted from objects is critical for hand functionality and, as in other investigations with frail elderly subjects (Ranganathan et al. 2001), we found that there is a statistically significant correlation between decrease in hand strength and decreased in hand sensibility, with women showing the highest decrease in strength (Frederiksen et al. 2006; Ranganathan et al. 2001). In fact the average GS in women of all ages is lower than that of men and this may have to do with genetic differences in muscle mass but also to environmental differences (Andersen-Ranberg et al. 2009). However, the reason why the difference becomes more pronounced towards the end of life can stem from further decrease in bone density in women (Dixon et al. 2005).

In our experiment, from all the phenotype frailty criteria, GS was the only one with significant correlations values with TD and with BATST. In fact, GS has been indicated as a possible sole criterion in the evaluation of frailty (Syddall et al. 2003) and is an indicator of decreased general strength and a predictor global loss of functionality (Bohannon 2008). In elderly people of both genders it can also be a sign of poor nutrition, confirmed by a lower BMI associated with the presence of sarcopenia (Norman et al. 2011).

With regard to the association between TD and BATST we found that there is no evidence in the literature concerning this relationship in frail elderly people. However, in our study we found a statistically significant correlation between these two variables, and it has been found that a greater reduction of TD corresponds to a greater amount of avoidance BATST.

Dunn (1999, 2001) states that the sensory processing involves the physiological dimension, related to the nervous system integrity, but also involves the behavioural dimension. Ben-Avi (2012) suggests that sensory processing is also linked to psychological and social dimensions, and that some interpersonal difficulties, such as social alienation and social isolation, are characteristic of individuals with a sensory avoidance profile. The "Social Touch" hypothesis is also corroborative of this relationship (Walker & McGlone 2013).

In order to become aware of spatial relationships with other persons and with the environment, it is crucial to have undamaged sensory receptors, not only the tactile ones but also in all other sensory modalities. The amount of information that can become conscious when the stimuli are presented through the tactile modality is influenced by the amount of visual, auditory and olfactory information. As a matter of fact, these stimuli begin to be processed simultaneously and this multisensory interaction leads to the recognition, reproduction and maintenance of interpersonal relationship patterns (Gallace & Spence 2008).

These aspects are fundamental in institutionalized elderly people, because avoidance BATST can lead to a physical social isolation associated to a subjective feeling of isolation, of not being integrated, and to a lack of companionship (Perissinotto et al. 2012). As a matter of fact, in a residential home, elderly people are not alone but they may feel alone, and such feeling of loneliness can predict functional decline and death.

In this sample, besides the criteria that explain the level of frailty (unintentional weight loss, self-reported exhaustion, decrease GS, slow walking speed and low physical activity level) we found another variable that can also differentiate frail and pre-frail elderly subjects, namely the TD of the hand. So far this factor has not been given significant recognition by the scientific community and it does not come into play in either assessment or intervention protocols in frail elderly people.

Nevertheless, scientific evidence proves that sensory deterioration of the hand is strongly related to the decrease of muscle strength and of functionality. The hand is a major tactile sensory part of the body and the right processing of the sensory input is essential for manipulation and for different activities of daily life. For these reasons and taking into account the results of this study we recommend the TD of the hand to be included in assessment and intervention protocols in frail and pre frail elderly people.

In our sample, the risk factors for frailty analysed (BMI, polypharmacy and cognition) revealed that only polypharmacy should be considered as a risk factor for frailty. The mean values obtained for both BMI and cognition have not shown enough relevance to be considered as valuable risk factors regarding the sample used for this study.

In general, no great relevance is being given to sensory aspects, except to the limitations that elderly people are aware of or that have a great impact on their daily activities. In this sense, the measures of self-perception showed great importance in this study, noting that the perception of the subjects is not always in line with reality, as it can be seen in the case of self-perception of tactile sensory difficulties. Indeed none of the elderly attributed their difficulties in activities of daily life to tactile sensory problems. But in reality the results indicate that there is a decrease of the hand TD and, since tactile information from the hand is essential for grasping and dexterous manipulation, this could contribute to a decrease in functional activities. However and unlike other sensory modalities, there is no awareness of the tactile sensory decrease.

Pre-frail condition is a strong indicator of physical decline associated with aging (Fernández-Garrido et al. 2014) and pre-frail individuals have twice the risk of becoming frail in the next three years than non-frail individuals (Fried et al. 2001). However, Frailty Syndrome in the elderly can be prevented and reversed (Lang & Michel, 2009) and in the literature we can find several proposals for intervention in frailty. However, despite considering many variables, they do not consider the tactile sensory function. Nevertheless, there are studies on healthy elderly people that conclude that it is possible to improve sensorimotor function through passive tactile sensory stimulation because it promotes perceptual learning (Fahle 2005; Kalisch et al. 2008; Ragert et al. 2008; Seitz & Dinse 2007). Despite the importance of unisensorial stimulation protocols, multisensory stimulation protocols are more effective for sensorimotor learning and in the case of elderly people there is evidence that there is an increase or maintenance of brain multisensory processing, regardless of continuous decline in unisensoriais systems. The multisensory processing is critical during aging because it helps to minimize the consequences of the unisensorial decline (Freiherr, Lundström, Habel, & Reetz, 2013). In this sense it is required that tactile sensory stimulation of the hand is applied in combination with the stimulation of another sensory modality, such as verbal stimulation, appealing to feel the hand.

In intervention studies in frail elderly subjects that include exercise, the exercise is always directed either to increase the strength of the lower limbs or to promote general mobility, but it is never done for hand functionality (Daniels et al. 2010; Gustafsson et al. 2009; Oswald et al. 2006). Regarding the increase of hand functionality, several studies were conducted with healthy elderly subjects, who reported that improvement is possible by practicing different motor tasks, and that the increase of functionality is due to the interaction between the motor and sensory system (Ranganathan et al. 2001). As such, and regarding the intervention programs with frail elderly people, we recommend that strategies directed to hand functionality should be envisaged.

An individual-centered approach is required because each individual constitutes a single entity, and may present different problems when compared to others in terms of structure and function, functional activity and participation, as well as in terms of self-influence factors (Clegg et al. 2013; Fairhall et al. 2008).

In normal aging process, the individual is confronted physical, emotional and social losses. The way he raises awareness and accepts those changes and how he maintains the relationships with oneself and with others, ensure the personal balance, the acceptance of himself, a redefinition of identity and the reorganization of the *Self*.

The Frailty Syndrome induces a feeling of loss of identity, of threat and of *Self* disintegration, i.e., poses a serious challenge to the stability of this sense of unit *Self* (Atchley, 1991; Coleman, Ivani-Chalian, & Robinson, 1999). Knowing and understanding those feelings allows detecting them early and may help in the adaptation to the problems that come with them.

This clinical reasoning should guide us in formulating the assessment protocols for frailty elderly people and should also shape the type of intervention.

Due to the small number of subjects in the sample, our results should be considered as preliminary. In that sense it is recommended that the sample should be extended and the results compared with community-dwelling elderly sample, applying the same methodological assumptions.

3.6 References

Agresti, A. (2002) Logit Models for Multinomial Responses, in Categorical Data Analysis, Second Edition, John Wiley & Sons, Inc., Hoboken, NJ, USA. doi: 10.1002/0471249688.ch7

Alsaeed, S., Alhomid, T., Zakaria, H., Alwhaibi, R. (2014) Normative Values of Two-Point Discrimination Test among Students of Princess Noura Bint Abdulrahman University in Riyadh. *International Journal of Advanced Physiology and Allied Sciences, 1*(1), 42–52.

Ament, B. H. L., Vugt, M. E., Verhey, F. R. J., Kempen, G. I. J. M. (2014) Are physically frail older persons more at risk of adverse outcomes if they also suffer from cognitive, social, and psychological frailty? *European Journal of Ageing,* 213–219. doi:10.1007/s10433-014-0308-x

Andersen-Ranberg, K., Petersen, I., Frederiksen, H., Mackenbach, J. P., & Christensen, K. (2009) Cross-national differences in grip strength among 50+ year-old Europeans: Results from the SHARE study. *European Journal of Ageing, 6*(3), 227–236. doi:10.1007/s10433-009-0128-6.

Atchley, R. C. (1991). *The influence of aging or frailty on perceptions and expressions of the self: Theoretical and methodological issues*. In J. E. Birren, J. E. Lubben, J. C. Rowe, & D. E. Deutchman (Eds.), *The concept and measurement of quality of life in the frail elderly* (pp. 207–225). New York: Academic Press.

Ben-Avi, N. (2012) Sensory Processing Difficulties and Interpersonal Relationships in Adults: An Exploratory Study. *Psychology, 3*(01):70–77. doi:10.4236/psych.2012.31012

Björnsdotter, M., Löken, L., Olausson, H., Vallbo, A., & Wessberg, J. (2009) Somatotopic organization of gentle touch processing in the posterior insular cortex. *The Journal of Neuroscience, 29*(29), 9314–9320. doi:10.1523/JNEUROSCI.0400-09.2009.

Boesveldt, S., Lindau, S. T., McClintock, M. K., Hummel, T., & Lundström, J. N. (2011) Gustatory and olfactory dysfunction in older adults: a national probability study. *Rhinology, 49*(3), 324–330

Bohannon, R. W. (2008). Hand-grip dynamometry predicts future outcomes in aging adults. *Journal of Geriatric Physical Therapy, 31*(1), 3–10. doi:10.1519/00139143-200831010-00002.

Bohannon, R. W., Peolsson, A., Massy-Westropp, N., Desrosiers, J., & Bear-Lehman, J. (2006). Reference values for adult grip strength measured with a Jamar dynamometer: a descriptive meta-analysis. *Physiotherapy, 92*(1), 11–15. doi:10.1016/j.physio.2005.05.003.

Bowden, J. L., & McNulty, P. (2013) Age-related changes in cutaneous sensation in the healthy human hand. *Age 35*(4), 1077–1089. doi:10.1007/s11357-012-9429-3

Brodoehl, S., Klingner, C., Stieglitz, K., & Witte, O. W. (2013). Age-related changes in the somatosensory processing of tactile stimulation--an fMRI study. *Behavioural Brain Research, 238*, 259–64. doi:10.1016/j.bbr.2012.10.038.

Carmeli, E., Patish, H., & Coleman, R. (2003). The Aging Hand. *Journal of Gerontology, 58A*(2), 146–152.

Clegg, A., Young, J., Iliff, S., Rikkert, M. O., & Rockwood, K. (2013) Frailty in elderly people. *Lancet 381*, 752–762. doi:10.1016/S0140-6736(12)62167-9

Craig, J. C., & Rollman, G. B. (1999). SOMESTHESIS. *Annual Reviews Psychology, 50*, 305–331.

Coleman, P., Ivani-Chalian, C., & Robinson, M. (1999). Self and Identity in Advanced old age: Validation of theory through longitudinal case analysis. *Journal of Personality, 67*, 819-849.

Denneboom, W., Dautzenberg, M. G. H., Grol, R., & De Smet, P.A.G.M. (2006). Analysis of polypharmacy in older patients in primary care using a multidisciplinary expert panel. *The British Journal of General Practice, 56*(528), 504–510.

Dillon, Y. K., Haynes, J., & Henneberg, M. (2001). The relationship of the number of Meissner's corpuscles to dermatoglyphic characters and finger size. *Journal of Anatomy, 199*(5), 577–584. doi:10.1046/j.1469-7580.2001.19950577.x.

Dixon, W. G., Lunt, M., Pye, S. R., Reeve, J., Felsenberg, D., Silman, A. J., & O'Neill, T.W. (2005). Low grip strength is associated with bone mineral density and vertebral fracture in women. *Rheumatology, 44*(5), 642–646. doi:10.1093/rheumatology/keh569.

Doty, R. L. (2012). Olfaction in Parkinson's disease and related disorders. *Neurobiology of Disease*, *46*(3), 527–552. doi:10.1016/j.nbd.2011.10.026.Olfaction.

Dunbar, R. I. M. (2010). The social role of touch in humans and primates: Behavioural function and neurobiological mechanisms. *Neuroscience and Biobehavioral Reviews*, *34*(2), 260–268. doi:10.1016/j.neubiorev.2008.07.001.

Dunn, W. (1999) The Sensory Profile. T. P. Corporation, Ed. San Antonio

Dunn, W. (2001) The sensations of everyday life: Empirical, theoretical, and pragmatic considerations. *American Journal of Occupational Therapy, 55*(6), 608–620. doi:10.5014/ajot.55.6.608

Dunn, W., Griffith, J. W., Morrison, M. T., Tanquary, J., Sabata, D., Carey, L. M., & Gershon, R. C. (2013). Somatosensation assessment using the NIH Toolbox. *American Academy of Neurology, 3*, 41–44.

Elias, L. J., Bryden, M. P., & Bulman-Fleming, M. B. (1998) Footedness is a better predictor than is handedness of emotional lateralization. *Neuropsychologia 36*(1):37–43. doi:10.1016/S0028-3932(97)00107-3

Fahle, M. (2005) Perceptual learning: specificity versus generalization. Current Opinion in Neurobiology, 15(2), 154–60. doi:10.1016/j.conb.2005.03.010

Fairhall, N., Aggar, C., Kurrle, S. E., Sherrington, C., Lord, S., Lockwood, K., Cameron, I. D. (2008). Frailty Intervention Trial (FIT). *BMC Geriatrics, 8*(27), 1–10. doi:10.1186/1471-2318-8-27.

Fernández-Garrido, J., Ruiz-Ros, V., Buigues, C., Navarro-Martinez, R., & Cauli, O. (2014). Clinical features of prefrail older individuals and emerging peripheral biomarkers: A systematic review. *Archives of Gerontology and Geriatrics, 59*(1), 7–17. doi:10.1016/j.archger.2014.02.008.

Frederiksen, H., Hjelmborg, J., Mortensen, J., Mcgue, M., Vaupel, J. W., & Christensen, K. (2006). Age Trajectories of Grip Strength: Cross-Sectional and Longitudinal Data Among 8,342 Danes Aged 46 to 102. *Annals of Epidemiology*, *16*(7), 554–562. doi:10.1016/j.annepidem.2005.10.006.

Freiherr, J., Lundström, J. N., Habel, U., & Reetz, K. (2013). Multisensory integration mechanisms during aging. *Frontiers in Human Neuroscience, 7*(863), 1–6. doi:10.3389/fnhum.2013.00863

Fried, L. P., Tangen, C. M., Walston, J., Newman, A. B., Hirsch, C., Gottdiener, J., & Burke, G. (2001). Frailty in Older Adults : Evidence for a Phenotype. *Journal of Gerontology, 56*(3), 146–157.

Gallace, A., & Spence, C. (2008). The cognitive and neural correlates of "tactile consciousness": A multisensory perspective. *Consciousness and Cognition*, *17*(1), 370–407. doi:10.1016/j.concog.2007.01.005.

Gallace, A., & Spence, C. (2010). The science of interpersonal touch: An overview. *Neuroscience and Biobehavioral Reviews, 34*(2), 246–259. doi:10.1016/j.neubiorev.2008.10.004.

Gopinath, B., Schneider, J., Mcmahon, C. M., Burlutsky, G., Leeder, S. R., & Mitchell, P. (2013). Dual Sensory Impairment in Older Adults Increases the Risk of Mortality : A Population-Based Study. *PloS One, 8*(3), e55054. doi:10.1371/journal.pone.0055054.

Gopinath, B., Schneider, J., McMahon, C. M., Teber, E., Leeder, S. R., & Mitchell, P. (2012). Severity of age-related hearing loss is associated with impaired activities of daily living. *Age and Ageing*, *41*(2), 195–200. doi:10.1093/ageing/afr155.

Gordon, I., Voos, A. C., Bennett, R. H., Bolling, D. Z., Pelphrey, K. a, & Kaiser, M. D. (2013). Brain mechanisms for processing affective touch. *Human Brain Mapping*, *34*(4), 914–22. doi:10.1002/hbm.21480.

Guclu-Gunduz, A., Citaker, S., Nazliel, B., & Irkec, C. (2012). Upper extremity function and its relation with hand sensation and upper extremity strength in patients with multiple sclerosis. *NeuroRehabilitation, 30*, 369–374. doi:10.3233/NRE-2012-0768.

Hertenstein, M. J., Keltner, D., App, B., Bulleit, B. a, & Jaskolka, A. R. (2006). Touch communicates distinct emotions. *Emotion, 6*(3), 528–33. doi:10.1037/1528-3542.6.3.528.

