5th Body Representation Network Conference 2023

Theme: The interactive body: Multisensory and embodied signatures of bodies interacting in the world

BRNET CONFERENCE 2023

Coordinators

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Venue address

CaixaForum Palma. Plaza Weyler. 3. 07001 Palma de Mallorca. Balearic Islands, Spain.

Link here to venue address and points of interest around venue.

*Additional info in the last page

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Mission and vision:

BRNet is an international network of scientists who investigate the psychology and neuroscience of body representation. We organise triannual online seminars, annual workshops and conferences. We are currently expanding the range and frequency of our activities.

Website:

https://bodyrepresentation.wixsite.com/brnet

In collaboration with

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AGENCIA ESTATAL DE INVESTIGACIÓN

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Program at glance

Thursday 14th September

15:00	Registration
15:30	Welcome from the organizers (Alejandro Galvez-Pol, Laura Crucianelli & Ana Tajadura-Jiménez)
15:40	**ERC session** - Chair: Laura Crucianelli (Queen Mary Univ. of London) *Body representation & its research context: A career in Academic editing, Working with industry, and Creating a research team.* **Panelists:** Henrietta Howells (Nature Comms), Sonia Ponzo (Healios Ltd.), Bigna Lenggenhager (Uni. Konstanz)
16:40	Coffee break
17:00	**Session in honor of Prof. Francesca Frassinetti** - Chair: Andrea Serino (Univ.of Lausanne) **Invited speakers:** Mariano D'Angelo (Karolinska Institutet), Francesca Garbarini (Univ. degli Studi di Torino), Valentina Cazzato (Liverpool John Moores Univ).
18:00	Final observations, announcements, and end of day 1

Friday 15th September

09:00	Welcome and registration
09:30	**Keynote:** *Multisensory decisions from the bodily self to world* - **Invited speaker:** Roy Salomon (Univ. of Haifa. Israel)
	Short talks - Session 1. Chair: Ana Tajadura-Jiménez (Univ. Carlos III de Madrid)
10:30	*The importance of socio-tactile interactions* (Louise P. Kirsch, Univ. Paris Cité, Paris)
10:50	*Body perception and brain plasticity in blind and sighted individuals* (Dominika Radziun, Karolinska Inst. Stockholm)
11:10	*Touching a painful body: behavioural and physiological responses to Virtual social and pleasant touch in chronic pain* (Maddalena Beccherle, Univ. of Verona)
11:30	Coffee break
12:00	**Poster session (A)**
13:00	Lunch break
15:00	**Keynote:** *Why should people interested in body representation care about the vestibular system?* - **Invited Speaker:** Laurence R Harris (York Univ, CA)
	Short talks - Session 2. Chair: Alejandro Galvez-Pol (Univ. of the Balearic Islands)
16:00	*Body dissatisfaction and disembodiment in body-shape-manipulated virtual self-avatars* (Philipp A. Schroeder, Univ. of Tübingen, Tübingen)
16:20	*An electrophysiological marker of peripersonal space representation detects consciousness changes in sleep and brain injury.* (Tommaso Bertoni, Univ. Hospital Lausanne)
16:40	*Breath influences bodily self-consciousness in a female sample* (Andrea Salaris, Sapienza Univ. of Rome & Italian Inst of Technology, Rome)
17:00	**Poster session (B)**
18:00	Announcements, poster prize and closure

KEYNOTES

Roy Salomon

University of Haifa, Israel

Dr. Salomon's work focuses on the neural and cognitive mechanisms underlying the representation of the "Self" and "Reality" in the human mind. Specifically, he examines the computations giving rise to models of bodily self and how these interact and form representational models of the world, in both healthy and psychiatric populations.

Laurence R Harris

York University, Canada

Dr. Harris' studies how the different senses are combined to generate our perceptions of the world and of our body. He is particularly interested in the way these combinations can adapt to changing demands brought about by unusual environments which he creates using various means including virtual reality, the microgravity of space, human centrifuges, and moving rooms.

Session in honor of Prof. Francesca Frassinetti

MARIANO D'ANGELO
(Karolinska Institutet)

FRANCESCA GARBARINI
(Univ. degli Studi di Torino)

VALENTINA CAZZATO
(Liverpool John Moores Univ)

Invited speakers: **Mariano D'Angelo**

The interpersonal bodily self

D'Angelo, M. [1]

[1] Karolinska Institutet, Department of Neuroscience, Stockholm

Studies on embodied cognition have highlighted the connection between one's own body representation and high-level interpersonal attitudes1. Here, in two separate studies, we have investigated the socio-cognitive implications of perceiving oneself as invisible. In Study 1, we showed that perceiving one's own body as invisible modulates the interpersonal space, i.e., the distance individuals maintain from others during social interactions2. Moreover, the experience of invisibility did not affect the perceived reaching- space. Thus, a manipulation of the conscious body external appearance modulates the space representation only when its interpersonal significance is emphasized. On the other hand, when the sensorimotor representation of the arm was modulated through the active use of a tool, it enlarged the perceived reaching space, without affecting the social interpersonal space. Thus, these two different body manipulations reveal a functional dissociation of the representation of the space around the body.
In Study 2, we demonstrated that the illusion of having an invisible face affects the perception of gaze direction3. The concept of the "cone of gaze" was employed to describe the range of eye deviations participants judge as being directed towards them. Crucially, embodying an invisible face reduced the width of the cone of gaze, suggesting that participants perceived themselves as being less observed by others. Both studies provide evidence for the social relevance of one's own body representation. Specifically, experiencing of one's own body as invisible updates the expectation that the attention of others is directed toward the self, consistently with the new body representation.

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3. D'Angelo, M., Maister, L., Tucciarelli, R., Frassinetti, F., & Longo, M. R. (2021). Embodying an invisible face shrinks the cone of gaze. *Journal of Experimental Psychology: General*, *150*(6), 1132.