Hoffman, H. J., Cruickshanks, K. J., & Davis, B. (2009). Perspectives on population-based epidemiological studies of olfactory and taste impairment. *Annals of the New York Academy of Sciences, 1170*, 514–530. doi:10.1111/j.1749-6632.2009.04597.x.Perspectives.

Hubbard, R. E., Lang, I. A., Llewellyn, D. J., & Rockwood, K. (2010). Frailty, body mass index, and abdominal obesity in older people. *The Journals of Gerontology, 65*(4), 377–381. doi:10.1093/gerona/glp186.

Humes, L. E., Busey, T. A., Craig, J., & Kewley-Port, D. (2013). Are age-related changes in cognitive function driven by age-related changes in sensory processing? *Attention Perception Psychophys, 75,* 508–524. doi:10.3758/s13414-012-0406-9.

Kalisch, T., Tegenthoff, M., & Dinse, H. R. (2008). Improvement of sensorimotor functions in old age by passive sensory stimulation. *Clinical Interventions in Aging, 3*(4), 673–690.

Kan, G. A. V., Rolland, Y., Bergman, H., Morley, J. E., Kritchevsky, S. B., & Vellas, B. (2008). The I.A.N.A. Task Force on Frailty Assessment of Older People in Clinical Practice. *The Journal of Nutrition, Health & Aging, 12*(1), 29–37.

Kaneko, A., Asai, N., & Kanda, T. (2005). The influence of age on pressure perception of static and moving two-point discrimination in normal subjects. *Journal of Hand Therapy, 18*(4), 421–425. doi:10.1197/j.jht.2005.09.010.

Kim, S., Park, J. L., Hwang, H. S., & Kim, Y. P. (2014). Correlation between Frailty and Cognitive Function in Non-Demented Community Dwelling Older Koreans. *Journal of the Korean Academy of Family Medicine, 35*(6), 309–320.

Klein, B., Klein, R., Knudtson, M., & Lee, K. (2003). Relationship of measures of frailty to visual function: the beaver dam eye study. *Transactions of the American Ophthalmological Society, 101*, 191–200.

Lang, P., & Michel, J. (2009). Frailty Syndrome : A Transitional State in a Dynamic Process. *Gerontology, 55*, 539–549. doi:10.1159/000211949.

Lloyd, D. M., Gillis, V., Lewis, E., Farrell, M. J., & Morrison, I. (2013). Pleasant touch moderates the subjective but not objective aspects of body perception. *Frontiers in Behavioral Neuroscience*, *7*(207), 1–11. doi:10.3389/fnbeh.2013.00207

Lundborg, G., & Rosen, B. (2004). The two-point discrimination test – time for a re-apraisal? *Journal of Hand Surgery, 29B*(5), 418–422.

McCabe, C., Rolls, E. T., Bilderbeck, A., & McGlone, F. (2008). Cognitive influences on the affective representation of touch and the sight of touch in the human brain. *Social Cognitive and Affective Neuroscience, 3*(2), 97–108. doi:10.1093/scan/nsn005

McGlone, F., Olausson, H., Boyle, J. A., Jones-Gotman, M., Dancer, C., Guest, S., & Essick, G. (2012). Touching and feeling: Differences in pleasant touch processing between glabrous and hairy skin in humans. *European Journal of Neuroscience, 35*(11), 1782–1788. doi:10.1111/j.1460-9568.2012.08092.x

McGlone, F., Wessberg, J., & Olausson, H. (2014). Discriminative and affective touch: sensing and feeling. *Neuron, 21*(82(4)), 737–755.

Mahoney, J. R., Wang, C., Dumas, K., & Holtzer, R. (2014). Visual-somatosensory integration in aging: Does stimulus location really matter? *Visual Neuroscience, 31*(3), 275–283. doi:10.1017/S0952523814000078.Visual-somatosensory.

Malaguarnera, M., Vacante, M., Frazzetto, P. M., & Motta, M. (2013). What is the frailty in elderly? Value and significance of the multidimensional assessments. *Archives of Gerontology and Geriatrics, 56*(1), 23–26. doi:10.1016/j.archger.2011.09.017.

Melchior, H., Vatine, J.-J., & Weiss, P. L. (2007). Is there a relationship between light touch-pressure sensation and functional hand ability? *Disability and Rehabilitation, 29*(7), 567–575.

Mener, D. J., M.P.H., Joshua Betz, M. S., Genther, D. J., Chen, D., & Lin, F. R. (2013). Hearing Loss and Depression in Older Adults. *Journal of the American Geriatrics Society, 61*(9), 1627–1629. doi:10.1016/j.biotechadv.2011.08.021.Secreted.

Mobley, A. S., Rodriguez-Gil, D. J., Imamura, F., & Greer, C. A. (2014). Aging in the olfactory system. *Trends in Neurosciences, 37*(2), 77–84. doi:10.1016/j.tins.2013.11.004.Aging.

Morgado, J., Rocha, C. S., Maruta, C., Guerreiro, M., & Martins, I. P. (2009). Cut-off scores in MMSE: A moving target? *European Journal of Neurology, 17*(5), 1–4. doi:10.1111/j.1468-1331.2009.02907.x.

Morley, J. E., Vellas, B., Kan, G. A. van, Anker, S. D., Bauer, J. M., Bernabei, R., Walston, J. (2013). Frailty Consensus: A Call to Action. *Journal of the American Medical Directors Association, 14*(6), 392–397.

Morrison, I., Löken, L. S., & Olausson, H. (2010). The skin as a social organ. *Experimental Brain Research, 204*(3), 305–314. doi:10.1007/s00221-009-2007-y.

Norman, K., Stobäus, N., Gonzalez, M. C., Schulzke, J. D., & Pirlich, M. (2011). Hand grip strength: Outcome predictor and marker of nutritional status. *Clinical Nutrition, 30*(2), 135–142. doi:10.1016/j.clnu.2010.09.010.

Nowak, A., & Hubbard, R. E. (2009). Falls and frailty : lessons from complex systems. *Journal of the Royal Society of Medicine, 102*, 98–102. doi:10.1258/jrsm.2009.080274.

Olausson, H., Wessberg, J., Morrison, I., McGlone, F., & Vallbo, A. (2010). The neurophysiology of unmyelinated tactile afferents. *Neuroscience and Biobehavioral Reviews, 34*(2), 185–191. doi:10.1016/j.neubiorev.2008.09.011.

Oswald, W. D., Gunzelmann, T., Rupprecht, R., & Hagen, B. (2006). Differential effects of single versus combined cognitive and physical training with older adults: The SimA study in a 5-year perspective. *European Journal of Ageing, 3*(4), 179–192. doi:10.1007/s10433-006-0035-z.

Perissinotto, C. M., Cenzer, I. S., & Covinsky, K. E. (2012). Loneliness in Older Persons: A predictor of functional decline and death. *Archives of Internal Medicine, 172*(14), 1078–1083. doi:doi:10.1001/archinternmed.2012.1993.

Radloff, L. S. (1977). The CES-D scale: A self report depression scale for research in the general population. *Applied Psychological Measurement, 1*, 385–401.

Ragert, P., Kalisch, T., Bliem, B., Franzkowiak, S., & Dinse, H. R. (2008). Differential effects of tactile high- and low-frequency stimulation on tactile discrimination in human subjects. *BMC Neuroscience, 9*, 9. doi:10.1186/1471-2202-9-9.

Ranganathan, V. K., Siemionow, V., Sahgal, V., Liu, J. Z., & Yue, G. H. (2001). Skilled Finger Movement Exercise Improves Hand Function. *Journal of Gerontology, 56*(8), 518–522.

Ranganathan, V. K., Siemionow, V., Sahgal, V., & Yue, G. H. (2001). Effects of aging on hand function. *Journal of the American Geriatrics Society, 49*(11), 1478–1484.

Roberts, H. C., Denison, H. J., Martin, H. J., Patel, H. P., Syddall, H., Cooper, C., & Sayer, A. A. (2011). A review of the measurement of grip strength in clinical and epidemiological studies: Towards a standardised approach. *Age and Ageing, 40*(4), 423–429. doi:10.1093/ageing/afr051.

Rockenbach, J., Smith, P., Green, N., Williams, S., Lindly, C., Baker, T., & Justus, M. (2010). A Training Manual for Height and Weight Assessment. Arkansas Center for Health Improvement. Retrieved from http://www.achi.net/BMIContent/Documents/101007_Height_and_Weight_Measurement_Training_Manual1with_revisions.pdf.

Rockwood, K., Song, X., Macknight, C., Bergman, H., Hogan, D. B., Mcdowell, I., & Mitnitski, A. (2005). A global clinical measure of fitness and frailty in elderly people. *Canadian Medical Association Journal, 173*(5), 489–495.

Schumm, L. P., Mcclintock, M., Williams, S., Leitsch, S., Lundstrom, J., Hummel, T., & Lindau, S. T. (2009). Assessment of Sensory Function in the National Social Life, Health and Aging Project. *Journal of Gerontology, 64B,* 76–85. doi:10.1093/geronb/gbp048.Assessment.

Seitz, A. R., & Dinse, H. R. (2007). A common framework for perceptual learning. *Current Opinion in Neurobiology, 17*(2), 148–53. doi:10.1016/j.conb.2007.02.004.

Shaffer, S. W., Harrison, A. L., (2007) Aging of the Somatosensory System : a Translational Perspective. *Physical Therapy 87*(2):193–207. doi:10.2522/ptj.20060083

Shimokata, H., & Kuzuya, F. (1995). Two-point discrimination test of the skin as an index of sensory aging. *Gerontology, 41*(5), 267–272.

Syddall, H., Cooper, C., Martin, F., Briggs, R., & Sayer, A. A. (2003). Is grip strength a useful single marker of frailty? *Age and Ageing, 32*(6), 650–656. doi:10.1093/ageing/afg111.

Tassler, P. L., & Dellon, A. L. (1995). Correlation of measurements of pressure perception using the pressure-specified sensory device with electrodiagnostic testing. Journal *of Occupational and Environmental Medicine, 37*(7), 862–866.

Walker, S. C., & McGlone, F. P. (2013). The social brain: Neurobiological basis of affiliative behaviours and psychological well-being. *Neuropeptides*, *47*(6), 379–393. doi:10.1016/j.npep.2013.10.008.

Wickremaratchi, M. M., & Llewelyn, J. G. (2006). Effects of ageing on touch. *Postgraduate Medical Journal, 82*, 301–304. doi:10.1136/pgmj.2005.039651.

Wilhelm, F. H., Kochar, A. S., Roth, W. T., & Gross, J. J. (2001). Social anxiety and response to touch: Incongruence between self-evaluative and physiological reactions. *Biological Psychology, 58*, 181–202. doi:10.1016/S0301-0511(01)00113-2.

Van Stralen, H. E., van Zandvoort, M. J. E., Hoppenbrouwers, S. S., Vissers, L. M. G., Kappelle, L. J., Dijkerman, H. C., Morrison, I. (2013). Affective touch modulates the rubber hand illusion. *Frontiers in Behavioral Neuroscience, 7,* 147–158. doi:10.3389/fnbeh.2013.00207

.

CHAPTER 4

4 Reliability and Validity of the European Portuguese version of the Social Touch Questionnaire

The following study is a version of an article that has been published in Journal of Nonverbal Behavior:

Vieira, A. I., Ramos, A. V., Carvalheiro, L. M., Almeida, P., Nogueira, D., Reis, E. A., Rosado, M. L., Nunes, M.V., Castro-Caldas, A. (2016). Reliability and Validity of the European Portuguese Version of the Social Touch Questionnaire. *Journal of Nonverbal Behavior*. DOI 10.1007/s1091901602397.

4.1 Introduction

Touch is our first form of communication and probably the most important and universal form of the human attachment bond. From the day we are born, we touch and are touched by others and the quality of this tactile interaction is determinant in neurodevelopment, and in the capability to transmit, control and understand emotions. Moreover, it is crucial to learning how to cope with social interactions (Dunbar, 2010).

Social touch is a distinct domain of touch and is a fundamental human need, essential for our physical and emotional wellbeing (Olausson, Wessberg, Morrison, McGlone, & Vallbo, 2010). It encompasses all the situations in which people touch each other (Haans, Bruijn, & IJsselsteijn, 2014; Jones & Brown, 1996). To understand in which contexts social touch can occur, it is important to clarify what is meant by social environment. According to Barnett & Casper (2001), human social environments include the social relationships and the places in which people function and interact with each other. Social, human, and health services are also some components of the social environment. Components of the social environment also contain social, human, and health services.

Social touch-based contact can be categorized into (1) simple, if the touch has a short duration, is intentional and is applied on a restricted part of the body; (2) protracted, if touch involves longer and mutual contact (embrace or holding hands); (3) dynamic, if touch comprises continuous and repetitive movements over the skin (caressing) (Morrison, Löken, & Olausson, 2010).

Pleaseant touch is the core of the “Social Touch Hypothesis”, since it mediates the communication and interpretation of affective contact during the interactions with others. C tactile (CT) afferents, together with Aβ afferents, support this theory and represent the neurobiological substrate of affective touch (McGlone, Wessberg, & Olausson, 2014). The CT afferents are present in hairy skin, mostly on the face, arms and legs, and are responsible for coding gentle touch as affective touch, fostering empathic responses (Morrison et al., 2011) and therefore interpersonal touch, affiliative behavior and social interaction (Mcglone et al., 2012; Olausson et al., 2010).

Like all nonverbal behaviors, touch may have many interpretations or meanings and the above mentioned social touch categories are not always well received and the experience of being touched is not always pleasant.

The individual differences in interpersonal touch can be influenced by intrinsic and extrinsic factors. For instance, the use of touch in some cultures is perceived as warm and friendly while in others it is seen as intrusive and inappropriate (Wilson & Rockstraw, 2012). Communicating emotions through touch facilitates social interactions (Field, 2010) but this process can be influenced by culture. People in southern European and Latin American cultures interact in closer proximity to each other and touching is more common than in noncontact cultures, thus influencing their touching behaviours (Dibiase & Gunnoe, 2004; Lustig & Koester, 1996).

The personal differences in the perception of touch also depend on the specific body part where the touch occurs and on the specific characteristics of the person that touches (gender, age and relationship with the touched person) (Gallace & Spence, 2010), but it may also be influenced by emotional and psychological aspects of the recipient. In fact, individuals with mental disorders may experience significant distress in certain social situations and can even demonstrate social disability (American Psychiatric Association, 2013). This is the case of individuals with depressive disorders, schizophrenia spectrum disorders and anxiety disorders, for whom social withdrawal is a common factor. Individuals suffering from social anxiety disorder tend to avoid social interactions and these avoidant behaviours lead to depressive symptoms (Moitra, Herbert, & Forman, 2008). Wilhelm, Kochar, Roth, & Gross (2001) also state that there is a correlation between social anxiety, increased anxiety and avoidant behaviours in touching situations.

Behaviours and attitudes generated in particular situations involving either touching or being touched reflect how they are perceived by the individual. Touch receptivity should be evaluated to understand the different individual responses and to identify how it affects an individual's perception of health and psychosocial state (Hertenstein & Weiss, 2011). However, the large number of variables involved makes the study of interpersonal touch difficult.

In fact, touch is a non-verbal variable in health care that can cause problems in therapeutic settings (Wilson & Rockstraw, 2012) and touch avoidance is an indicator of a person's attitude towards touch (Andersen, 1999). The same author defends that touch avoidance is comparable to a personality trait and is therefore not easy to modify. Unless this behaviour is taken into account by health professional, the therapeutic relationship may collapse.

Before any therapeutic intervention involving hands-on strategies[4], it is essential to assess the patient's perception of touch. Moreover, the individual reactions of both the client and the health professional must be continuously monitored. This entails discussing interventions to ensure a clear understanding of the therapeutic intent and the meaning of touch (Fosshage, 2000).

We considered the Social Touch Questionnaire (STQ) by Wilhelm, Kochar, Roth, & Gross (2001) to be the most appropriate instrument for the first performance evaluation measure social touch adapted to the Portuguese culture as it evaluates a very comprehensive range of behaviours and attitudes towards touch and can be applied in various contexts and by different professionals in health, social and educational areas.

Other instruments to assess behaviours and attitudes towards touch described in the literature did not fulfil our purposes of evaluating specifically social touch. For instance, the Touch Avoidance Questionnaire (TAQ) places particular emphasis on situations involving partners, parents, siblings, and friends as opposed to social touch (Ozolins &

[4] Hands-On Strategies is a common term used in Physiotherapy and it means an intervention where physiotherapists use their hands in direct contact with a patient's body.

Sandberg, 2009); the Andersen and Leibowitz Inventory Touch Avoidance Measurement (TAM) was designed to assess individual differences in the perception of touch behaviour by a friend of the same or opposite sex (Andersen & Leibowitz, 1978). We found no instruments regarding touch perception adapted to the Portuguese culture.

Questionnaires designed to assess health and health outcomes from the clients' point of view are of great importance (Feeney, 2002) not only because they give the health professional insights into problems that are not consciously or verbally referenced by the user but also because these problems may have a negative influence on the success of the intervention and can therefore influence the prognosis.

The translation and cultural adaptation of instruments facilitates research by academics and health professionals, making them more culturally appropriate and comparable across different populations. The adaptation and validation process aims to produce an instrument with the same comparable psychometric qualities as the original. This process is crucial because there may be some inconsistency between the culture and language of the original measurement instrument and the context in which it will be applied (Scientific Advisory Committee of the Medical Outcome Trust, 2002; Terwee et al., 2007).

The aim of the current research was thus to produce a valid and reliable European Portuguese version of the STQ.

This study followed the basic ethical principles set by the Declaration of Helsinki and we received prior approval from an institutional review board and all subjects gave their written informed consent. All subjects involved in the study signed a written informed consent for the usage of the data provided (Annex F).

4.2 Methodology

This study was conducted in two phases: (phase 1) a cultural and linguistic adaptation to Portuguese of the STQ; (phase 2) a reliability and validity test of the version obtained in phase one.

Permission to carry out the translation and validation of the instrument was requested the authors of the original STQ (Wilhelm et al., 2001) (Annex G).

4.2.1 Description of the original Social Touch Questionnaire (STQ)

The STQ (Wilhelm et al., 2001) was designed to assess the behaviour and attitudes towards social touch in a study of college students with social anxiety. The questionnaire consists of 20 items covering a wide range of issues concerning affections and attitudes towards social touch, such as touching versus being touched, touching someone you known versus touching a stranger, touching someone in a public place versus in a private place, touching without sexual connotation versus touching with sexual connotation.

Each subject is asked to state how far the statements are true using a Likert scale from 0 (not at all) to 4 (extremely). To obtain the total score, ten items with negative polarity need to be encoded in reverse (item 1, 4, 6, 9, 11, 12, 14, 15, 18 and 20), since they have negative polarity. The total score is thus obtained by summing the scores for each of the items; the spectral quantification of the total score goes from 0 (lowest avoidance of social touch) to 80 (most avoidance of social touch). The internal consistency (Cronbach's Alpha (α)) of the overall questionnaire in the sample of the original study was 0.89, with an average item inter-correlation of 0.29.

4.2.2 Phase 1 - Cultural and linguistic adaptation

The process of forward and back translations (Beaton, Bombardier, Guillemin & Ferraz, 2000; Guillemin, Bombardier, & Beaton, 1993) began with the translation of the original version of STQ into Portuguese. This translation was performed independently by two bilingual Portuguese translators.

A consensus version was then obtained by a panel of experts in order to examine the equivalence of meaning of the translated items and the quality of translation, namely with respect to clarity, colloquial language and literal translation. The back translation was performed by two translators whose native language is English, and a panel of experts then crosschecked these versions with the original questionnaire. Back translation was sent also to the authors of the original questionnaire and their opinions were taken into consideration (Annex H). The semantic equivalence was then analyzed from the clinical point a view by two physiotherapists specialized in Human Behaviour and Neurology and with proven scientific work in the area of "Touch". This led to the pre-final version of the questionnaire.

The content validity was examined to assess the clarity, understanding, cultural relevance and the setting of the words used when applying the STQ by administering a comprehension test to a convenience sample of 20 adult individuals. The sample consisted of 10 finalists of a Physiotherapy degree and 10 institutionalized individuals diagnosed with schizophrenia. This clinical condition was selected as its symptoms lead to changes in social functioning, (Sitzer, Twamley, Patterson, & Jeste, 2008) and the avoidance of contact with others. Students from the Physiotherapy degree course were chosen as they are exposed to numerous situations where they have to touch and be touched and so they may exhibit fewer touch avoidance behaviours and attitudes.

Table 1 presents the characterization of the sample. The majority of subjects were female (90%) with a mean age of 39 ± 18.4 years (min=21, max=64) and a mean education of 14 ± 2.9 years (min=9; max=16). The average time taken to complete the questionnaire was 9.1 ± 6.9 minutes (min=2, max=23). Subjects with schizophrenia took much longer (15.3 ± 3.7; min=11, max=23) than the students (3 ± 0.8; min=2, max=4); this difference may be explained by the typical symptomatology of schizophrenia, namely disorganized thinking, cognitive deficits, deficit of attention, deficits of declarative and working memory, memory, language function and slower planning of activities (American Psychiatric Association, 2013).

Table 1: Sample Characteristics (N = 20) and completion time of STQ

Individuals with schizophrenia (n; %)	10 (50%)
Students (n; %)	10 (50%)
Women (n; %)	18 (90%)
Average age sample (years)	39±18.4 (21-64)*
Average patient age with schizophrenia (years)	56.8±4.0 (50-64)*
Average students age (years)	21,3±0.4 (21-22)*
Education of the sample (years)	14 ±2.9 (9-16)*
Education of individuals with schizophrenia (years)	12 ±3.0 (9-16)*
Education of students (years)	16 ±0.0 (16-16)*
STQ completion time (minutes)	9.1±6.9 (2-23)*
Completion time by individuals with schizophrenia (minutes)	15.3±3.7 (11-23)*
Completion time by students (minutes)	3±0.8 (2-4)*

* mean ± standard deviation (minimum-maximum)

All the subjects (n=20) were of the opinion that the STQ was a relevant questionnaire, explicit, noticeable, understandable, quick and easy to answer and that the instructions were clear. The proposed solutions were reviewed by the panel of experts and analyzed for their responsiveness and adequacy. The European Portuguese version of the STQ resulted from consensus achieved amongst the panel of experts. The items of the Portuguese version following the cultural and linguistic adaptation are presented in table 2.

Table 2: Items from the European Portuguese version of the STQ

Item	Original version	Portuguese version
1	I generally like when people express their affection towards me in a physical way*	Normalmente gosto que as pessoas manifestem o seu afeto por mim de uma forma física*
2	I feel uncomfortable when someone I don't know very well hugs me	Sinto-me pouco à vontade quando alguém que não conheço muito bem me dá um abraço
3	I get nervous when an acquaintance keeps holding my hand after a handshake	Fico nervoso(a) quando uma pessoa não larga a minha mão depois de um aperto de mão
4	I generally seek physical contact with others*	Normalmente procuro contato físico com os outros*
5	I feel embarrassed if I have to touch someone in order to get their attention	Sinto-me constrangido/a se tenho de tocar em alguém para chamar a sua atenção
6	I consider myself to be a 'touchy-feely' person*	Considero-me uma pessoa que gosta de expressar afeto através do toque*
7	It annoys me when someone touches me unexpectedly	Aborrece-me que alguém me toque inesperadamente
8	I'd feel uncomfortable if a professor touched me on the shoulder in public	Sentir-me-ia pouco à vontade se um professor me tocasse no ombro em público
9	I'd be happy to give a neck/shoulder massage to a friend if they are feeling stressed*	Teria todo o gosto em fazer uma massagem no pescoço ou nos ombros a uma pessoa amiga que estivesse tensa*
10	I feel uncomfortable if I make physical contact with a stranger on the bus or subway	Sinto-me pouco à vontade se tiver contato físico com um estranho no autocarro ou no metropolitano
11	I like being caressed in intimate situations*	Gosto de receber carícias em situações íntimas*
12	As a child, I was often cuddled by family members (e.g. parents, siblings)*	Quando era criança, os meus familiares (por exemplo, pais, irmãos) faziam-me festas muitas vezes*
13	I would rather avoid shaking hands with strangers	Preferiria evitar dar apertos de mão a estranhos
14	I greet my close friends with a kiss, cheek-to-cheek *	Cumprimento os meus amigos mais chegados com um beijo na face*
15	I feel comfortable touching people I do not know very well*	Sinto-me à vontade ao tocar em pessoas que não conheço muito bem*
16	I feel disgusted when I see public displays of intimate affection	Sinto-me enojado(a) quando vejo demonstrações íntimas de afeto em público
17	It would make me feel anxious if someone I had just met touched me on the wrist	Sentir-me-ia ansioso(a) se alguém que tivesse acabado de conhecer me tocasse no punho
18	If I had the means, I would get weekly professional massages*	Se tivesse condições, todas as semanas fazia massagens com um profissional*
19	I hate being tickled	Detesto que me façam cócegas
20	I like petting animals*	Gosto de fazer festas a animais*

* Items scored in reverse

4.2.3 Phase 2 – Reliability and Validity test of the Portuguese version of the STQ

4.2.3.1 Study population

For reliability and validity assessment, a total sample of 242 Portuguese university students was selected (59% were students of Physiotherapy and 41% of Speech Therapy and Occupational Therapy) from volunteers to participate in the study. The choice of college students as the sample type followed the example of the original study.

The majority of the sample is female (83.1%) and the mean age of the entire sample is 21.3 ±3.8 (min=17; max=45) years. The sample size was in accordance with recommendations in the literature on the number of participants required for a factor analysis: more specifically, between four to ten subjects per questionnaire item with a minimum number of 100 subjects to ensure stability of the variance-covariance matrix (Kline, 1993). The questionnaires (Annex I) were distributed to students in class and they were asked to register the total amount of time taken to complete the questionnaire. All subjects returned the questionnaire. Test-retest reliability was performed with a smaller student sample (n=50) over a two-week interval (Terwee et al., 2007). None of the subjects reported any psychiatric or psychological condition or anxiolytic medication. Table 3 shows the sample characteristics.

Table 3: Sample Characteristics (N=242) and completion time of STQ

Age (years)*	21.31±3.8 (max=45;min=21)
Female: Male (nº ;%)	201(83.1%):41 (16.9%)
Physiotherapy (nº ;%)	143 (59%)
Speech Therapy and Occupational Therapy (nº ;%)	99 (41%)
Completion time (minutes)*	2.92±0.71 (max=2;min=5)

*Mean±Std. Deviation (max;min)

4.2.3.2 Reliability

The internal consistency was assessed using Cronbach's α coefficient. An alpha value between 0.70 and 0.95 is considered acceptable and indicates a high correlation amongst the items in the questionnaire.

Test-retest reliability were performed with a smaller student sample (n=50) and assessed using Intraclass Correlation Coefficient (ICC). An ICC higher or equal to 0.70 is considered positive, as long as the sample is at least composed of 50 subjects.

4.2.3.3 Validity

The construct validity is determined by how the score of an instrument relates with other measurements. This relationship must show consistency with theoretically derived hypotheses concerning the concepts involved in the study. In light of the relationship between social anxiety and avoidance behaviours towards touch described in the literature, we selected the European Portuguese version of the Social Interaction and Performance Anxiety and Avoidance Scale (SIPAAS) as a comparison measure (Pinto-Gouveia, Cunha, & Salvador, 2003). Permission was given to use this scale (Annex J).

It comprises two subscales, namely the distress/anxiety subscale and the avoidance subscale, and it is a self-report questionnaire to assess the level of distress and avoidance in a large variety of social performance and interaction situations. Both scales showed high levels of internal consistency. Total scores may range from 44 to 176 and the authors suggest cut-off scores (distress/anxiety subscale - 115; avoidance subscale – 105), thus discriminating between subject with generalized social phobia and the non-clinical population.

The construct validity was assessed using the predefined hypotheses test (Streiner & Norman, 2003; Terwee et al., 2007): (1) A positive correlation is expected between the total scores of the STQ and the anxiety and avoidance subscales of the Social Interaction and Performance Anxiety and Avoidance Scale (SIPAAS); (2) Physiotherapy students have fewer avoidance behaviours and attitudes towards social touch, when compared with Speech Therapy and Occupational Therapy students.

The Pearson Correlation Coefficient and the t-test for equality of two population means were used for the statistical analysis of the construct validity. A value of $p \leq 0.05$ was considered statistically significant. A SPSS version 22 was used for all statistical analysis.

4.3 Results

The mean STQ completion time was 2.92 minutes, ranging from 2 minutes to 5 minutes. All items were completed. To assess the floor and ceiling effects of the STQ, we analyzed the distribution of each item; no such effects were found (Table 4).

Table 4: Floor and Ceiling effects

	n	Floor effect %	Ceiling effect %
STQ	242	0.00	0.00

As we can see in table 5, the STQ showed adequate internal consistency (Cronbach's α =0.734) and the test-retest correlation with the STQ items revealed a high concordance between the tests over a two-week interval for a sample size of 50 students (ICC=0.990; Lower Bound=0.981; Upper Bound=0.995)

Table 5: Reliability - STQ

	Cronbach α (n= 242)	ICC (n= 50)	Lower Bound	Upper Bound
STQ	0.734	0.990	0.981	0.995

The results showed a significant conceptual convergence between the STQ and the SIPAAS-Anxiety (r=0.64; p=0.000) and SIPAAS-Avoidance (r=0.59; p=0.000), with a positive correlation between measurements. However, it appears that the avoidance behaviours and attitudes towards social touch (measured with STQ) are more associated with the distress felt in situations involving performance and social interaction (measured with the SIPAAS-Anxiety subscale) than with avoidance situations of performance and social interaction (measured with the SIPAAS-Avoidance subscale). As such, the first pre-defined hypothesis that there is a positive correlation between the total scores of the STQ and the anxiety and avoidance subscales of the SIPAAS was confirmed (Table 6).

Table 6: Validity – STQ vs. SIPAAS

		SIPAAS Anxiety Total Score	SIPAAS Avoidance Total Score
STQ Total Score	*r*	**0.639***	**0.590***
	p	0.000	0.000
	n	242	242

*Correlation is significant at the 0.01 level

Physiotherapy students exhibited fewer behaviours and attitudes towards social touch than Speech Therapy and Occupational Therapy students (p=0.000). In fact, Physiotherapy students have a lower score in STQ (29.18±8.66) than the students from the other two degree courses (37.77±7.85). Thus, the predefined hypothesis was confirmed (Table 7).

Table 7: Validity – STQ vs. Course

	Course	n	Mean	SD	*p*
STQ _ Total Score	Physiotherapy	143	29.18	8.66	
	Other	99	37.77	7.85	0.000

4.4 Discussion and conclusions

Our main goal was to evaluate the reliability and validity of the European Portuguese version of the STQ.

The European Portuguese version of the STQ is easily understood and takes little time to complete. No floor and ceiling effects were found, revealing an excellent content validity.

We found a high level of reliability in the STQ; in fact, Cronbach's α coefficient (0.734) show that the internal consistency was acceptable, indicative of a high correlation among the items in the questionnaire and that the items are suitable to evaluate behaviours and attitudes towards touch. However, this value is slightly lower than the one reported by the original authors (0.89). This result may be due to the fact that the original study sample consists of subjects with higher levels of anxiety. The Cronbach's alpha coefficient is an inherent property of the studied population response pattern, not a feature of the scale alone; i.e., the alpha value undergoes changes according to the population to which the scale is applied (Streiner, 2003). The STQ demonstrated excellent reproducibility, showing homogeneity in concept measurement and stability between evaluations over time.

The specific hypotheses established for construct validity were corroborated:

(1) There is a positive correlation between the total scores of the STQ and the anxiety and avoidance subscales of the SIPAAS. The total score of the STQ is significant and positively correlated with the total scores of the anxiety and avoidance subscales of the SIPAAS, which supports the use of the STQ as a screening tool. This correlation was

also found in the original study (Wilhelm et al., 2001) and there are other studies that corroborate this association (Nuszbaum, Voss, & Klauer, 2014). It means that social anxiety is related to a generalized pattern of anxiety and avoidance linked to situations involving touch. In this sample, the SIPAAS-Anxiety subscale is more associated with the avoidance behaviours and attitudes towards social touch (STQ) than with SIPAAS-Avoidance subscale, for which the total score indicates the level of avoidance in performance and social interaction situations. This relationship is probably associated with the fact that the sample consists of healthy individuals and, as such, they may feel high levels of anxiety in certain situations but, as they do not avoid these anxiogenic contexts, they are able to deal with situations and tasks that cause distress.