Invited speakers: **Francesca Garbarini**

Body-self visual recognition: a shared journey from patients to infants (with love)

Garbarini, F [1]

[1] University of Turin, Turin

While vision may be considered the dominant sense through which we identify other people's bodies, visual recognition of the own body may require the additional recruitment of sensorimotor system, since we constantly receive unique sensorimotor information from our body. Pioneering studies by Francesca Frassinetti demonstrated a behavioral advantage in the body-self visual recognition, and her insights about the role of the sensorimotor system in this visual self-advantage have paved the way for future investigations. In the present talk, I will start from our last coauthored study, in which we showed that, in brain-damaged patients, fiber-tracts disconnection between visual (occipito-temporal) and sensorimotor (fronto-parietal) regions are strongly associated with a severe impairment of the ability to visually recognize the own hand. Then, I will present you two novel EEG studies, which were deeply inspired by Francesca's work. In the first one, by exploiting an index of somatosensory activity during visual tasks, we found that the self-hand visual identity is coded in the neural dynamic of somatosensory cortices. In the second one, by exploiting fast periodic visual stimulation, we described a more efficient processing in discriminating self-hand than other-hand images not only at occipital but also at fronto-central sites, thus supporting Francesca's view that self-hand recognition relies on the association between visual and sensorimotor representations. Finally, I will mention future studies that, being constantly inspired by Francesca's thought, will exploit these EEG protocols in infants, to investigate the development of this visuo-sensorimotor association that allows the body-self to emerge early in life.

Invited speakers: **Valentina Cazzato**

Self-body recognition and attitudes towards negative body image across the lifespan: behavioural and TMS evidence

Cazzato, V [1]

[1] Liverpool John Moores University, UK

Self-body recognition, which refers to the unique ability in identifying one's own body and its parts as separate from others, allows for self–other discrimination, a pivotal cognitive function in social interaction and bodily self-awareness. Strongly inspired by the seminal work of Francesca Frassinetti and her research group, here, I will present a series of studies which aimed at investigating whether the ability of recognising self than other women's body parts (thighs, hand, stomach, foot) might be affected by body size overestimation and negative body image dispositions in populations of healthy and individuals suffering from anorexia nervosa (AN). In the first study, I will provide evidence that age is a factor contributing towards alterations of the implicit and explicit perceptual processing of body parts and that self-body recognition is not immune to the impact of perceptual and affective components of body image in younger and older women. I will then present some preliminary results obtained by a TMS study, which support the idea of a causative role of the right Extrastriate body area (EBA) and of temporo-parietal junction (TPJ), in the ability to implicitly match self and others' size distorted body parts depending on specific features of identity and size distortions. Finally, I will present novel data, that in line with Francesca's results of a dissociation of explicit vs. implicit self-body recognition, speak in favour of an altered ability of implicitly (but not explicitly) recognise self-body parts in two groups of healthy and AN adolescents. Significant associations between symptoms of appearance concerns, interoceptive deficits and the self-advantage for recognising (usually) negatively valanced body parts, such as the thigh and stomach in adolescents with AN, support the idea that facets of explicit/implicit access to self-body representation might differentially contribute to the aetiology of AN in adolescence. Thanks to the pioneering work of Francesca, these results have the potential to inspire new non-pharmacological therapeutic interventions for AN, as well as other bodily self-disorders, which aim at targeting layers of self-experience affected in each type of bodily self-disorder.

Short talks

LOUISE P. KIRSCH
(Université Paris Cité, Paris)

DOMINIKA RADZIUN
(Karolinska Institutet, Stockholm)

MADDALENA BECCHERLE
(University of Verona, Verona)

PHILIPP A. SCHROEDER
(University of Tübingen, Tübingen)

TOMMASO BERTONI
(University Hospital Lausanne, Lausanne)

ANDREA SALARIS
(Sapienza University of Rome & Italian Institute of Technology (IIT), Rome)

Session 1 | Talk 1: **Louise P. Kirsch**

The importance of socio-tactile interactions

Louise P. Kirsch [1]

[1] Integrative Neuroscience and Cognition Center, CNRS, Université Paris Cité, UMR 8002, Paris

At the boundary between the body, the environment and others, touch is a key path for social interactions. Indeed, touch enables the transmission of pro-social and emotional signals that cannot be communicated through other sensory modalities. Thus, touch is important in myriad social situations, but often neglected. In this presentation, I will briefly put together the results of our recent studies shedding some lights on: (i) the crucial role of affective touch in communicating emotions; (ii) the role of touch in buffering feelings of social isolation and rejection, especially in the time of forced social distancing; and (iii) the physiological markers of vicarious social touch (i.e. heart rate and facial electromyographic activity). In this last part, I will present very recent data, based on the idea that our perception of others in socio-tactile interactions are mediated by our bodily experiences, and our past interactions, showing how physiological responses to observed social touch is influenced by the amount of tactile interactions ones has received in the past week. Moreover, in these different studies, I will highlight the important effects of interindividual differences. Altogether, these studies highlight the necessity for future studies to investigate further the underlying mechanisms of social touch perception by taking into account interindividual differences, and the degree of socio-tactile interactions' deprivation.

Session 1 | Talk 2: **Dominika Radziun**

Body perception and brain plasticity in blind and sighted individuals

Radziun, D. [1], Korczyk, M. [2], Crucianelli, L. [1], Szwed, M. [2], & Ehrsson, H. H. [1]

[1] Karolinska Institutet, Stockholm
[2] Jagiellonian University, Kraków

Lack of vision is associated with large-scale brain plasticity. Visual input, together with touch, proprioception, interoception, and other sensory modalities, are thought to play an important role in the development and maintenance of multisensory awareness of one's own body. How does the feeling of body ownership arise in blind individuals, and what kind of compensatory plasticity processes are involved? Here we present a series of experiments that focused on this profoundly understudied topic. We tested 36 blind individuals and 36 age- and sex-matched sighted volunteers. In experiment 1, using the heartbeat counting task, we showed that blind individuals have significantly higher accuracy in perceiving their heartbeat compared to sighted individuals. In experiment 2, we provided a broader insight into tactile perception following blindness by studying both discriminative and affective touch plasticity in blind and sighted groups. In experiment 3, we re-examined a classic paradigm to study body ownership, the somatic rubber hand illusion, in a largest to date sample of blind participants. We showed that blind individuals do not experience the somatic rubber hand illusion, which suggests that changes in multisensory integration of tactile and proprioceptive signals, possibly combined with more accurate interoception, may explain why blind individuals appear "immune" to the nonvisual version of the rubber hand illusion. Taken together, this series of experiments is the first attempt to systematically describe differences and similarities between blind and sighted individuals in bodily awareness and the functioning of the bodily senses, opening an important line of research.