(2) Physiotherapy students exhibit fewer avoidance behaviours and attitudes towards social touch, compared with Speech Therapy and Occupational Therapy students. The Physiotherapy course is based on two core learning strategies: theoretical lectures and hands-on practice, reproducing real-life situations or in clinical placement. From the first year of the course, students experience various learning situations which require touching each other and touching patients. Touch represents the highest proportion of nonverbal behaviour in the physiotherapists' interventions (Roberts & Bucksey, 2007) and the profession depends on manual skills. But what distinguishes Physiotherapy from most other professions is the bodily interactions with the patients and long treatment sessions. Physiotherapists use touch through hands-on techniques but also to positively influence their relationship with patients (Roberts & Bucksey, 2007). The literature refers to these touch categories as instrumental touch (a deliberate physical contact necessary to perform a treatment strategy) and expressive or affective touch, (a spontaneous physical contact, not essential for the completion of a task) (Everett, Dennis, & Ricketts, 1995).

In different social contexts, touch, the amount of touch quantity and how often it is applied increases compliance and promotes interpersonal relationships (Bohm & Hendricks, 1997; Guéguen & Vion, 2009; Guéguen, 2004; Joule & Gueguen, 2003; Vaidis & Halimi-Falkowicz, 2008). However, it can also cause anxiety and avoidance reactions and when this occus in a therapeutic context, it may lead to the discontinuation of the therapy relationship. Therefore, it is advisable to evaluate the client's perception of touch through objective evaluation measures rather than on the basis of the therapist's feelings (hunch). In this case, the STQ may be considered an important indicator to assess the therapeutic relationship.

Moreover, if the sample comprises adults not attending school, the item “STQ-8. I’d feel uncomfortable if a professor touched me on the shoulder in public” should be excluded. In other words, it may be necessary to adjust the original questionnaire to each specific population.

The main limitation in this study is that the sample is mostly female, and it was therefore not possible to determine the differences between men and women in relation to social touch. We recommend the replication of this study, using either a larger sample or clinical samples.

The results of this study showed that the European Portuguese version of the STQ is a reliable, valid and comprehensive measurement tool. It is an instrument that can be used by different health professionals, in clinical practice and for research purposes, especially in studies that include touch experiences in their protocols whether they are tactile sensory stimuli applied passively or involving the haptic touch (when the subject actively explores and interacts with objects or other people).

4.5 References

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders*. (American Psychiatric Association, Ed.) (Fifth Edit.). Arlington, VA.

Andersen, P. A. (1999). *Nonverbal communication: Forms and functions.* Mountain-view, CA: Mayfield Publ. Co.

Andersen, P. A., & Leibowitz, K. (1978). The development and nature of the construct touch avoidance. *Environmental Psychology and Nonverbal Behavior*, *3*, 89–106. doi:doi:10.1007/BF01135607

Barnett, E., & Casper, M. (2001). A Definition of “Social Environment”. *American Journal of Public Health, 91*(3), 465.

Beaton, D. E., Bombardier, C., Guillemin, F., Ferraz, M. B. (2000). Guidelines for the Process of Cross-Cultural Adaptation of Self-Report Measures. *Spine, 25* (24), 3186-3191;

Bohm, J. K., & Hendricks, B. (1997). Effects of Interpersonal Touch, Degree of Justification, and Sex of Participant on Compliance With a Request. The Journal of Social Psychology, 137(4), 460–469. doi:10.1080/00224549709595462

Dibiase, R., & Gunnoe, J. (2004). Gender and culture differences in touching behavior. *The Journal of Social Psychology*, *144*(1), 49–62. doi:10.3200/SOCP.144.1.49-62

Dunbar, R. I. M. (2010). The social role of touch in humans and primates: Behavioural function and neurobiological mechanisms. *Neuroscience and Biobehavioral Reviews*, *34*(2), 260–268. doi:10.1016/j.neubiorev.2008.07.001

Everett, T., Dennis, M., & Ricketts, E. (1995). *Physiotherapy in Mental Health: A Practical Approach*. Oxford: Butterworth-Heinemann.

Feeney, J. (2002). Attachment-related dynamics: what can we learn from self-reports of avoidance and anxiety? *Attachment & Human Development*, *4*(2), 193–200. doi:10.1080/14616730210157475

Field, T. (2010). Touch for socioemotional and physical well-being: A review. *Developmental Review*, *30*(4), 367–383. doi:10.1016/j.dr.2011.01.001

Fosshage, J. L. (2000). The Meaning of Touch in Psychoanalysis: A Time for Reassessment. *Psychoanalytic Inquiry, 20*(1), 21–43.

Gallace, A., & Spence, C. (2010). The science of interpersonal touch: An overview. *Neuroscience and Biobehavioral Reviews*, *34*(2), 246–259. doi:10.1016/j.neubiorev.2008.10.004

Guéguen, N. (2004). Nonverbal encouragement of participation in a course: The effect of touching. *Social Psychology of Education, 7,* 89–98.

Guéguen, N., & Vion, M. (2009). The effect of a practitioner's touch on a patient's medication compliance. Psychology, Health & Medicine, 14(6), 689–694. doi:10.1080/13548500903334739

Guillemin, F., Bombardier, C., Beaton, D. (1993). Cross-Cultural Adaptation of Health-Related Quality of Life Measures: Literature Review and Proposed Guidelines. *Journal of Clinical Epidemiology, 46* (12), 1417-1432.

Haans, A., Bruijn, R., & IJsselsteijn, W. (2014). A Virtual Midas Touch? Touch, Compliance and Confederate Bias in Mediated Communication. *Journal of Nonverbal Behavior*, *38*(3), 301–311. doi:10.1007/s10919-014-0184-2

Hertenstein, M., & Weiss, S. (2011). *The handbook of touch - Neuroscience, behavioral and health perspectives*. New York: Springer Publishing Company.

Jones, S. E., & Brown, B. C. (1996). Touch attitudes and behaviors, recollections of early childhood touch, and social self-confidence. *Journal of Nonverbal Behavior*, *20*(3), 147–163.

Joule, R. V., & Gueguen, N. (2003). Touch, compliance and awareness of tactile contact. *Perceptual and Motor Skills*, *104*, 581–588.

Kline, P. (1993). *The handbook of psychological testing*. London: Routledge.

Lustig, M. W., & Koester, J. (1996). *Intercultural competence: Interpersonal communication across cultures* (2nd ed.). New York: HarperCollins.

Mcglone, F., Olausson, H., Boyle, J. A., Jones-Gotman, M., Dancer, C., Guest, S., & Essick, G. (2012). Touching and feeling: Differences in pleasant touch processing between glabrous and hairy skin in humans. European Journal of Neuroscience, 35(11), 1782–1788. doi:10.1111/j.1460-9568.2012.08092.x

McGlone, F., Wessberg, J., & Olausson, H. (2014). Discriminative and affective touch: sensing and feeling. Neuron, 21(82(4)), 737–755.

Moitra, E., Herbert, J., & Forman, E. (2008). Behavioral avoidance mediates the relationship between anxiety and depressive symptoms among social anxiety disorder patients. *Journal of Anxiety Disorders*, *22*(7), 1205–1213. doi:10.1016/j.janxdis.2008.01.002

Morrison, I., Löken, L. S., Minde, J., Wessberg, J., Perini, I., Nennesmo, I., & Olausson, H. (2011). Reduced C-afferent fibre density affects perceived pleasantness and empathy for touch. *Brain*, *134*(4), 1116–1126. doi:10.1093/brain/awr011

Morrison, I., Löken, L. S., & Olausson, H. (2010). The skin as a social organ. Experimental Brain Research, 204(3), 305–314. doi:10.1007/s00221-009-2007-y

Nuszbaum, M., Voss, A., & Klauer, K. C. (2014). Assessing individual differences in the need for interpersonal touch and need for touch. *Social Psychology*, *45*(1), 31–40. doi:10.1027/1864-9335/a000157

Olausson, H., Wessberg, J., Morrison, I., McGlone, F., & Vallbo, Å. (2010). The neurophysiology of unmyelinated tactile afferents. Neuroscience and Biobehavioral Reviews, 34(2), 185–191. doi:10.1016/j.neubiorev.2008.09.011

Ozolins, A., & Sandberg, C. (2009). Development of a Multifactor Scale Measuring the Psychological Dimensions of Touch Avoidance. *International Journal of Psychology*, *3*, 33–56.

Pinto-Gouveia, J., Cunha, M. I., & Salvador, M. do C. (2003). Assessment Of Social Phobia By Self-Report Questionnaires: The Social Interaction And Performance Anxiety And Avoidance Scale And The Social Phobia Safety Behaviours Scale. *Behavioural and Cognitive Psychotherapy*, *31*(3), 291–311. doi:10.1017/S1352465803003059

Roberts, L., & Bucksey, S. (2007). Communicating with patients: what happens in practice? *Physical Therapy*, *87*(5), 586–594. doi:10.2522/ptj.20060077

Scientific Advisory Committee of the Medical Outcome Trust. (2002). Assessing health status and quality of life instruments: attributes and review criteria. *Quality of Life Research*, *11*, 193–205.

Sitzer, D. I., Twamley, E. W., Patterson, T. L., & Jeste, D. V. (2008). Multivariate predictors of social skills performance in middle-aged and older out-patients with schizophrenia spectrum disorders. *Psychological Medicine*, *38*(5), 755–763. doi:10.1017/S0033291707001304

Streiner, D. L. (2003). Being Inconsistent About Consistency: When Coefficient Alpha Does and Doesn't Matter. *Journal of Personality Assessment*, *80*(3), 217–222. doi:10.1207/S15327752JPA8003

Streiner, D. L., & Norman, G. R. (2003). *Health measurement scales. A practical guide to their development and use*. New York: Oxford University Press.

Terwee, C., Bot, S., Boer, M., Windt, D., Knol, D., Dekker, J., Vet, H. (2007). Quality criteria were proposed for measurement properties of health status questionnaires. *Journal of Clinical Epidemiology*, *60*(1), 34–42. doi:10.1016/j.jclinepi.2006.03.012

Vaidis, D. C., & Halimi-Falkowicz, S. G. (2008). Increasing compliance with request: Two touches are more effective than one. *Psychological Reports*, *103*, 88–92.

Wilhelm, F. H., Kochar, A. S., Roth, W. T., & Gross, J. J. (2001). Social anxiety and response to touch: Incongruence between self-evaluative and physiological reactions. *Biological Psychology*, *58*, 181–202. doi:10.1016/S0301-0511(01)00113-2

Wilson, L., & Rockstraw, L. (2012). *Human Simulation for Nursing and Health Professions*. Springer Publishing Company.

CHAPTER 5

5 Final conclusion

We live in a multisensory environment, and the interaction between our body and the environment defines and organizes our brains at every moment. Our brain has a large capacity for automatic and simultaneous integration and processing of multisensory information, i.e., our brain integrates the information from the sensory channels into a unique and holistic perception.

In clinical practice it is important to use meaningful multisensory stimulations and stimuli must be related to the body, due to the fact that the body mediates all the interactions between the world around us and our brain.

In the case of elderly people, despite the deterioration of the sensory systems there is evidence of stabilization or increase of the multisensory integration processing.

Multisensory stimulation and multisensory brain processing play an important role in the daily life of elderly people by facilitating and improving the sensorial, perceptual, cognitive and emotional competences.

The multisensory stimulation we get through all sensory modalities helps us build the representation we make of ourselves, i.e. support the arising, maintenance and the preservation of the *Self*.

In fact the *Self* may change when exposed to aging and to various health conditions, or due to sensory and relational experiences that are relevant to the individual or even due to the lack of stimulation.

Regarding the general conclusions of the studies performed in this thesis, supported by scientific evidence collected, such as:

(1) Brain areas activated by the *Self-referential* multisensory stimulation are those related to the *Self* processing;

(2) Decreased tactile sensitivity of the hand in the elderly has implications in the hand strength and in behaviour and attitudes towards social touch. These problems could lead to difficulties in functional activities, to decrease in interpersonal relations and to the disintegration of the *Self*.

And taking into account that in case of elderly people, despite the deterioration of the sensory systems there is evidence of stabilization or increase of the multisensory integration processing, we recommend consider multisensory *Self-referential* stimulation composed of unisensory verbal stimulus requesting to feel specific body parts, when planning intervention strategies for healthy aging with the aim of increase of sensory and perceptive functions and of maintaining the integrity of the *Self* in the elderly.

This thesis (1) showed that multisensory stimulation with *Self-referential* stimuli related to the body parts activates brain areas responsible for processing the *Self*; (2) offers a perspective on the importance of the study of tactile sensory function, its relation to motor function, in interpersonal relationships and highlights the importance of the preservation of the *Self* in older people; (3) proposes a new therapeutic intervention of multisensory stimulation comprised of unisensory auditory-verbal stimulus requesting to feel specific body parts and unisensory tactile-manual stimulation of the same body parts. It is a simple strategy that respects the multisensory integration principles and promotes a therapeutic relationship. But to fully achieve the objectives, the Social Touch Questionnaire should be applied in order to evaluate the touch perception and receptivity of the clients. Also regarding to this intervention, physiotherapists should be trained in voice projection and in affective touch technique.

We believe that the problems and the objectives set in the beginning led us to create a methodological design that unfolded as planned.

One ends up with the conviction that the use of the results of this study will contribute to (1) produce knowledge about healthy aging; (2) encourage research with the proposed intervention, not only in the elderly people but also in children and in persons with different health conditions (mental, sensory, perceptive, neuromusculoskeletal and movement-related functions); (3) the improvement of clinical practice focused on supporting the elderly and directed to promote an active and healthy aging.

ANNEXES

List of Annexes:

ANNEX A - Informed consent and protocol - Multisensory *Self-referential* stimulation of the lower limb – an fMRI study on healthy subjects

ANNEX B – Brain activated areas - Multisensory *Self-referential* stimulation of the lower limb – an fMRI study on healthy subjects

ANNEX C - Informed consent- Tactile Discrimination, Social Touch and Frailty criteria in elderly people

ANNEX D - Protocol- Tactile Discrimination, Social Touch and Frailty criteria in elderly people

ANNEX E - Portuguese version Waterloo Handedness Questionnaire-Revised - Tactile Discrimination, Social Touch and Frailty criteria in elderly people

ANNEX F - Informed consent- Reliability and Validity of the European Portuguese version of the Social Touch Questionnaire

ANNEX G - Social Touch Questionnaire authorization- Reliability and Validity of the European Portuguese version of the Social Touch Questionnaire

ANNEX H - Review of the back translation by the original authors

ANNEX I - Evaluation protocol students STQ- Reliability and Validity of the European Portuguese version of the Social Touch Questionnaire

ANNEX J - EAESDIS authorization- Reliability and Validity of the European Portuguese version of the Social Touch Questionnaire

ANNEX A

Informed consent and protocol - Study on Multisensory *Self-referential* stimulation of the lower limb – an fMRI study on healthy subjects

Declaração de Consentimento Informado

Considerando a "Declaração de Helsínquia" da Associação Médica Mundial (Helsínquia 1964; Tóquio 1975; Veneza 1983; Hong Kong 1989; Somerset West 1996, Edimburgo 2000, Washington 2002, Tóquio 2004 e Seoul 2008)

Multisensory Self-referential stimulation of the lower limb – an fMRI study on healthy subjects

Eu, abaixo-assinado, (nome completo) -- --- , compreendi a explicação que me foi fornecida acerca do meu caso e da investigação que se tenciona realizar, bem como do estudo em que serei incluído. Foi-me dada oportunidade de fazer as perguntas que julguei necessárias, e de todas obtive resposta satisfatória.

Tomei conhecimento de que, de acordo com as recomendações da Declaração de Helsínquia, a informação ou explicação que me foi prestada versou os objetivos, os métodos, os benefícios previstos, os riscos potenciais e o eventual desconforto. Além disso, foi-me afirmado que tenho o direito de recusar a todo o tempo a minha participação no estudo, sem que isso possa ter como efeito qualquer prejuízo na assistência que me é prestada.

Por isso, consinto que me seja aplicado: os procedimentos de avaliação da ansiedade, da cognição, do toque social, da lateralidade podal e manual e o protocolo experimental associado à recolha com ressonância magnética funcional, propostos pelo investigador.

Data: ____ / __________________ / 20___

Assinatura do sujeito: ____

O Investigador responsável

Nome:

Assinatura:____

Dados recolhidos no procedimento experimental

Nº de sujeito ___
Data de recolha dos dados no procedimento experimental ___/___/___
Sujeito completou a recolha? Sim__ Não__
Tempo de recolha ____ min

Intercorrências

____
____
____
____
____
____
____
____

QUESTIONÁRIO DE AUTO-AVALIAÇÃO

de Charles D. Spielberger

STAI Forma Y – 1, Versão Portuguesa de Danilo R. Silva

E____T_____

Nome____

Data____/____/_____

Idade: ____anos   Sexo: M___ F___

Escolaridade:__________

Profissão:______________

INSTRUÇÕES: Em baixo encontra uma série de frases que as pessoas costumam usar para se descreverem a si próprias. Leia cada uma delas e faça uma cruz (x) no número da direita que indique como se sente agora, isto é, **neste preciso momento**. Não há respostas certas nem erradas. Não leve muito tempo com cada frase, mas dê a resposta que melhor lhe parece descrever os seus sentimentos **neste momento.**

	Nada	**Um pouco**	**Moderadament**	**Muito**
1. Sinto-me calmo	1	2	3	4
2. Sinto-me seguro	1	2	3	4
3. Sinto-me tenso..	1	2	3	4
4. Sinto-me esgotado..	1	2	3	4
5. Sinto-me à vontade..	1	2	3	4
6. Sinto-me perturbado..	1	2	3	4
7. Presentemente, ando preocupado com desgraças que podem vir a acontecer..	1	2	3	4
8. Sinto-me satisfeito..	1	2	3	4
9. Sinto-me assustado..	1	2	3	4
10. Estou descansado	1	2	3	4
11. Sinto-me confiante	1	2	3	4
12. Sinto-me nervoso	1	2	3	4
13. Estou inquieto..	1	2	3	4
14. Sinto-me	1	2	3	4

indeciso..

15. Estou descontraído	1	2	3	4
16. Sinto-me contente..	1	2	3	4
17. Estou preocupado	1	2	3	4
18. Sinto-me confuso	1	2	3	4
19. Sinto-me uma pessoa estável...	1	2	3	4
20. Sinto-me bem..	1	2	3	4

QUESTIONÁRIO DE AUTO-AVALIAÇÃO
de Charles D. Spielberger
Versão portuguesa de Danilo R. Silva

Chave de cotação do STAI Forma Y-1

	Nada	Um pouco	Moderadament	Muito
1…………………………………………………………………………………………	4	3	2	1
2…………………………………………………………………………………………	4	3	2	1
3…………………………………………………………………………………………	1	2	3	4
4…………………………………………………………………………………………	1	2	3	4
5…………………………………………………………………………………………	4	3	2	1
6…………………………………………………………………………………………	1	2	3	4
7…………………………………………………………………………………………	1	2	3	4
8…………………………………………………………………………………………	4	3	2	1
9…………………………………………………………………………………………	1	2	3	4
10…………………………………………………………………………………………	4	3	2	1
11…………………………………………………………………………………………	4	3	2	1
12…………………………………………………………………………………………	1	2	3	4
13…………………………………………………………………………………………	1	2	3	4
14…………………………………………………………………………………………	1	2	3	4
15…………………………………………………………………………………………	4	3	2	1
16…………………………………………………………………………………………	4	3	2	1
17…………………………………………………………………………………………	1	2	3	4
18……………………………………………………………………………	1	2	3	4

………..
19………………………………………………………………………… 4 3 2 1
………..
20………………………………………………………………………… 4 3 2 1
………..

SLUMS (Saint Louis University Mental Status)

Tarik et al (2006) com tradução portuguesa de Pinto, A. C. (2007).

Nome: ___________________________
Idade: ___________
O indivíduo está desperto? ____ Nível de escolaridade:

1. Que dia da semana é hoje?
2. Em que ano estamos?
3. Em que distrito estamos situados?
4. Lembre-se por favor das 5 palavras seguintes. Mais tarde vou pedir-lhe para as recordar.

Maçã Lápis Saia Casa Táxi

5. Se for a um supermercado com 100 euros para aí comprar uma dúzia de maçãs por 3 euros e um ferro de engomar por 20 euros, pergunto:

(1) Quanto gastou?
(2) Quanto lhe sobrou?

6. Diga por favor o maior número de animais que souber durante um minuto.

(0) - 0 a 4 animais
(1) - 5 a 9 animais
(2) - 10 a 14 animais
(3) - 15 ou + animais.

7. Quais são as 5 palavras que eu lhe pedi há pouco para recordar? *(1 ponto por cada recordação correcta)*
8. Vou dizer uma série de números e depois gostaria que os repetisse do fim para o princípio. Por exemplo se eu disser 4-2, gostaria que dissesse 2-4. Compreendeu?

(0) - 87; (1) - 6 4 9 (1) - 8 5 3 7

9. Este círculo é um mostrador de relógio. Escreva as marcas da hora e indique o tempo seguinte: 11 horas menos 10 minutos.

9.1.Marcas da hora correctas.
9.2.Tempo correcto
10.Coloque um X no triângulo.
10.1. Qual destas figuras é maior?

11. Eu vou contar-lhe uma história. Preste muita atenção, porque no fim eu vou fazer-lhe algumas perguntas sobre a história que ouviu.

A Elsa era uma economista de grande sucesso. Ganhou imenso dinheiro negociando na Bolsa. A certa altura conheceu o Daniel, um homem muito elegante. Casou-se com ele e teve 3 filhos. Eles viveram no concelho de Gaia. Ela deixou de trabalhar e ficou em casa para cuidar dos filhos.
Quando cresceram e já eram adolescentes, ela voltou a trabalhar. Ela e o Daniel viveram felizes para sempre.
(2) Qual era o nome da mulher? (2) Que profissão tinha? (2) Quando regressou ao trabalho? (2) A que distrito pertencia?

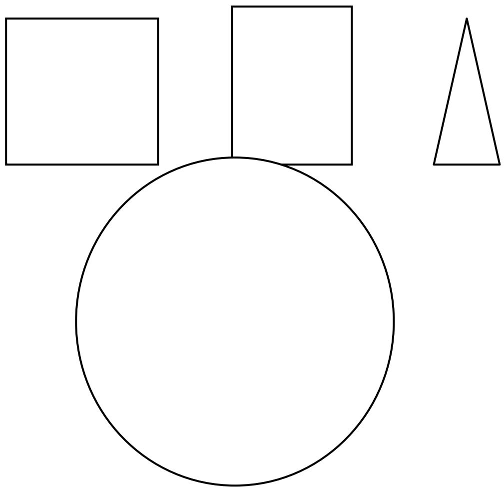
Total: ______

Valores propostos a partir da amostra original dos EUA (Tarik et al., 2006) para fins de diagnóstico

Ensino secundário ou superior	**Diagnóstico**	**Ensino inferior ao secundário**
27-30	Normal	25-30
21-26	Desordem Neurocognitiva Ligeira	20-24
1-20	Demência	1-19

Tariq, S. H., Tumosa, N., Chibnall, J. T., Perry, M. H., e Morley, J. E. (2006). Comparison of the Saint Louis university mental status examination and the mini-mental state examination for detecting dementia and mild neurocognitive disorder - A pilot study. *The American Journal of Geriatric Psychiatry, 14*, 900-910.

Tradução Portuguesa de Amâncio C. Pinto (FPCE-UP). E-mail: amancio@fpce.up.pt



Questionário sobre o Toque Social

Frank H. Wilhelm, Ajay S. Kochar, Walton T. Roth and James J. Gross (2001)
(Versão Portuguesa)

As seguintes afirmações fornecem uma variedade de afetos e atitudes relativas ao toque social.
Indique até que ponto cada uma das seguintes afirmações o/a carateriza ou é verdadeira.
0=absolutamente nada 1=ligeiramente 2=moderadamente 3=muito

		0	1	2	3	4
1	Normalmente gosto que as pessoas manifestem o seu afeto por mim de uma forma física					
2	Sinto-me pouco à vontade quando alguém que não conheço muito bem me dá um abraço					
3	Fico nervoso/a quando uma pessoa não larga a minha mão depois de um aperto de mão					
4	Normalmente procuro contato físico com os outros					
5	Sinto-me constrangido/a se tenho de tocar em alguém para chamar a sua atenção					
6	Considero-me uma pessoa que gosta de expressar afeto através do toque					
7	Aborrece-me que alguém me toque inesperadamente					
8	Sentir-me-ia pouco à vontade se um professor me tocasse no ombro em público					
9	Teria todo o gosto em fazer uma massagem no pescoço ou nos ombros a uma pessoa amiga que estivesse tensa					
10	Sinto-me pouco à vontade se tiver contato físico com um estranho no autocarro ou no metropolitano					
11	Gosto de receber carícias em situações íntimas					
12	Quando era criança, os meus familiares (por exemplo, pais, irmãos) faziam-me festas muitas vezes					
13	Preferiria evitar dar apertos de mão a estranhos					
14	Cumprimento os meus amigos mais chegados com um beijo na face					
15	Sinto-me à vontade ao tocar em pessoas que não conheço muito bem					
16	Sinto-me enojado/a quando vejo demonstrações íntimas de afeto em público					
17	Sentir-me-ia ansioso/a se alguém que tivesse acabado de conhecer me tocasse no punho					
18	Se tivesse condições, todas as semanas fazia massagens com um profissional					
19	Detesto que me façam cócegas					
20	Gosto de fazer festas a animais					

Pontuação Final: ____________

Questionário de Waterloo de lateralidade podal – revisto

Tradução para Português – Europeu

L.J.Elias et al (1998)

Nome: ____

Instruções: Responda a cada uma das questões apresentadas, o melhor que conseguir. Se usa **sempre** o mesmo pé para realizar a atividade descrita, assinale **DS** ou **ES** (**Direito Sempre** ou **Esquerdo Sempre**). Se **habitualmente** usa um dos pés, assinale **DH** ou **EH** (**Direito Habitualmente** ou **Esquerdo Habitualmente**). Se usa **ambos** os pés com a mesma frequência, assinale **A** (**Ambos**).

Por favor, não assinale simplesmente a resposta mas imagine-se a realizar cada atividade e só depois marque a resposta. Se necessário, pare e realize o movimento.

1	Qual é o pé que usa para dar um pontapé numa bola parada em direção a um alvo à sua frente?	ES	EH	A	DH	DS
2	Se tiver que se apoiar num pé, em que pé seria?	ES	EH	A	DH	DS
3	Que pé utilizaria para alisar a areia da praia?	ES	EH	A	DH	DS
4	Se tivesse que subir para a uma cadeira que pé colocaria primeiro na cadeira?	ES	EH	A	DH	DS
5	Que pé utilizaria para pisar um inseto rastejante em movimento?	ES	EH	A	DH	DS
6	Se se quisesse equilibrar num dos rails do caminho-de-ferro, que pé utilizaria?	ES	EH	A	DH	DS
7	Se quisesse apanhar um berlinde com os dedos de um pé, que pé utilizaria?	ES	EH	A	DH	DS
8	Se tivesse que saltar ao pé-coxinho, que pé utilizaria?	ES	EH	A	DH	DS
9	Que pé utilizaria para empurrar uma pá enquanto escava a terra?	ES	EH	A	DH	DS
10	Quando estão em pé as pessoas costumam colocar o peso do corpo num dos pés, deixando a outra perna ligeiramente dobrada. Em que pé costuma colocar inicialmente o peso do corpo?	ES	EH	A	DH	DS
11	Existe algum motivo (por exemplo uma lesão) que o tenha obrigado a trocar o seu pé preferido numa das atividades anteriores?	Sim ( ) Não ( )				
12	Alguma vez teve treino especial ou encorajamento para utilizar um determinado pé nalguma atividade?	Sim ( ) Não ( )				
13	Se respondeu sim às questões 11 ou 12, por favor explique.					

Questionário de Waterloo de lateralidade manual – revisto

L.J.Elias et al (1998)

Nome: ____

Instruções: Responda a cada uma das questões apresentadas, o melhor que conseguir. Se usa **sempre** a mesma mão para realizar a atividade descrita, assinale **DS** ou **ES** (**Direita Sempre** ou **Esquerda Sempre**). Se **habitualmente** usa uma das mãos, assinale **DH** ou **EH** (**Direita Habitualmente** ou **Esquerda Habitualmente**). Se usa **ambas** as mãos com a mesma frequência, assinale **A** (**Ambas**).

Por favor, não assinale simplesmente a resposta mas imagine-se a realizar cada atividade e só depois marque a resposta. Se necessário, pare e realize o movimento.

1	Que mão utilizaria para ajustar o botão de volume de um rádio?	ES	EH	A	DH	DS
2	Com que mão utilizaria um pincel para pintar uma parede?	ES	EH	A	DH	DS
3	Com que mão utilizaria uma colher para comer sopa?	ES	EH	A	DH	DS
4	Que mão utilizaria para apontar para um ponto distante?	ES	EH	A	DH	DS
5	Que mão utilizaria para lançar um dardo?	ES	EH	A	DH	DS
6	Com que mão utilizaria a borracha no topo de um lápis?	ES	EH	A	DH	DS
7	Que mão utilizaria para segurar uma bengala?	ES	EH	A	DH	DS
8	Com que mão utilizaria um ferro de engomar para passar uma camisa?	ES	EH	A	DH	DS
9	Que mão utilizaria para fazer um desenho?	ES	EH	A	DH	DS
10	Em que mão seguraria uma caneca cheia de café?	ES	EH	A	DH	DS
11	Que mão utilizaria para martelar um prego?	ES	EH	A	DH	DS
12	Com que mão utilizaria o controlo remoto da televisão?	ES	EH	A	DH	DS
13	Com que mão utilizaria uma faca para cortar pão?	ES	EH	A	DH	DS
14	Que mão utilizaria para virar as páginas de um livro?	ES	EH	A	DH	DS
15	Com que mão utilizaria uma tesoura para cortar papel?	ES	EH	A	DH	DS
16	Que mão utilizaria para apagar um quadro preto?	ES	EH	A	DH	DS
17	Com que mão utilizaria uma pinça?	ES	EH	A	DH	DS
18	Que mão utilizaria para agarrar um livro?	ES	EH	A	DH	DS
19	Que mão utilizaria para transportar uma mala?	ES	EH	A	DH	DS
20	Que mão utilizaria para servir uma chávena de café?	ES	EH	A	DH	DS
21	Com que mão utilizaria um rato de computador?	ES	EH	A	DH	DS
22	Que mão utilizaria para ligar uma ficha numa tomada?	ES	EH	A	DH	DS
23	Que mão utilizaria para atirar uma moeda ao ar?	ES	EH	A	DH	DS
24	Com que mão utilizaria uma escova de dentes para lavar os seus dentes?	ES	EH	A	DH	DS
25	Que mão utilizaria para lançar uma bola de basebol?	ES	EH	A	DH	DS
26	Que mão utilizaria para girar a maçaneta de uma porta?	ES	EH	A	DH	DS
27	Que mão utilizaria para escrever?	ES	EH	A	DH	DS
28	Que mão utilizaria para agarrar numa folha de papel?	ES	EH	A	DH	DS
29	Com que mão utilizaria uma serra?	ES	EH	A	DH	DS
30	Que mão utilizaria para mexer o líquido com uma colher?	ES	EH	A	DH	DS
31	Em que mão seguraria um guarda-chuva?	ES	EH	A	DH	DS
32	Em que mão seguraria uma agulha enquanto cose?	ES	EH	A	DH	DS
33	Que mão utilizaria para acender um fosforo?	ES	EH	A	DH	DS
34	Que mão utilizaria para ligar um interruptor?	ES	EH	A	DH	DS
35	Que mão utilizaria para abrir uma gaveta?	ES	EH	A	DH	DS
36	Que mão utilizaria para carregar nos botões de uma calculadora?	ES	EH	A	DH	DS
37	Existe algum motivo (por exemplo uma lesão) que o tenha obrigado a trocar a sua preferência manual numa das atividades anteriores?	Sim ( ) Não ( )				
38	Alguma vez teve treino especial ou encorajamento para utilizar uma determinada mão nalguma atividade?	Sim ( ) Não ( )				
39	Se respondeu sim às questões 37 ou 38, por favor explique.					