Session 1 | Talk 3: Maddalena Beccherle

Touching a painful body: behavioural and physiological responses to Virtual social and pleasant touch in chronic pain

Beccherle, M. [1], Fusaro, M. [2], Moro, V. [1]

[1] Department of Human Sciences, University of Verona, Verona
[2] IRCCS Fondazione Santa Lucia, Rome

Despite the chronic pain affecting Fibromyalgia patients (FM) impacts bodily representations, social life, and relationships, little is known about how social touch involving different body parts is perceived in FM, it modifies these representations, and modulates pain. Hence, we conducted a series of studies investigating this topic through the combination of Immersive Virtual Reality(IVR), behavioural (explicit) and physiological (implicit, Skin Conductance Response-SCR and Heart Rate-HR) measures.
42 FM and 41 healthy controls (HC) evaluated the appropriateness, pleasantness and erogeneity elicited by virtual pleasant touches administered by a female avatar on different body areas[1] (neutral, i.e. foot, knee), social (i.e. hand, head), and intimate (i.e. pelvis, breast) on a virtual body presented in first-person perspective (Study1). Study 2 compared groups' judgements (i.e. pleasantness and intensity) in response to pleasant, neutral and painful stimuli administered on an embodied virtual hand. Finally, Study 3, compared the perceived pain intensity rated before and after a series of repeated pleasant and neutral virtual stimuli to investigate the analgesic power of virtual pleasant touch.
An intriguing implicit-explicit dissociation emerged in FM. Indeed, while the two groups' explicit/behavioural evaluations were comparable[2], FM showed higher SCRs than HC, signalling an increased physiological reactivity to virtual touch. Crucially this response was not associated with the clinical/psychological variables (e.g. mood). Furthermore, a trend towards pain reduction was found in FM after the observation of repeated pleasant stimuli, suggesting that the analgesic effect of pleasant touch[3] could be achieved also in IVR, highlighting its feasibility and applicability as a promising therapeutic tool.

References:

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Session 2 | Talk 4: **Philipp A. Schroeder**

Body dissatisfaction and disembodiment in body-shape-manipulated virtual self-avatars

Schroeder, P.A. [1*], Gehrer, N.A. [1], Reents, M. [1], Reimer, N. [1], Vagedes, J. [2,3], Svaldi, J. [1]

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[2] ARCIM Institute, Im Haberschlai 7, 70794 Filderstadt
[3] Department of Neonatology, University Children's Hospital Tübingen, 72016 Tübingen

Body dissatisfaction (BD) describes a negative subjective experience and evaluation of one's own body, which can become a central and burdensome symptom, particularly in patients with eating disorders. BD is associated with negative self-esteem, fear of weight gain, and maladaptive behaviors such as dangerous weight loss, binge-eating and/or purging episodes, and even suicide ideation. BD- related experience is linked to automatic visual-selective attention, i.e., how the own or other bodies are perceived. In this study, we used multisensory interactions in virtual reality (VR) to induce embodiment of a body-shape manipulated self-avatar, prior to a virtual mirror exposure with eye- tracking recording. Two groups composed of females with high vs. low BD participated in this study. Prior to a brief mirror exposure with their self-avatars, they experienced synchronous visuo-motor and visuo-tactile contingencies in VR to increase embodiment, delivered through small movement exercises with real-time animation from first-person-perspective and passive haptics. In a cross-over study design, self-avatar weight was manipulated (normal weight vs. overweight) in both groups (low BD vs. high BD) and subjective experience was assessed before and after exposure. Embodiment was induced by the visuo-tactile contingencies but decreased during mirror exposure. Interestingly, disembodiment was stronger in women with low BD. Further, eye-tracking showed that participants with high BD looked longer at weight-related body-parts when immersed in the overweight self-avatar, whereas participants with low BD looked longer at weight-related body-parts when immersed in the normal-weight self-avatar. We suggest an implicit self-identification through gaze and disembodiment and discuss possible future projects.

Session 2 | Talk 5: Tommaso Bertoni

An electrophysiological marker of peripersonal space representation detects consciousness changes in sleep and brain injury

T Bertoni [1] & G Ricci [2], J Cataldi [3], B Donno [1], J Fellrath [1], JP Noel [4], C Foglia [1], M Bassolino [1], J Johr [5], K Diserens [5], F Siclari [3], A Serino [1]

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[3] Department of Clinical Neurosciences, University Hospital Lausanne (CHUV), Lausanne.
[4] Center for Neural Science, New York University, New York.
[5] Acute Neurological Rehabilitation Unit, Department of Clinical Neurosciences, University Hospital Lausanne (CHUV), Lausanne.

The experience of being "here and now" is a fundamental aspect of human consciousness, and it relies on the integration of multisensory information from the environment (Tononi & Koch, 2015) and one's own body (Blanke et al., 2015). The Peripersonal Space (PPS) system, which integrates tactile information on the body with external stimuli near the body, serves as the neural interface between self and environment, potentially supporting consciousness (Blanke et al., 2015). Here, we aimed to follow up on such hypothesis, by investigating whether electrophysiological markers of PPS representation are related to changes in consciousness occurring during wakefulness and sleep. To assess PPS representation (Noel et al., 2019), we delivered tactile, auditory and audiotactile stimuli near or far from participants, while recording high-density EEG. This was done during wakefulness and sleep, and subjective reports about the consciousness state during sleep were collected through an awakening protocol.
During wakefulness, we observed a centro-parietal decrease in high-beta power specific for audiotactile stimuli near the body. This was considered a putative electrophysiological marker of PPS representation. Such marker was not overall present in sleep, but it was significantly more similar to the awake state when subjects reported conscious content (i.e., dreams).
We then asked whether our PPS marker generalized to consciousness alterations occurring following brain damage, by adapting our paradigm to low-density EEG bedside recordings. Compared to purely behavioural clinical scales, our marker improved predictions about the long-term clinical outcome of patients, possibly by detecting the presence of residual covert consciousness. In sum, these experiments highlight a new electrophysiological marker of PPS processing, which may detect changes in overt and covert consciousness occurring due to natural or pathological causes.