Betts´Questionnaire Upon Mental Imagery

Shortened form by Peter W. Sheehan

(Versão traduzida para português e adaptada ao estudo com a avaliação apenas dos itens relacionados com o corpo e com o som)

Instruções: Este questionário mede a clareza e a vivacidade da sua capacidade de formular imagens mentais. Vai-lhe ser pedido para gerar uma imagem específica na sua mente, para avaliar quão clara e vívida a consegue visualizar na sua mente.

Por exemplo: Pense num semáforo vermelho. Utilize a seguinte escala para descreveu como clara e vívida consegue "ver" o semáforo vermelho.

1	2	3	4	5	6	7
Muito vívida e clara tal como na realidade	Vívida e quase tão clara como na realidade	Em geral clara e vívida	Não tão clara e vívida, mas ainda reconhecível	Vaga e imprecisa	Muito vaga e dificilmente reconhecível	Consigo pensar nisso mas não consigo visualizar

Por favor, faça o mesmo para cada um dos seguintes itens. Escolha a partir das descrições acima mencionados a que melhor se adapta ao item que vai imaginar, com o objetivo de indicar quão clara e vívida é a imagem mental desse item.

Não há respostas certas ou erradas e não há limite de tempo. Não demore muito tempo com um item específico; a primeira impressão é muitas vezes a correta. Por favor, não salte nenhum item.

Com que clareza e vivacidade consegue imaginar o som quando pensa:

Num apito de um comboio?							
Num motor de um carro?							
No miar de um gato?							
No som da libertação de vapor?							
No som de um aplauso batendo as palmas das mãos?							

Pense no que faz com os seus braços, pernas, lábios, etc. Com que clareza e vivacidade consegue visualizar o que faz quando:

Sobe uma escada?							
Salta por cima de um riacho?							
Desenha um círculo num papel?							
Alcança um objeto numa prateleira alta?							
Dá um pontapé em algo?							

ANNEX B

Brain activated areas - Study on Multisensory *Self-referential* stimulation of the lower limb – an fMRI study on healthy subjects

*O t corresponde à intensidade de ativação do respetivo peak voxel. Todos os valores de t estão abaixo do nível de significância estatística de 0,05

Right Stimulation - Control Group			
Contrasts	**B.A**	**Peak Voxel**	**t***
Verbal vs BL	**S1 (BA1, BA2, BA3) -** *Primary Somatosensory cortex* (left)	-50, -8, 36	5,190
	M1 (BA4) - *Primary motor cortex* (right, left)	2, -5, 57 - 49, -8, 36	5,600 5,195
	BA 6 - *Premotor Cortex* (right, left)	8, 13, 36 -4, -2, 48	5,031 4,900
	BA22 - *Wernicke`s area* (right, left)	59, -5, 3 -55, -29, 9	6,910 5,619
	BA21 - *Lateral Temporal Lobe* (right, left)	56, -17, -3 -59, -25, 1	5,562 5,555
	BA38 - *Temporal Pole* (right, left)	47, 18, -9 -53, 5, 0	4,668 5,291
	BA39 – *Angular Gyrus* (right, left)	59, -38, 33 -61, -35, 15	3,745 4,294
	A1 (BA41, **42) -** *Primary Auditory Cortex* (right, left)	49, -17, 6 -58, -31, 12	7,394 6,464
	BA44 - *Broca`s area* (right, left)	50, 16, 6 -53, 9, 4	4,573 4,664
	BA45 - *Pars triangularis* (right)	30, 19, 12 -31, 16, 12	5,344 3,432
	Insula (right, left)	30, 19, 12 -31, 7, 15	5,344 4,294
	Anterior Lobe (*Cerebellum*) (right, left)	26, -53, -27 -31, -53, -30	4,878 6,038
	Posterior Lobe (*Cerebellum*) (right, left)	17, -80, -30 -4, -80, -24	4,154 4,121
	Thalamus (right, left)	2, -17, 12 0, -11, 12	4,288 4,227
Manual vs BL	**S1 (BA1, BA2, BA3) -** *Primary Somatosensory cortex* (left)	-46, -8, 30	4,157
	M1 (BA4) - *Primary motor cortex* (right, left)	3, -5, 57 0, -5, 57	4,147 4,286
	BA6 - *Premotor Cortex* (right, left)	60, 1, 24 -55, 7, 9	4,370 5,292
	S2 (BA7)- *Secondary Somatosensorial cortex* (right, left)	47, -4139 -55, -38, 43	3,726 4,222
	BA39 – *AngularGyrus* (right, left)	50, -35, 24 -61, -38, 18	4,595 4,737
	S2 (BA40)- *Secondary somatosensorial representation* - (right, left)	53,-35,27 -61, -38, 20	4,713 4,467
	Insula (right, left)	30, 19, 12 -31, 7, 15	4,458 4,956
Verbal+Manual vs BL	**S1 (BA1, BA2, BA3) -** *Primary Somatosensory cortex* (left)	-50, -8, 36	3,553
	M1 (BA4) - *Primary motor cortex* (right,	2, -5, 57	4,851

	left)	0, -5, 57	4,545
	BA6 - *Premotor area* (right, left)	50, -3, 6 -52, -1, 7	4,653 4,579
	S2 (BA7)- *Secondary Somatosensorial cortex* (left)	-37, -47, 39 1, -5, 57	4,649 4,698
	BA21- *Lateral Temporal Lobe* (right, left)	53, -21, 0 -61, -28, 0	5,307 5,685
	BA22 - *Wernicke`s area* (right, left)	59, -5, 3 -60, -28, 13	7,170 6,196
	BA38 - *Temporal Pole* (right, left)	53, 10, -3 -53, 5, 0	3,969 5,434
	BA39 – *AngularGyrus* (right, left)	59, -35, 24 -43, -41, 15	5,126 5,648
	S2 (BA40)- *Secondary somatosensorial representation* (right, left)	47, -28, 22 -58, -29, 19	4,509 5,572
	A1 (BA41, 42) - *Primary Auditory Cortex* (right, left)	53, -20, 12 -58, -31, 12	8,768 7,732
	BA44- *Broca´s area* (right, left)	56, 3, 8 -53, 9, 4	4,369 4,208
	Brainstem (right, left)	8, -29, 6 -1, -26, 3	3,493 4,249
Verbal vs Manual	**BA22 -** *Wernicke* (right, left)	59, -5, 3 -60, -17, 6	6,737 5,243
	BA38 - *Temporal Pole* (right, left)	47, 18, -9 -53, 5, 0	4,417 4,094
	BA39 – *AngularGyrus* (left)	-62, -35, 14	3,565
	A1 (BA42) - (right, left)	56, -17, 9 -58, -14, 9	4,255 5,367
	BA45 - *Pars Triangularis* (right, left)	41, 22, 0 -56, 16, 3	3,189 4,175
	Posterior Lobe (*Cerebellum*) (right, left)	17, -80, -30 -4, -68, -24	3,756 3,617
	Anterior Lobe (*Cerebellum*) (right, left)	41, -41, -43 -31, -53, -30	4,020 4,736
Manual vs Verbal	**BA 6** - *Premotor Cortex* (right,left)	38, -5, 15 -55, 9, 8	3,082 2,577
	S2 (BA7) - *Secondary Somatosensorial cortex* (left)	-55, -38, 43	3,113
	BA39- *Angular gyrus* (left)	-61, -44, 33	3,331
	S2 (BA40)- *Secondary somatosensorial representation* (right, left)	44, -26, 24 -62, -29, 36	4,493 4,022
	BA42 - *Primary Auditory Cortex* (right, left)	44, -29, 18 -58, -23, 18	3,312 3,092
	BA44- *Broca´s area* (right, left)	53, 13, 15 -44, 10, 6	4,257 3,318
	BA45 - *Pars Triangularis* (left)	-46, 36, 6	3,241
	BA46 - *Part of the dorsolateral prefrontal cortex* (left)	-45, 40, 6	3,708

	Insula (right)	35, 1, 12	3,916
Verbal vs Manual + Verbal	*Insula* (right)	41, 19, 3	4,103
	Thalamus (*right, left*)	2, -11, 12 -1, -11, 12	5,059 4,185
	Posterior Lobe (*Cerebellum*) (right)	32, -65, -30	4,264
	Anterior Lobe (*Cerebellum*) (left)	-31, -53, -30	4,035
Manual + Verbal vs Verbal	**A1 (BA41, 42)** (left) and **BA42** (right) *Primary Auditory Cortex*	53, -20, 12 -58, -29, 16	4,475 4,150
	S2 (BA5) - *Secondary Somatosensorial cortex* (left)	-17, -49, 57	4,531
	BA 6 - *Premotor Cortex* (left)	-43, -5, 12	3,802
	BA19 - *V2* (left)	-58, -56, 9	3,550
	BA22 - *Wernicke* (right, left)	-43, -8, 0	4,080
	BA37 - *Fusiform gyrus/Inferior Temporal gyrus* (left)	-55, -41, 9	3,021
	BA38 - *Temporal Pole* (left)	-40, -2, -9	3,740
	BA39- *Angular gyrus* (right, left)	56, -41, 18 -43, -40, 15	3,979 3,795
	S2 (BA40) - *Secondary somatosensorial representation* (right, left)	44, -26, 24 -57, -29, -9	3,742 3,740
	A1 (BA41, BA42) (left); **BA42** (right) *Primary Auditory Cortex*	53,-20,12 -58, -29, 12	4,475 4,150
Manual vs Manual + Verbal			
Manual + Verbal vs Manual	**BA22 -** *Wernicke* (right, left)	59, -5, 3 -58, -20, 6	6,948 5,383
	BA38 - *Temporal Pole* (right, left)	53, 10, -3 -53, 5, 0	3,723 4,210
	BA39 - *Angular Gyrus* (right, left)	62, -35, 27 -43, -41, 15	2,913 4,041
	S2 (BA40) - *Secondary somatosensorial representation* (right, left)	46, -31, 20 -58, -35, 21	2,741 2,826
	A1 (BA41, 42) - *Primary Auditory Cortex* (right, left)	56, -17, 9 -58, -31, 12	7,244 5,974
	Brainstem (right, left)	8, -29, 0 -1, -32, -3	4,070 3,355

Left Stimulation - Control Group			
Contrasts	**B.A**	**Peak Voxel**	**t***
Verbal vs BL	**S1 (BA1, BA2, BA3) -** *Primary Somatosensory cortex* (left)	-49, -7, 31	3,412
	M1 (BA4) - *Primary motor cortex* (left, right)	0, -17, 66 -1, -17, 65	5,061 5,272
	S2 (BA5 e BA7) – *Secondary somatosensorial representation* (right, left)	53, -32, 42 -51, -44, 48	2,416 6,339
	BA 6 - *Premotor Cortex* (right, left)	-52, 9, 24 58, 2, 23	6,281 6,152
	BA22 - *Wernicke`s area* (right, left)	53, -23, 3 -58, -2, 3	5,017 5,806
	BA21 - *Lateral Temporal Lobe* (right, left)	44, -29, 3 -64, -23, 0	4,600 6,442
	BA37 - *Fusiform gyrus (caudal)* (right, left)	53, -38,9 -61, -50, 3	3,997 5,790
	S2 (BA40) - *Secondary somatosensorial representation* (left)	-61, -35, 36	4,708
	A1 (BA41, 42) - *Primary Auditory Cortex* (right, left)	47, -20, 9 -61, -29, 12	4,565 5,829
	BA44 - *Broca`s area* (right, left)	50, 16, 6 -50, 10, 24	4,815 6,103
	BA45 - *Pars triangular* (right, left)	44, 22, 3 -48, 31, 9	3,414 2,959
	BA46 - *Part of the dorsolateral prefrontal cortex* (left)	-40, 45, 11	2,794
	BA47 - *Orbital Surface* (left)	-32, 22, 3	2,477
	Insula (right, left)	44, 14, 10 -34, 10, 12	4,163 4,187
	Caudate (left)	-13, -8, 21	5,053
	Anterior Lobe, Culmen (*Cerebellum*) (right, left)	29, -53, -21 -34, -50, -30	4,260 5,523
	Posterior Lobe, Pyramis (*Cerebellum*) (right, left)	14, -71, -30 -19, -74, -27	3,058 4,885
Manual vs BL	**S1 (BA1, BA2, BA3) -** *Primary Somatosensory cortex* (left)	-55, -8, 36	4,486
	M1 (BA4) - *Primary motor cortex* (right, left)	44, -5, 52 -56, -2, 32	4,554 5,298
	BA6 - *Premotor Cortex* (right, left)	50, 4, 40 -52, 9, 24	4,267 7,999
	S2 (BA7) - *Secondary Somatosensorial cortex* (right, left)	53,-32, 42 -51, -44, 48	2,416 6,339
	BA9 and BA11 – *Prefrontal cortex* (left)	-40, 28, 36	4,722
	V1 (BA17) - (left)	-19, -95, -15	5,081
	V2 (BA18, BA19) - (left)	-37, -56, 36	6,603
	BA20- *Inferior Temporal Lobe* (left)	-46, -35, -18	4,136
	BA37 - *Fusiform gyrus/Inferior Temporal gyrus* (left)	-52, -47, 0	5,399

	BA38 - *Temporal pole* (left)	-40,1, -12	5,236
	BA39- *Angular gyrus* (right, left)	50, -33, 24 -58, -50, 21	3,988 6,749
	S2 (BA40) - *Secondary somatosensorial representation* (right, left)	50, -32, 24 -61, -38, 30	4,421 7,193
	A1 (BA42) - *Primary Auditory Cortex* (right, left)	50, -32, 24 -61, -29, 18	4,421 7,503
	BA44 - *Broca* (right, left)	47, 13, 30 -51, 10, 25	3,677 7,901
	BA45 - *Pars triangular* (left)	-48, 31, 9	4,524
	BA46 - *Part of the dorsolateral prefrontal cortex* (left)	-37, 49, 12	4,272
	BA32 *(Anterior Cingulate cortex)* (left)	-1, -14, 57	4,512
	Insula (left)	-35, 4, 6	4,458
	Caudate (left)	-13, -8, 21	4,857
	Thalamus - lentiform nucleus (left)	-13, -14, 3	4,410
	Anterior Lobe (Cerebellum)(left)	-34, -20, 12	5,989
Verbal+Manual vs BL	**S1 (BA1, BA2, BA3) -** *Primary somatosensory cortex* (right, left)	5, -29, 60 -47, -14, 54	3,503 4,040
	M1 (BA4) - *Primary motor cortex* (right, left)	0, -17, 66 -1, -17, 65	4,826 4,589
	BA6 - *Premotor area* (right, left)	-56, 4, 6 50,4, 20	5,727 5,421
	S2 (BA7) - *Secondary Somatosensorial cortex* (left)	-55, -35, 42	6,161
	BA9 - *Prefrontal Cortex* (left)	-34, 37, 36	3,912
	V2 (BA19) – (left)	-46, -56, 12	5,747
	BA21- *Lateral Temporal Lobe* (right, left)	59, -32, 6 -46, -23, 3	4,545 7,830
	BA22 - *Wernicke`s area* (right, left)	62, -23, 15 -58, -5, 3	4,451 7,829
	BA37 – *Fusiform gyrus/Inferior Temporal gyrus* (right, left)	47, -38, 9 -61, -41, 6	4,433 6,077
	BA38 - *Temporal Pole* (left)	-40, 1, -12	5,028
	BA39 - *Angular Gyrus* (right, left)	53, -38, 24 -61, -35, 15	4,254 6,363
	S2 (BA40)- *Secondary somatosensorial representation* (right, left)	44, -28, 22 -61, -35, 36	3,834 6,534
	A1 (BA41, 42) - *Primary Auditory Cortex* (right, left)	44, -20, 12 -59, -29, 15	4,885 8,503
	BA44 - *Broca* (right, left)	50, 16, 6 -53, 12, 24	3,901 5,274
	BA45 - *Pars triangular* (left)	-35, 17, 7	2,927
	Posterior Lobe (Cerebellum) (left)	-28, -50, -33	4,958
	Ínsula (right, left)	32, -20, 12 -31, 10, 9	3,989 3,247
Verbal vs Manual	**BA22 -** *Wernicke* (right, left)	56, -17, -3 -48, -23, 3	4,576 4,804
	BA37 - *Fusiform gyrus (caudal portion)*	45, -30, 9	2,845