References:

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Session 2 | Talk 6: Andrea Salaris

Breath influences bodily self-consciousness in a female sample

Andrea Salaris [1,2], Chiara Cantoni[1,2], Alessandro Monti[1], Giuseppina Porciello[1,2], Salvatore Maria Aglioti[1,2]

[1] Department of Psychology, Sapienza University of Rome & Center for Life Nano- & Neuroscience, Italian Institute of Technology (IIT), Rome.
[2] IRCCS Fondazione Santa Lucia, Rome

Internal and external bodily signals shape bodily self-consciousness (BSC)1, the basic feeling that one has a body (body ownership) that acts according to one's will (body agency) and occupies a specific position (body location). Very little is known about how women integrate interoceptive and exteroceptive cues in their conscious experience of the body. Evidence shows that females are less accurate in perceiving their internal signals compared to males2. To address this gap, we induced a breath-based bodily illusion3 in a female population.
33 female participants (mean =24.57±3.4 years) underwent an immersive virtual reality experience in which we manipulated the appearance, breathing pattern, and perspective of a virtual body. Additionally, measures of interoceptive accuracy (performance at the Heartbeat Counting task4 and Pneumoception task3) and sensibility (MAIA II questionnaire scores5) were collected.
We ran a series of linear mixed models to assess the effects of experimental manipulations on different facets of BSC. For the sense of ownership, we found a main effect of Breath ($F_{1,210}$ =5.77; p=.02), Appearance ($F_{1,210}$ =4.47; p=.04) and Perspective ($F_{1,210}$ =122.69; p<.0001). Regarding the sense of agency, there was a main effect of Perspective ($F_{1,210}$ =7.44; p=.007) and Breath ($F_{1,210}$ =14.65; p=.0002). Finally, for the sense of location, we found a main effect of Perspective ($F_{1,210}$ =664.98; p<.0001).
In keeping with what found in the men sample3, women adjust their bodily awareness by integrating internal and external bodily cues. This finding has potential implications for the study of disorders that affect BSC in females, such as eating disorders.

References:

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POSTERS

SESSION A

POSTER Session A	
1A	**Manja M. Engel** (Utrecht University, The Netherlands)
	Effects of response delay on visual body size estimation in people with body image disturbances
2A	**Laura Battistel** (University of Trento, Trento)
	An investigation on humans' sensitivity to environmental temperature
3A	**Rebecca Boehme** (Linköping University, Linköping)
	Ketamine reduces the neural distinction between self- and other-produced affective touch - a double-blind placebo-controlled study
4A	**Matteo Girondini** (Università Milano-Bicocca, Milan)
	Modulating the haptic feedback during the motor interaction with virtual objects impairs temporal discrimination of tactile information presented on own body
5A	**Denise Cadete** (University of London, London)
	The smaller, the lighter: Embodying an enlarged and a shrunken hand changes how much we underestimate hand weight
6A	**Loredana Catinari** (Department of Clinical Neurosciences, Lausanne University Hospital)
	Eye tracking in virtual reality as a measure of attentional deficits in brain damaged patients
7A	**Thomas Chazelle** (University Grenoble Alpes, Grenoble)
	Integration of visual and verbal cues in judgments of body size
8A	**Stefania Cionca** (German Institute of Human Nutrition, Germany)
	Effects of Clothing Tightness on Body Image and Food Choice
9A	**Dorothy Cowie** (Durham University, UK)
	Neural and behavioural adaptations in children with limb differences
10A	**Anna Crossland** (University of York, York)
	Development of a scale for prenatal interoception
11A	**Rosie Drysdale** (University of London, London)
	Preliminary evidence for age-related changes in cardiac interoception from 13 to 21 months of age
12A	**Adam Enmalm** (Linköping University, Linköping)
	Body perception and social touch preferences during times of grief

13A	**Kirralise J. Hansford** (University of York, York)
	The Addition of Non-Naturalistic Auditory Input During Resizing Illusions
14A	**Laurence R. Harris** (York University, Toronto)
	Representation of body height affects how big you see the world
15A	**Genaro Lopez-Martin** (University of the Balearic Islands, Palma de Mallorca)
	Integration of Bodily Signals in the Plasticity of Self-Representation
16A	**Marta Matamala-Gomez** (University of Barcelona, Barcelona)
	Characterization of EEG neural markers in the sensorimotor cortex when using movement sonification for walking ability
17A	**Lydia Munns** (University of York, York)
	The effects of pregnancy bodily experience on mother-infant outcomes
18A	**Sarah Cooney** (University College Dublin, Dublin)
	Investigating aspects of Interoceptive Sensibility, body shame and body surveillance in female groups of high and low negative body image: A Network Comparison Study
19A	**Sergio Navas-León** (Universidad Loyola Andalucía, Spain)
	Exploring multisensory integration of non-naturalistic sounds on body perception in young females with eating disorders symptomatology
20A	**Ryu Ohata** (Karolinska Institutet, Stockholm)
	Bodily illusion enhances subjective fear of margin-of-safety invasions around the self
21A	**Paula C. Salamone** (Linköping University, Linköping)
	Feeling yourself when your self is altered, a study in Schizophrenia
22A	**Federica Scarpina** (University of Turin, Turin)
	Disgust processing in Anorexia Nervosa: effects on body representation
23A	**Oscar J. Sill** (Durham University, Durham)
	"My hands are my feet, but it's still my body!" Children's developing own-body representations in virtual reality
24A	**Irene Valori** (Technische Universität Dresden, Dresden)
	Touch from a distance: virtual reality and wearable technologies for interpersonal virtual touch
25A	**Wen Wen** (Rikkyo University, Tokyo)
	Is It Me or Is It You? Disassociated Agency and Ownership in a Face and Action Mixing Paradigm

26A	**Mateusz Woźniak** (Central European University, Vienna)
	Identifying with an avatar face changes mental representation of one's real face
27A	**Andrea Zaccaro** (University of Chieti-Pescara, Chieti)
	Exploring the dynamic interplay between cardiac interoception, focus of attention, and respiration
28A	**H. Chris Dijkerman** (Utrecht University, Utrecht)
	Touch time: The effect of finger size distortions on tactile temporal-order judgments
29A	**Natalie C. Bowling** (University of Greenwich, London)
	Where do we like to be touched? Body maps of interpersonal touch preference vary according to extraversion and attachment style
30A	**Albert H. Van der Veer** (University of Konstanz, Konstanz)
	Individual perspectives on interoception display methods
31A	**Maria R. Pasciucco** (University of Chieti and Pescara, Chieti)
	Weighting the Contributions of Interoceptive and Exteroceptive Body Representations to Schizotypy
32A	**Duangkamol Srismith** (University of Konstanz, Konstanz)
	The Role of Olfaction in Body Representations within Extended Reality
33A	**Gaia Risso** (Institute of Health, School of Health Sciences, Sion, Switzerland)
	Changes in metric body representations and hand ownership in healthy older adults

POSTERS

Session A | Poster 1: Manja M. Engel

Effects of response delay on visual body size estimation in people with body image disturbances

M.M. Engel [1], A. Keizer [1] & H. C. Dijkerman [1]

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Research suggests that the body representation (BR) is formed through interaction with the environment and comprised of perception (how do we experience our body) and attitudes (our conscious judgements of our body). People suffering from body image disturbances (BID) often overestimate their own body size. In the past 50 years there has been a debate in research whether this overestimation is due to perceptual overestimations or is caused by attitudinal factors, for example the discrepancy between once own body and the expected 'perfect' body through society. The current study investigated whether visual overestimation of body size in people with BID is caused by attitudinal factors (e.g., a large discrepancy between once own body and socially desired body) or a visual (perception) overrepresentation of the body. In a computer task we presented a series of single bodies that differed in BMI (Longo et al., 2017) to participants and they were asked to judge if their own body was bigger or smaller. We used our novel response-delay method where allowed response time is used to minimize the influence of attitudinal factors (Engel et al., 2021). In the direct condition participants had to make their judgements within 300ms, eliminating time to reflect on their judgement. In the delayed condition participants were allowed 5 seconds to answer. We included 162 participants in our study. We are currently analyzing the data.

Session A | Poster 2: Laura Battistel

An investigation on humans' sensitivity to environmental temperature

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According to the grounded cognition perspective, our perception depends on the re-activation of sensorimotor experiences, as well as on our current bodily states and on the environment (Barsalou, 2008). Our environment provides us with a lot of cues but, above all, temperature appears of great importance for the survival and wellbeing of our body (Kelly, 2007). Nonetheless, research on human perception lacks a quantitative result on thermal perception when the full body is involved. We developed an innovative experimental paradigm to address this question with four climate chambers set at varied temperatures between 24 °C ± 1 °C. 26 participants moved from a reference chamber to a target chamber and noted whether this was warmer or colder than the former. Data has been analysed by adopting the generalised linear mixed-effects models (GLMM). The results showed a PSE of -0.13 °C and a JND of 0.38 °C (Figure 1). These results point out both the high accuracy of participants' performance and the small variability between them, with the latter suggesting that this sensitivity could be an intrinsic mechanism in our body. In light of these findings, we further investigated the possible multisensory interactions between temperature and vision. Considering the ongoing literature controversy (e.g., see Table 1 Brambilla et al., 2020), we specifically looked into the impact that the colour of the lights might have on thermal sensitivity. In conclusion, these experiments answer a still-open question revealing our body's ability to accurately perceive the environment, even without participants' awareness of this capability.

Session A | Poster 3: Rebecca Boehme

Ketamine reduces the neural distinction between self- and other-produced affective touch - a double-blind placebo-controlled study

Reinoud Kaldewaij [1,2], Paula C. Salamone [1], Adam Enmalm [1], Lars Östman [1], Michal Pietrzak [1], Hanna Karlsson [1], Andreas Löfberg [1], Emelie Gauffin [1], Martin Samuelsson [1], Sarah Gustavson [1], Andrea J. Capusan [1], Håkan Olausson [1, 2], Markus Heilig [1,2], Rebecca Boehme [1,2]

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A coherent sense of self is crucial for social functioning and mental health. The N-methyl-D-aspartate antagonist ketamine induces short-term dissociative experiences and has therefore been used to model an altered state of self-perception. However, the mechanisms for its effects on the bodily sense of self remain largely unknown.
In this randomized double-blind placebo-controlled within-subject study, 30 participants received intravenous ketamine while performing a previously validated task during functional MRI: self- touch and touch by someone else were used as a measure of self-other-distinction. Afterwards, tactile detection thresholds during self- and other-touch were assessed, as well as dissociative states, interoceptive awareness, and social touch attitudes.
Compared to placebo, ketamine administration induced a higher state of dissociation and a reduction of self-other distinction in the temporoparietal cortex. This reduction correlated with ketamine-related reductions in interoceptive awareness.
Our results indicate that disrupting the self-experience by ketamine-administration affects self-other-distinction in a region associated with touch perception and social cognition. This process may be driven by ketamine-induced effects on top-down signaling, rendering the processing of predictable self-generated and unpredictable other-generated touch more similar. Our findings provide further evidence for the intricate relationship of the bodily self with social touch.

Session A | Poster 4: **Matteo Girondini**

Modulating the haptic feedback during the motor interaction with virtual objects impairs temporal discrimination of tactile information presented on own body

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Our brain continuously maps our body in space. It has been suggested that at least two main frames of reference are used to process stimuli presented on our own body: the anatomical frame of reference (based on the somatotopic representation of our body in the somatosensory cortex) and the spatial frame of reference (where body parts are mapped in external space)[1]. Interestingly, a mismatch between somatotopic and spatial information significantly affects the processing of bodily information, as demonstrated by the "crossing hand effect[2,3]. However, it is not clear if this impairment could occur if the conflict between these frames of reference is determined by a static change in the body position (e.g., by crossing the hands) or also when new associations between motor and sensory responses are created (e.g., by presenting feedback stimuli on a side of the body that is not involved in the movement). In the present study, 16 participants performed a temporal order judgment task before and after a congruent or incongruent visual-tactile-motor- task in virtual reality where they had to move a cube using a virtual stick. In the congruent condition, the haptic feedback during the interaction with the cube was provided on the right hand (the one used to control the stick). In the incongruent condition, the haptic feedback was provided to the contralateral hand, simulating a sort of 'active' crossing-hand effect during the interaction. A temporal order judgement task (TOJ) was performed before and after the VR manipulation task, in both sessions, and the point of subjective equality (or PSE, i.e., the probability to respond left or right to the first stimulus in the sequence in 50% of the cases) was calculated for both sessions. After the VR task, compared to the baseline condition, the PSE shifted in the direction of the hand which received the haptic feedback during the interaction (right lateralization for the congruent condition, left lateralization for the incongruent condition) (fig. 1). This study demonstrated the possibility of impairing the processing of bodily information also by modulating the sensory-motor interaction between stimuli in virtual environments (while keeping constant the actual position of the body in space).