	(right, left)	-61, -50, 3	4,461
	A1 (BA41, **BA42)** - (right); **BA42** (left)	62, -17, 6 -52, -17, 8	4,342 4,264
Manual vs Verbal	**BA6** - *Premotor cortex* (right, left)	0, 10, 54 -52, 9, 27	3,501 5,148
	S2 (BA7) - *Secondary somatosensorial cortex* (right, left)	21, -50, 66 -19, -59, 55	4,924 4,567
	BA9 - *Orbitofrontal cortex* (left)	-40, 23, 30	3,664
	V1 (BA17) - (left)	-19, -95, -15	5,415
	V2 (BA18, BA19) - (left)	-40, -68, 39	4,741
	BA20 - *Inferior Temporal Lobe* (left)	-46, -35, -18	4,134
	BA21 - *Lateral Temporal Lobe* (left)	-58, -41, -9	3,743
	BA37 - *Fusiform gyrus (Caudal)* (left)	-52, -47, 0	4,579
	BA39 - *Angular Gyrus* (left)	-61, -41, 24	5,029
	S2 (BA40) - *Secondary somatosensorial representation* (left)	-61, -38, 30	5,880
	BA44 - *Broca* (left)	-53, 12, 24	5,074
	BA46 - *Part of the Dorsolateral Prefrontal Cortex* (left)	-34, 39, 12	3,817
	Posterior Lobe (cerebellum) (left)	-19, -74, -30	4,639
Verbal vs Manual + Verbal	**BA6 -** Premotor area (left)	-52, 9, 24	4,526
	BA47 - *Orbital Surface* (left)	-46, 46, -6	4,216
	Posterior Lobe (Cerebellum) (right)	14, -68, -24	4,862
	Posterior Lobe (Cerebellum) (left)	-1, -74, -18	4,373
	Anterior Lobe (Cerebellum) (right, left)	14, -38, -33 -1, -74, -18	4,069 4,373
Manual + Verbal vs Verbal	**S2 (BA7)** (right, left); **BA5** (right)- *Secondary somatosensorial cortex*	21, -50, 66 -55, -35, 42	6,338 4,909
	V2 (BA18, BA19) - (left)	-46 -56, 12	5,285
	BA22 - *Wernicke* (left)	-58, -5, 3	4,653
	BA37 - *Fusiform gyrus* (caudal) (left)	-55, -47, 0	4,459
	BA39 - *Angular Gyrus* (right, left)	47, -35, 21 -52, -48, 21	4,029 4,267
	S2 (BA40) - *Secondary somatosensorial representation* (right, left)	44, -26, 21 -61, -23, 33	3,472 4,879
	A1 (BA42) - *Primary Auditory Cortex* (right, left)	50,-33, 22 -58, -30, 15	3,280 4,974
	Posterior Lobe - (Cerebellum) (left)	-28, -65, -43	4,507
Manual vs Manual + Verbal	**M1 (BA4) -** *Primary motor cortex* (left)	-19, -8, 51	3,971
	BA6 - *Premotor cortex* (left)	-52, 9, 24	5,929
	BA37 - *Fusiform Gyrus (Caudal)* (left)	-58, -47, -6	4,688
	BA39 - *Angular Gyrus* (right)	-58, -50, 21	4,384
	S2 (BA40) - *Secondary somatosensorial representation* (left)	-52, -35, 30	4,260
	BA44 - *Broca* (left)	-51, 10, 25	5,929
	BA46 - *Part of the Dorsolateral Prefrontal cortex* (left)	-37, 49, 12	3,360
	Insula (left)	-31, 19, -6	4,051

	Posterior Lobe (Cerebellum)(right, left)	14, -68, -24 -19, -77, -24	4,605 5,038
	Thalamus (left)	-7, -5, 9	4,283
Manual+Verbal vs Manual	**BA22** - *Wernicke* (right, left)	62, -8, 5 -48, -23, 3	3,804 5,933
	BA39 - *Angular gyrus* (right, left)	56, -32, 9 -49, -37, 9	3,861 4,219
	A1 (BA41, **BA42 -** *Primary Auditory Cortex* (right, left)	44, -20, 12 -60, -29, 12	4,805 5,647

ANNEX C

Informed Consent – Study on Tactile Discrimination, Social Touch and Frailty Criteria in Elderly People.

DECLARAÇÃO DE CONSENTIMENTO INFORMADO

Considerando a "Declaração de Helsínquia" da Associação Médica Mundial, a International Ethical Guidelines for Biomedical Research Involving Human Subjects e os Padrões de Prática da Fisioterapia da Associação Portuguesa de Fisioterapeutas (2005)

ESTUDO DE AVALIAÇÃO DO SÍNDROME DE FRAGILIDADE DO IDOSO

Eu, abaixo-assinado, (nome completo) -- --, compreendi a explicação que me foi fornecida acerca da investigação que se tenciona realizar, bem como do estudo em que serei incluído. Foi-me dada oportunidade de fazer as perguntas que julguei necessárias, e de todas obtive resposta satisfatória.

Tomei conhecimento de que a explicação que me foi prestada versou os objetivos, os métodos, os benefícios previstos, os riscos potenciais e o eventual desconforto. Além disso, foi-me dito que tenho o direito de recusar a qualquer momento a minha participação no estudo, sem que isso possa ter como efeito qualquer prejuízo na assistência que me é prestada.

Compreendo que os resultados deste estudo poderão vir a ser publicados, sendo que a minha identidade não será revelada.

No sentido de manter a confidencialidade dos meus registos, o investigador irá utilizar códigos, que serão protegidos pelo acesso individualizado à base de dados resultante.

Fui informado que não serei compensado monetariamente pela participação neste estudo.

Por isso, consinto que me sejam aplicados os procedimentos de avaliação da força de preensão, prova de marcha, medidas de peso, altura, pressão arterial e frequência cardíaca, assim como alguns questionários.

Data: ____ / _________________ / 2015

Assinatura do participante:

____

Instituição:

CSPSJSPE: ___

SCMC: ___

O avaliador:

Nome: ____

Assinatura: ____

ANNEX D

Protocol – Study on Tactile Discrimination, Social Touch and Frailty Criteria in Elderly People.

PROTOCOLO DE FRAGILIDADE

Nome do Investigador: ____

Data: ___ / ___ / ___ Local:____

A - DADOS SOCIODEMOGRÁFICOS

1.Nome____

2.Idade ________anos

3.Sexo: F __ M __

4.Local: Residências MOR Alcoitão __ Residência MOR Fisgas __ CSPSJSPE __

5.Estado Civil

Solteiro(a) ___ Casado(a) ___ Viúvo ___ Separado/Divorciado ___ União de Facto___

6.Nível de Escolaridade

Frequentou a escola? Não ___ Sim ___

Não completou o ensino primário _____ Ensino primário_____ Ensino preparatório _____ Ensino Secundário _____ Ensino profissional _____ Ensino Universitário_____

B. AVALIAÇÃO DO FENÓTIPO DE FRAGILIDADE (Fried, 2001)

Medidas antropométricas:

Peso ____ Kg Altura _____ m IMC _______ kg/m2

Perímetro abdominal: ________ cm Perímetro da anca: _________ cm RCA (Razão Cintura/Anca): ______

Pessoas idosas com três ou mais critérios são consideradas frágeis e com um ou dois dos critérios, são pré-frágeis. Pessoas que não pontuam em nenhum destes critérios são consideradas não frágeis (robustas).

B1.Força de preensão

Descrição Geral: A força da mão é medida com um dinamómetro de força.

Equipamento: Dinamómetro

Instruções

1.Dizer: " O objetivo deste teste é medir a maior capacidade de força que tem na sua mão dominante

O sujeito deve estar confortavelmente sentado, posicionado com o ombro aduzido e em extensão, o cotovelo a 90º de flexão, o antebraço em posição neutra e a posição do punho pode variar de 0 a 30º de extensão. Obtém-se o valor máximo e médio de três medições alternadas, registadas em quilogramas (kg), para a mão dominante. A força isométrica é avaliada 3 vezes, por períodos de 10 segundos com intervalo de repouso de 60 segundos.

Mão dominante	Tentativa	Valor obtido	Valor máximo	Média
_____________	1ª			
	2ª			
	3ª			

Peso ____ Kg Altura _____ m IMC _______ kg/m2

Indicadores de fragilidade			
Homens		**Mulheres**	
IMC	**Força de preensão**	**IMC**	**Força de preensão**
≤ 24	≤ 29	≤ 23	≤ 17
24,1 - 26	≤ 30	23,1 – 26	≤ 17,3
26,1 - 28	≤ 30	26,1 – 29	≤ 18
> 28	≤ 32	> 29	≤ 21

Fragilidade – Não ____ Sim _____

B2. Perda de Peso

No último ano perdeu mais de 4,5Kg de peso não intencional. (não devido a uma dieta ou exercício físico)

Não _____ Sim ____

Fragilidade – Não ____ Sim _____

B3. Velocidade da marcha: tempo gasto em segundos para percorrer uma distância de 4,6m, ajustado ao sexo e altura

(valor de corte – 0,60 m/seg.)

Sexo _______

Altura ______ cm

Tempo percorrido _____ segundos

Observações:

____

Indicadores de fragilidade			
Homens		**Mulheres**	
Altura	**Velocidade**	**Altura**	**Velocidade**
≤ 173 cm	≥ 7 seg.	≤ 159 cm	≥ 7 seg.
> 173 cm	≥ 6 seg.	> 159 cm	≥ 6 seg.

Fragilidade – Não ____ Sim _____

B4. Exaustão subjetiva – 2 questões da escala de Depressão Geriátrica (Yesavage et al., 1983; Sheikh & Yesavage, 1986)

Cotação: sujeitos que respondam 2 ou 3 a ambas as questões são considerados frágeis
Auto-percepção de exaustão – É avaliada de acordo com a resposta a duas perguntas do questionário do Center for Epidemiologic Studies of Depression (CES-D) (versão portuguesa, Loureiro, 2009)
Com que frequência se sentiu desta forma na última semana?

	0 - Raramente ou nenhum do tempo (< 1 dia)	1 – Algum ou pouco tempo (1-2 dias)	2 – Uma quantidade moderada de tempo (3-4 dias)	3 – A maior parte do tempo
Eu senti que tudo o que fazia era um esforço				
Eu senti falta de energia				

Fragilidade – Não ____ Sim _____

B5. Nível de atividade física - Fairhall et al, 2008

Considera-se “inativo” se nos últimos três meses o sujeito:

- Não praticou atividades que implicassem carregar pesos
- Passou mais de 4h por dia sentado
- E/ou saiu para pequeno passeio a pé uma vez por mês ou menos.

Fragilidade: Não ____ Sim _____

Classificação da fragilidade do idoso segundo o fenótipo:
Frágil - Presença de 3 a 5 critérios
Pré-frágil – Presença de 1 ou 2 dos critérios
Não frágil (robusto) - nenhum critério

C. Fatores de risco geriátrico

C1. IMC - Classificação de Lipschitz (1994) citado por Cervi, Franceschini, & Priore, (2005) que tem em consideração as modificações corporais presentes no idoso sugerindo o uso dos seguintes intervalos: baixo-peso com um IMC <22 kg/m2, eutrófico com um IMC 22-27 kg/m2 e excesso de peso com um IMC> 27kg/m2. IMC abaixo do normal é indicador de fragilidade.
Peso ____ Kg Altura _____ m IMC _______ kg/m2

C2. Medicação

Faz alguma medicação? Não_____ Sim _______ Qual?
____

D. Cognição

Valor MMSE: ______
Defeito cognitivo: Sim ___ Não ___

E. Auto perceção das dificuldades sensoriais

Tem dificuldades na vida diária devido à diminuição do paladar/olfato? (A comida não lhe sabe a nada ou tem pouco sabor)?	Não	Sim

Tem dificuldades na vida diária devido à falta de visão?	Não	Sim

Tem dificuldades na vida diária devido à falta de audição?	Não	Sim

Tem dificuldades na vida diária devido à falta de sensibilidade ao tato?	Não	Sim

F. Questionário de Toque Social (0 a 80)

Questionário sobre o Toque Social

Frank H. Wilhelm, Ajay S. Kochar, Walton T. Roth and James J. Gross (2001)

As seguintes afirmações fornecem uma variedade de afetos e atitudes relativas ao toque social.
Indique até que ponto cada uma das seguintes afirmações o/a carateriza ou é verdadeira.
0=absolutamente nada 1=ligeiramente 2=moderadamente 3=muito 4=extremamente

		0	1	2	3	4
1	Normalmente gosto que as pessoas manifestem o seu afeto por mim de uma forma física					
2	Sinto-me pouco à vontade quando alguém que não conheço muito bem me dá um abraço					
3	Fico nervoso/a quando uma pessoa não larga a minha mão depois de um aperto de mão					
4	Normalmente procuro contato físico com os outros					
5	Sinto-me constrangido/a se tenho de tocar em alguém para chamar a sua atenção					
6	Considero-me uma pessoa que gosta de expressar afeto através do toque					
7	Aborrece-me que alguém me toque inesperadamente					
8	Sentir-me-ia pouco à vontade se um professor me tocasse no ombro em público					
9	Teria todo o gosto em fazer uma massagem no pescoço ou nos ombros a uma pessoa amiga que estivesse tensa					
10	Sinto-me pouco à vontade se tiver contato físico com um estranho no autocarro ou no metropolitano					
11	Gosto de receber carícias em situações íntimas					
12	Quando era criança, os meus familiares (por exemplo, pais, irmãos) faziam-me festas muitas vezes					
13	Preferiria evitar dar apertos de mão a estranhos					
14	Cumprimento os meus amigos mais chegados com um beijo na face					
15	Sinto-me à vontade ao tocar em pessoas que não conheço muito bem					
16	Sinto-me enojado/a quando vejo demonstrações íntimas de afeto em público					
17	Sentir-me-ia ansioso/a se alguém que tivesse acabado de conhecer me tocasse no pulso					
18	Se tivesse condições, todas as semanas fazia massagens com um profissional					
19	Detesto que me façam cócegas					
20	Gosto de fazer festas a animais					

Pontuação Final: ____________

G. Sensibilidade discriminativa

MacKinnon-Dellon Disk-Criminator

<u>**Medidas a avaliar:**</u>
12 mm
1 ponto
10 mm
8 mm
6 mm
4 mm

<u>**Indicações para a aplicação do teste:**</u>
Pergunta para cada distância: sentiu 1 ou 2 pontos?
Regista-se a distância mínima onde o sujeito refere ter sentido 2 pontos (Schumm, L. et al, 2009)
Palma da mão dominante – região distal hipotenar (Bowden, J. 2013) e inicia-se pela maior distância

ANNEX E

Portuguese version Waterloo Handedness Questionnaire Revised –

Study on Tactile Discrimination, Social Touch and Frailty Criteria in Elderly People.

Questionário de Waterloo de lateralidade manual – revisto

L.J.Elias et al (1998)

Nome: ____

Instruções: Responda a cada uma das questões apresentadas, o melhor que conseguir. Se usa **sempre** a mesma mão para realizar a atividade descrita, assinale **DS** ou **ES** (**Direita Sempre** ou **Esquerda Sempre**). Se **habitualmente** usa uma das mãos, assinale **DH** ou **EH** (**Direita Habitualmente** ou **Esquerda Habitualmente**). Se usa **ambas** as mãos com a mesma frequência, assinale **A** (**Ambas**).

Por favor, não assinale simplesmente a resposta mas imagine-se a realizar cada atividade e só depois marque a resposta. Se necessário, pare e realize o movimento.