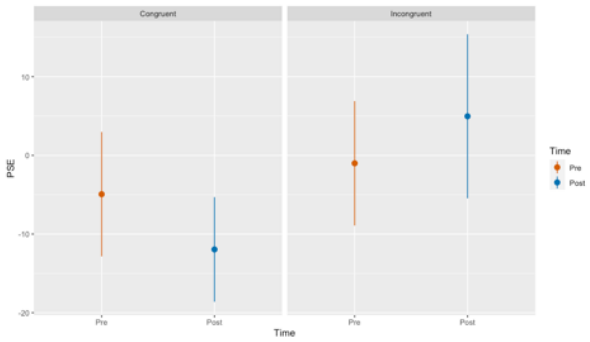

Figure 1: PSE before and after the VR task for the congruent vs. incongruent condition

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Session A | Poster 5: **Denise Cadete**

The smaller, the lighter: Embodying an enlarged and a shrunken hand changes how much we underestimate hand weight

Denise Cadete [1], Vincenzo Marino [1], Elisa R. Ferrè [1], Matthew R. Longo [1]

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The size of objects and the size of our body parts modulate how heavy or light we perceive objects in our environment (Buckingham, 2014; Haggard & Jundi, 2009; Linkenauger et al., 2010, 2013). However, little is known on how perceived size informs the perceived weight of our own body parts. Recently, it has been found that we underestimate the weight of our hand in baseline conditions on Earth (Ferrè et al., in preparation). In this study, we investigated if embodying an enlarged and a shrunken hand would change perceived hand weight. We used a visual-tactile illusion with magnifying and minifying mirrors, after which participants underwent a psychophysics matching task, in which they estimated if the weight hanged on their wrist was heavier or lighter than the experienced weight of their hand. We also measured felt hand length and width. Our results show that participants underestimated more their hand weight when embodying a smaller hand, and less when embodying a larger hand. This suggests that perceived hand size informs and updates its perceived weight. The representation of hand weight is flexible, and consistently underestimated, even when embodying a larger hand. Vestibular-gravitational signals are used to shape hand weight representation (Ferrè et al., 2015, 2019), and this study shows that visual-tactile signals also contribute to perceived hand weight.

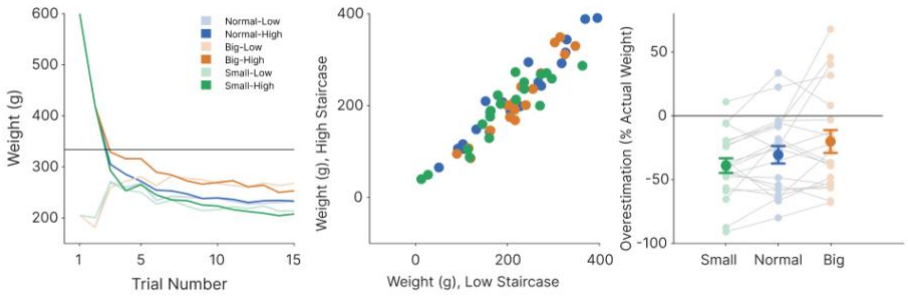

Fig 3. Perception of hand weight across conditions. *Left panel*: The low and high staircases converged on common estimates of hand weight, for the three conditions. The black horizontal line indicates the mean weight of the actual hand. *Centre panel*: Estimates of hand weight were strongly correlated between the two staircases for all conditions, p <.001. *Right panel*: There was a clear underestimation of hand weight in the three conditions, with higher underestimation in the small hand condition, and lower underestimation in the big hand condition.

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Session A | Poster 6: **Loredana Catinari**

Eye tracking in virtual reality as a measure of attentional deficits in brain damaged patients

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Attention is a fundamental cognitive process that can be severely affected by brain lesions[1,2]. Among the impacted attentional components, alertness and spatial attention are frequently impaired[3]. Alertness is a prerequisite of all the other attentional components [4,5] and spatial attention deficits, including neglect, are best predictor of long-term poor functional outcome[6,7]. Current available tools for the diagnosis and rehabilitation of attentional deficits are based on computerised or paper-and-pencil tasks[7]. Immersive Virtual Reality (VR) has been recently proposed both as a tool to improve diagnosis and to alleviate cognitive deficits[8,9]. Eye-tracker sensors embedded in VR allow the collection of parameters known to be biomarkers of attention capacity [6,10-12]. The main objectives is to assess the validity of eye-tracking markers during a VR-based free- viewing exploration task (Fig.1) for assessment of alertness and spatial attention deficits in brain-lesioned patients and to analyse the evolution of both behavioural and eye-tracking components by means of a novel battery of VR-based short tests (Fig.2, MindFocus, MindMaze SA) during the course of a rehabilitation program, and compare them to the standard Test of Attentional Performance (TAP). We collected data from a group of 20 acquired brain-injured patients with attentional deficits. The group underwent a VR-based rehabilitation protocol consisting of 4-5 weekly 45-min training sessions over 4 weeks, in addition to standard of care. Patients performed TAP and VR-based tests at baseline and after completing the rehabilitation protocol. Multiple eye-tracking parameters, including total fixation duration, fixation stability, mean blink duration correlated significatively with the clinical diagnosis as well as with the standardised attentional tests. In conclusion, eye tracking during free-viewing and VR-based short tests can be as effective as time-consuming standardised batteries in assessing alertness and spatial attentional deficits in brain-injured patients.

Fig 1. free-viewing VR-based task

Fig 2. Short VR-based spatial-selective attention task

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Session A | Poster 7: Thomas Chazelle

Integration of visual and verbal cues in judgments of body size

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This preregistered study investigates how weight labels influence perceptual judgments of others' body size. Is the information provided by labels integrated optimally with sensory cues, similar to multisensory integration? In a two-alternative forced choice procedure, participants judge the body size of targets described by either a verbal cue (a weight label, e.g., "thin"), a visual cue (i.e., a clear or blurred picture of a body), or both types of cues combined and providing conflicting information. We use the participants' responses in single-cue trials (verbal or visual cue) to predict the behavior of a Bayes-optimal agent in multi-cue trials (verbal and visual cues). Alternatively, verbal cues could be neglected in the presence of visual cues, reflecting visual dominance. These predictions are then compared to the actual performance of the participants (n = 10). If they integrate both cues optimally, participants' estimates in multi-cue trials should be more reliable than those in single-cue trials. They should also be closer to the verbal cue, the noisier the visual cue. Finally, we hypothesize that the effect of weight labels should be greater for participants with higher suggestibility, reflecting higher weighing of social information. Preliminary results from pilot participants are leaning in favor of an visual dominance model, relativizing the extent of social influence on the perception of body size.

Session A | Poster 8: Stefania Cionca

Effects of Clothing Tightness on Body Image and Food Choice

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Despite the popularity of shapewear, especially among women, quantitative research that systematically and rigorously examines their effects on our body and behavior is lacking. Wearing such clothing that changes one's body shape provides a constant external tactile cue, signaling cognitive or behavioral adjustment via interoceptive channels. The sensation of tightness around the stomach can enhance interoception (Boswell et al., 2019). Moreover, clothing type, such as formal or informal attire, can influence food choices (Wang et al., 2021). To be understand this, in our pre-registered study (osf.io/5suaf), we aim to investigate the effects of wearing tight shapewear on body image and decision- making related to nutrition, employing an experimental within-subject design. Forty-five healthy adult participants, aged 18 to 45 years, with a normal body mass index (BMI) range of 20-25, were recruited for this study. They each attended two laboratory visits, during which they wore either tight shapewear or a loose shirt for a duration of four hours, employing a counter-balanced design. While wearing this, they completed tasks and questionnaires. Food choice was assessed through a task measuring hedonic ratings of high- and low-calorie foods, as well as willingness to pay. Body image was evaluated using metric body size estimation and a questionnaire. Additionally, interoception, risk-taking, and eating behaviors were assessed. Results on the impact of shapewear on body image and food choice will be discussed. Our study contributes to the existing body of knowledge on the complex relationship between bodily sensations, body image, and decision-making in nutrition.

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Session A | Poster 9: Dorothy Cowie

Neural and behavioural adaptations in children with limb differences

Laura-Ashleigh Bird [1,2], Dr. Raffaele Tucciarelli [2], Prof. Tamar Makin [2] & Dr. Dorothy Cowie [1]

[1] Durham University
[2] Cambridge University

In the UK, around 500 children per year are born with congenital upper limb differences, where part or all of a hand is missing. These children must develop special motor strategies and skills to achieve everyday tasks. This study asks which body parts these children use for everyday object manipulation, and how this is reflected in their developing brains. Behavioural data: We gave 70 one-handed children and 35 two-handed children (3-9 years) a battery of tasks including opening containers and separating Lego bricks. While two-handed children completed these tasks bimanually, children with limb differences used a variety of alternative effectors including the mouth, legs, and torso (often together). Use of the residual limb was consistently high (78% of task time), followed by legs & feet (43%), torso (20%), and mouth (2%). In the preschool period (3-5 years), decreasing foot use correlated with increasing use of the residual arm and torso. Neuroimaging data: With a subset of 20 one-handed and 20 two-handed children we used soft-pressure actuators to deliver a series of rapid flutter sensations to locations on the skin. We observed responses to the stimulated body parts within contralateral primary somatosensory cortex. Crucially, we found that stimulation on the residual arm produced activation within the 'missing hand area', suggesting remapping of body parts into this area. Overall, limb different children adapt their behaviour to fit their body. We will relate neuroimaging and behavioural data to determine how behaviour may scaffold neural differences; and the age at which neural adaptations occur.

Session A | Poster 10: Anna Crossland

Development of a scale for prenatal interoception

Crossland, A.[1] and Preston, C.[1]

[1] University of York

During pregnancy, women experience new internal signals (e.g. pregnancy specific pain) over and above the signals experienced by the general population like hunger and thirst; collectively referred to as interoception. During pregnancy it is important for women to interact with their body by recognising and interpreting interoceptive signals, for monitoring both fetal and maternal wellbeing. It is also important for researchers and health professionals to understand how interoception is experienced and interpreted during pregnancy, due to implications of these sensations for perinatal mental health. However, current interoception measures are not validated for pregnancy. We present data from a mixed methods scale development project assessing the specific interoceptive experience during pregnancy. First, we adapted an established scale, the Multidimensional Assessment of Interoceptive Awareness (MAIA; Mehling et al., 2012), for use with pregnant samples using exploratory and confirmatory factor analyses (total N= 716). Although some constructs remained stable in pregnancy (trust), others were lost (e.g. noticing, not distracting). Next, thematic analysis of online focus groups (N=32) in conjunction with quantitative survey data (N=80), suggested that recognition, interpretation and responses to bodily signals change during pregnancy. This integrated data, together with theoretical constructs and existing measures, were used to develop initial scale items that were assessed for suitability and accessibility by perinatal participants and midwives using the Thinking Aloud Approach (N = 15). These findings resulted in development of a preliminary multi-dimensional scale to measure interoception in pregnancy, assessing recognition and attribution of bodily sensations as well as reactions and responses to them.