1	Que mão utilizaria para ajustar o botão de volume de um rádio?	ES	EH	A	DH	DS
2	Com que mão utilizaria um pincel para pintar uma parede?	ES	EH	A	DH	DS
3	Com que mão utilizaria uma colher para comer sopa?	ES	EH	A	DH	DS
4	Que mão utilizaria para apontar para um ponto distante?	ES	EH	A	DH	DS
5	Que mão utilizaria para lançar um dardo?	ES	EH	A	DH	DS
6	Com que mão utilizaria a borracha no topo de um lápis?	ES	EH	A	DH	DS
7	Que mão utilizaria para segurar uma bengala?	ES	EH	A	DH	DS
8	Com que mão utilizaria um ferro de engomar para passar uma camisa?	ES	EH	A	DH	DS
9	Que mão utilizaria para fazer um desenho?	ES	EH	A	DH	DS
10	Em que mão seguraria uma caneca cheia de café?	ES	EH	A	DH	DS
11	Que mão utilizaria para martelar um prego?	ES	EH	A	DH	DS
12	Com que mão utilizaria o controlo remoto da televisão?	ES	EH	A	DH	DS
13	Com que mão utilizaria uma faca para cortar pão?	ES	EH	A	DH	DS
14	Que mão utilizaria para virar as páginas de um livro?	ES	EH	A	DH	DS
15	Com que mão utilizaria uma tesoura para cortar papel?	ES	EH	A	DH	DS
16	Que mão utilizaria para apagar um quadro preto?	ES	EH	A	DH	DS
17	Com que mão utilizaria uma pinça?	ES	EH	A	DH	DS
18	Que mão utilizaria para agarrar um livro?	ES	EH	A	DH	DS
19	Que mão utilizaria para transportar uma mala?	ES	EH	A	DH	DS
20	Que mão utilizaria para servir uma chávena de café?	ES	EH	A	DH	DS
21	Com que mão utilizaria um rato de computador?	ES	EH	A	DH	DS
22	Que mão utilizaria para ligar uma ficha numa tomada?	ES	EH	A	DH	DS
23	Que mão utilizaria para atirar uma moeda ao ar?	ES	EH	A	DH	DS
24	Com que mão utilizaria uma escova de dentes para lavar os seus dentes?	ES	EH	A	DH	DS
25	Que mão utilizaria para lançar uma bola de basebol?	ES	EH	A	DH	DS
26	Que mão utilizaria para girar a maçaneta de uma porta?	ES	EH	A	DH	DS
27	Que mão utilizaria para escrever?	ES	EH	A	DH	DS
28	Que mão utilizaria para agarrar numa folha de papel?	ES	EH	A	DH	DS
29	Com que mão utilizaria uma serra?	ES	EH	A	DH	DS
30	Que mão utilizaria para mexer o líquido com uma colher?	ES	EH	A	DH	DS
31	Em que mão seguraria um guarda-chuva?	ES	EH	A	DH	DS
32	Em que mão seguraria uma agulha enquanto cose?	ES	EH	A	DH	DS
33	Que mão utilizaria para acender um fosforo?	ES	EH	A	DH	DS
34	Que mão utilizaria para ligar um interruptor?	ES	EH	A	DH	DS
35	Que mão utilizaria para abrir uma gaveta?	ES	EH	A	DH	DS
36	Que mão utilizaria para carregar nos botões de uma calculadora?	ES	EH	A	DH	DS
37	Existe algum motivo (por exemplo uma lesão) que o tenha obrigado a trocar a sua preferência manual numa das atividades anteriores?	Sim ( ) Não ( )				
38	Alguma vez teve treino especial ou encorajamento para utilizar uma determinada mão nalguma atividade?	Sim ( ) Não ( )				
39	Se respondeu sim às questões 37 ou 38, por favor explique.					

ANNEX F

Informed Consent – Study on Reliability and Validity of the European Portuguese version of the Social Touch Questionnaire

DECLARAÇÃO DE CONSENTIMENTO INFORMADO

Eu, abaixo assinado, declaro consentir participar no estudo subordinado ao tema "Avaliação das propriedades psicométricas do QTS - Questionário sobre o Toque Social".

O investigador mencionou de forma clara e acessível o objetivo do estudo e as suas possíveis implicações, bem como os seus princípios e procedimentos.

Compreendi que toda a informação será tratada de forma estritamente confidencial.

Nome:____

Assinatura:____

Data: ____/_____/_____

Confirmo que expliquei a natureza do estudo ao aluno acima mencionado.

Nome do Investigador: ____

Assinatura: ____

Data: ____/_____/_____

ANNEX G

Social Touch Questionnaire authorization – Study on Reliability and Validity of the European Portuguese version of the Social Touch Questionnaire

Social Touch Questionnaire - validation

Caixa de entrada x

Patricia Almeida <patriciamdalmeida@gmail.com> 09/05/12

para fwilhelm, mim

inglês
português

Traduzir mensagem

Desactivar para mensagens em: inglês

Dear Professor Wilhelm,

Regarding our phD research (Health Sciences - Neurorehabilitation - Instituto de Ciências da Saúde da Universidade Católica Portuguesa www.**ics**.**lisboa**.**ucp**.pt,) we need to use a questionnaire related with touch.
On our literature review we found the following article (written by you and colleagues):

Frank H. Wilhelm, Ajay S. Kochar c, Walton T. Roth, James J. Gross
"Social anxiety and response to touch: incongruence between self-evaluative and physiological reactions."
Biological Psychology 58 (2001) 181–202.

The questionnaire used on this study and we believe that created by you, responds to our needs.
To use it we need to make the validation process to Portuguese language and culture.
For that purpose, we kindly ask you your permission for this validation process and the original of the questionnaire.

Certain you your attention, we kindly thank you in advance.
Best regards

Ana Isabel Vieira
MsC, Senior Lecturer - Physiotherapy Department of Higher Health School of Alcoitão - Portugal www.essa.pt
Patrícia Almeida
MsC, Senior Lecturer - Physiotherapy Department of Higher Health School of Alcoitão - Portugal www.essa.pt

Patricia Almeida <patriciamdalmeida@gmail.com> 09/05/12

para gross, fwilhelm, mim

inglês
português

Traduzir mensagem

Desactivar para mensagens em: inglês

Dear Professor

Wilhelm and James Gross

1 **James Gross** <gross@stanford.edu> 09/05/12

para Patricia, fwilhelm, mim

inglês
português

Traduzir mensagem

Desactivar para mensagens em: inglês

You'd be welcome to translate this measure.

Best,

James

ANNEX H

Review of the back translation by the original authors – Study on Reliability and Validity of the European Portuguese version of the Social Touch Questionnaire

2 **Ana Isabel Vieira** **<vieira.anaisabel@gmail.com>** 21/01

para James, fwilhelm

Dear Professors James and Wilhelm:

To ensure the adequacy of the translation process carried out, I'm sending you the translation and back-translation of the "Social Touch Questionnaire".

We are using all the methodological criteria recommended by the European Research Group on Health Outcomes (ERGHO) and by the Center for Health Research and the University of Coimbra (CEISUC).

Thank you for your help,

Best regards

Ana

W

STQ_ translation and Back tranlation_authours.docx

3 **James Gross** 22/01

para mim, fwilhelm

inglês
português

Traduzir mensagem

Desactivar para mensagens em: inglês

Ana,

I think these translations look reasonable. The points I'm not sure about are:

8. Professor refers to college level, whereas teacher is broader.
16. Offends is different from disgusted.
18. Circumstances being right is different from having the means.

Best,

James

James J. Gross, Ph.D.
Professor of Psychology
Bass University Fellow in Undergraduate Education

Department of Psychology
Stanford University
Stanford, CA 94305-2130
Tel: (650) 723-1281
Fax: (650) 725-5699

Email: gross@stanford.edu

Director, Stanford Psychophysiology Laboratory
http://spl.stanford.edu

Director, Stanford Psychology One Program
http://psychone.stanford.edu

4 **Ana Isabel Vieira** **<vieira.anaisabel@gmail.com>** 22/1

para James

Dear James:

I appreciate the prompt response to my email.

I will consider the recommendations.

Best regards,

Ana

ANNEX I

Evaluation Protocol Students – Study on Reliability and Validity of the European Portuguese version of the Social Touch Questionnaire

DADOS DE CARACTERIZAÇÃO DA AMOSTRA

- Nº de identificação do sujeito:___________
- Idade:_____
- Género: M __ F __
- Curso que frequenta: Fisioterapia __ Terapia Ocupacional __

  Terapia da Fala __
- Ano do curso em que se encontra: 1º __ 2º __ 3º __ 4º __
- Estado civil: Solteiro __ Casado __ União de facto__ Outra __

  Qual? _________
- Faz algum tipo de medicação regularmente? Não __ Sim __ Para que efeito?

  ____

ESCALA DE ANSIEDADE E EVITAMENTO EM SITUAÇÕES DE DESEMPENHO E INTERAÇÃO SOCIAL (EAESDIS)

(Pinto Gouveia, J., Cunha, M. & Salvador, M.C., 1997)

INSTRUÇÕES

Segue-se uma lista de situações em que as pessoas podem sentir desconforto e mal-estar, o que pode levar ao evitamento dessas situações. Assinale o grau de desconforto ou ansiedade e o grau de evitamento que cada uma das situações assinaladas lhe provoca, utilizando a escala de resposta de 1 a 4, abaixo indicada.

Aponte, nas linhas em branco, outras situações que lhe causam desconforto ou que evite mas que não estejam mencionadas.

Se nunca se confrontou com alguma das situações apresentadas, imagine o desconforto que sentiria se tivesse que o fazer.

Situações Sociais	**Desconforto/Ansiedade** 1= Nenhum 2=Ligeiro 3= Médio 4= Severo	**Evitamento** 1=Nunca (0%) 2=Às vezes (1-33%) 3=Muitas vezes (34-67%) 4=Quase sempre (68-100%)
1. Participar numa atividade de grupo		
2. Comer em público		
3. Beber num local público		
4. Representar, agir ou falar perante uma audiência		
5. Ir a uma festa		
6. Trabalhar enquanto se está a ser observado/a		
7. Escrever enquanto se está a ser observado/a		
8.Telefonar a alguém que não conhece bem		
9. Falar com alguém que não conhece bem		
10. Encontrar-se com estranhos/desconhecidos		
11. Urinar num W.C. público		
12. Entrar numa sala onde os outros já estão sentados		
13. Ser o centro das atenções		
14. Levantar-se e fazer um pequeno discurso, sem preparação prévia, numa festa		
15. Fazer um teste às suas capacidades, competências ou conhecimentos		
16. Expressar desacordo ou reprovação a alguém que não se conhece muito bem		
17. Olhar diretamente nos olhos de alguém que não se conhece muito bem		
18. Apresentar oralmente um trabalho		
19. Tentar convencer alguém para um relacionamento romântico/sexual (cortejar)		
20. Devolver um artigo e obter o reembolso		
21. Dar uma festa		
22. Resistir à pressão elevada dum vendedor		
23. Ir a uma entrevista para arranjar emprego		
24. Pedir uma informação a uma pessoa desconhecida (p. ex.: perguntar as horas, o nome da rua, morada pretendida, etc.)		
25. Juntar-se, numa mesa de café, a um grupo de colegas que não se conhece bem		
26. Pedir um favor a outra pessoa		
27. Falar com uma pessoa que admire		
28. Numa festa, participar em jogos e/ou danças		

Situações Sociais	**Desconforto/Ansiedade** 1= Nenhum 2=Ligeiro 3= Médio 4= Severo	**Evitamento** 1=Nunca (0%) 2=Às vezes (1-33%) 3=Muitas vezes (34-67%) 4=Quase sempre (68-100%)
29. Convidar alguém, pela 1ª vez, para sair		
30. Aproximação do empregado quando se entrou numa loja só para ver		
31. Conversar com pessoas do sexo oposto		
32. Aceitar um elogio		
33. Participar num encontro com pessoas de cultura diferente		
34. Ir a uma discoteca com um(a) amigo(a)		
35. Pedir a outra pessoa que mude um comportamento que nos desagrada		
36. Ser chamado ao gabinete do chefe ou professor		
37. Falar com alguém uma língua estrangeira que não se domina bem		
38. Fazer um exame oral		
39. Queixar-se quando alguém tenta passar à sua frente numa fila		
40. Ser chamado para "ir ao quadro"		
41. Tomar a iniciativa de colocar uma questão ou pedir um esclarecimento numa aula ou reunião		
42. Responder a uma questão colocada pelo professor no meio da aula		
43. Chegar atrasado(a) ou adiantado(a) a uma reunião ou aula		
44. Falar com pessoas duma condição sociocultural superior		
45.		
46.		
TOTAL		

Questionário sobre o Toque Social

Frank H. Wilhelm, Ajay S. Kochar, Walton T. Roth and James J. Gross (2001)

As seguintes afirmações fornecem uma variedade de afetos e atitudes relativas ao toque social.
Uma pontuação mais alta indica que há mais atitudes de evitar o toque e de desconforto relativo ao toque.
Indique até que ponto cada uma das seguintes afirmações o/a carateriza ou é verdadeira.

0=absolutamente nada 1=ligeiramente 2=moderadamente 3=muito 4=extremamente

		0	1	2	3	4
1	Normalmente gosto que as pessoas manifestem o seu afeto por mim de uma forma física					
2	Sinto-me pouco à vontade quando alguém que não conheço muito bem me dá um abraço					
3	Fico nervoso/a quando uma pessoa não larga a minha mão depois de um aperto de mão					
4	Normalmente procuro contato físico com os outros					
5	Sinto-me constrangido/a se tenho de tocar em alguém para chamar a sua atenção					
6	Considero-me uma pessoa que gosta de expressar afeto através do toque					
7	Aborrece-me que alguém me toque inesperadamente					
8	Sentir-me-ia pouco à vontade se um professor me tocasse no ombro em público					
9	Teria todo o gosto em fazer uma massagem no pescoço ou nos ombros a uma pessoa amiga que estivesse tensa					
10	Sinto-me pouco à vontade se tiver contato físico com um estranho no autocarro ou no metropolitano					
11	Gosto de receber carícias em situações íntimas					
12	Quando era criança, os meus familiares (por exemplo, pais, irmãos) faziam-me festas muitas vezes					
13	Preferiria evitar dar apertos de mão a estranhos					
14	Cumprimento os meus amigos mais chegados com um beijo na face					
15	Sinto-me à vontade ao tocar em pessoas que não conheço muito bem					
16	Sinto-me enojado/a quando vejo demonstrações íntimas de afeto em público					
17	Sentir-me-ia ansioso/a se alguém que tivesse acabado de conhecer me tocasse no punho					
18	Se tivesse condições, todas as semanas fazia massagens com um profissional					
19	Detesto que me façam cócegas					
20	Gosto de fazer festas a animais					

Pontuação Final: ____________

Agradecemos a sua colaboração e o tempo que nos concedeu ao preencher este questionário.

ANNEX J

EAESDIS authorization – Study on Reliability and Validity of the European Portuguese version of the Social Touch Questionnaire

Pedido de autorização para a utilização da Escala de Ansiedade e Evitamento em Situações de Desempenho e Interação Social

Caixa de entrada	x

Ana Isabel Vieira <vieira.anaisabel@gmail.com> 18/11/14

para José, marina_cunha, eu, Bcc:Patricia

Exmo Sr Professor Doutor José Pinto-Gouveia:

Chamo-me Ana Isabel Vieira, sou professora na Escola Superior de Saúde do Alcoitão e estou a realizar um doutoramento em Ciências da Saúde na Universidade Católica.

Um dos estudos que estou a desenvolver tem como objetivo perceber a associação entre os comportamentos de evitamento ao toque e a ansiedade social.

Este trabalho está a ser acompanhado pelo Centro de Estudos e Investigação em Saúde da Universidade de Coimbra (CEISUC).

Nesse sentido solicito autorização para utilizar a versão portuguesa da Escala de Ansiedade e Evitamento em Situações de Desempenho e Interação Social.

Agradeço antecipadamente.

Com os melhores cumprimentos,

marina_cunha@ismt.pt 19/11/14

para mim, José

Cara Ana Isabel Vieira,
Em meu nome pessoal, e em nome dos restantes autores, autorizo a utilização da EAESDIS que envio em anexo, bem como a caracterização deste instrumento e suporte bibliográfico.
Pedíamos encarecidamente que, quando terminasse a sua investigação, partilhava connosco os dados obtidos com esta escala permitindo-nos assim analisar o comportamento deste instrumento noutras amostras.
Votos de um bom trabalho,
Marina Cunha

Citando Ana Isabel Vieira <vieira.anaisabel@gmail.com>:
Exmo Sr Professor Doutor José Pinto-Gouveia:

Marina Cunha

Psicóloga Clínica, PhD
Presidente do Conselho Científico do ISMT
Coordenação do 2º ciclo em Psicologia Clínica
Instituto Superior Miguel Torga
Largo da Cruz de Celas, 1
3000-132 Coimbra, Portugal
Telephone: (+351) 239 488030
Fax: (+351) 239 488031