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Session A | Poster 11: **Rosie Drysdale**

Preliminary evidence for age-related changes in cardiac interoception from 13 to 21 months of age

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Research with adults shows that cardiac interoception is implicated in a range of cognitive and affective processes, including emotion processing (Critchley & Garfinkel, 2017), adaptive decision-making (Dunn et al., 2010) and behavioural inhibition (Rae et al., 2020). Despite this, empirical research on the development of interoception in infancy is lacking. Using a sequential looking paradigm, Maister et al., (2017) found that 5-month-olds could discriminate auditory-visual stimuli moving in or out synchrony with their heartbeats. This suggests that at least some infants show implicit accuracy in perceiving cardiac signals, however, there is considerable variation in infants' performance and the capacity is likely to change throughout development. The present longitudinal study investigated the development of cardiac interoception and assessed whether individual differences related to variation in temperament, caregiver-infant interactional qualities and mirror self-recognition. We followed 58 infants and their caregivers at 13- and 21 months of age. Participants completed the cardiac discrimination task at both visits. At T1, we also assessed bio-behavioural synchrony between infants and their parents. At T2, we obtained parent-reported child temperament and toddler's performance on the mirror self-recognition task. Contrary to Maister et al.'s (2017) finding with 5-month-olds, preliminary analyses found no significant preference overall for synchronous or asynchronous stimuli at 13- or 21- months old, however, on average, infants showed significantly greater visual discrimination between synchronous and asynchronous cardiac stimuli at 13-, compared to 21-months old. If confirmed, these results suggest age-related changes in cardiac interoception. Data on temperament and mirror-self recognition will also be presented.

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Session A | Poster 12: **Adam Enmalm**

Body perception and social touch preferences during times of grief

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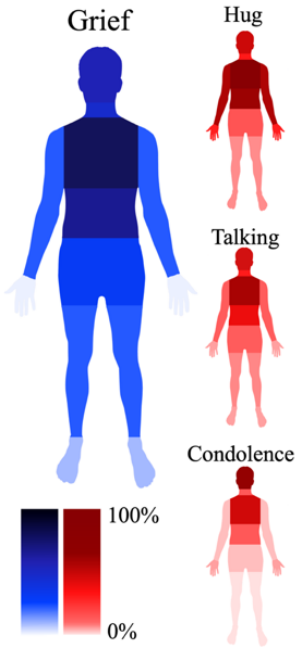
Grief is a core human experience. The time following the loss of a loved one is associated with an increased risk for negative health outcomes. Yet, only a few studies investigate bodily consequences of grief and consoling behaviors, specifically the potentially supportive role of interpersonal touch during grief. We conducted an online-study where participants were assigned into a recent-loss group (defined as losing a loved one within the last two years) or a no-recent-loss group. Participants filled in questionnaires and rated videos of short touch gestures and interactions. Overall, the groups rated the vicarious touch gestures similarly, with the recent-loss group endorsing touch more and considering it more consoling. However, discrepancies between groups were found for some types of touch, including slow affective stroking. The majority of people in the recent-loss sample reported that they perceived their own body and their bodily states less in the first six months following their loss. Two-thirds of these participants also reported feeling the presence of the deceased at least once, with more than half reporting several times. Grief-sensations were experienced mostly in the chest and upper body, the same areas where the consoling effect of a hug was perceived. These results contribute to a deeper understanding of the role that the body and bodily interactions like social touch play in grieving and consolation. Our findings can be seen as a first point of reference on how to interact with grieving individuals and could contribute to novel interventions for individuals with prolonged grief disorder.



Session A | Poster 13: Kirralise J. Hansford

The Addition of Non-Naturalistic Auditory Input During Resizing Illusions

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Background: Bodily resizing illusions typically use visual and/or tactile inputs to produce a vivid experience of one's body changing size. Naturalistic auditory input (input that reflects the natural sounds of a stimulus) has also been used and can increase illusory experience during the rubber hand illusion, whilst non-naturalistic auditory input can influence estimations of finger length.
Aims: To utilise non-naturalistic auditory input during a hand-based resizing illusions using augmented reality, to assess whether the addition of auditory input would increase both subjective and objective experience of hand-based resizing illusions.
Methods: 44 Participants underwent three conditions: no stretching, stretching without tactile feedback, and stretching with tactile feedback. Half of the participants had auditory input throughout conditions, whilst the other half did not. After each condition, participants were given one of three objective tasks: right-hand (stimulated) dot touch task, left-hand (non-stimulated) dot touch task and a ruler judgement task. Dot tasks involved participants touching a virtual dot, whereas the ruler task concerned estimations of the tip of their finger on a ruler, whilst the hand was hidden from view. Finally, participants completed a subjective questionnaire capturing illusion strength.
Results: The addition of auditory input increased subjective experience of the stretching illusion for manipulations without tactile feedback but not for those with tactile feedback. No facilitatory effects of audio were found for objective data.
Conclusions: Adding auditory input to illusory finger stretching increased subjective illusory experience without the need for tactile feedback, but did not affect objective measures of illusory experience.

Representation of body height affects how big you see the world

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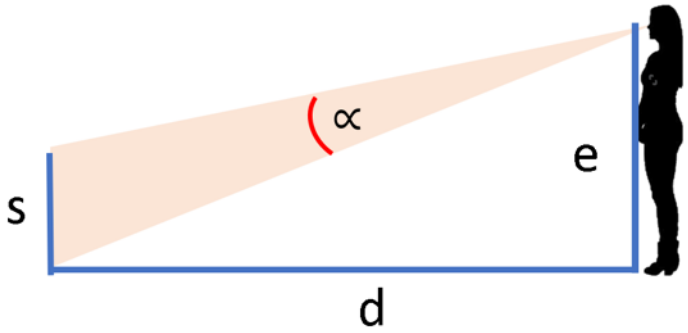
Eye height changes during the body's interaction with the world. When immersed in a virtual world (such as when watching TV or wearing a VR headset), one is subject to two simultaneous eye heights – the simulated one and the real-world one. Might they interact? Using virtual reality, 40 participants compared the size of a rectangle simulated at different distances with the length of a physical stick held in their hands with all combinations of three simulated eye heights in VR and three physical eye heights in the real world (sitting ~125cm, standing ~1650cm, and standing elevated on a table ~215cm). Simulated eye height affected perceived size. But physical eye height above the ground also had an effect: size was overestimated when standing on the floor relative to sitting and to standing on the table. There was an interaction between simulated and physical eye heights: people were more influenced by changes in simulated eye height depending on their external eye height! Here we have demonstrated for the first time an interaction between what happens in virtual reality and people's representation of their body's physical position in the real world. When the body interacts with the world it changes one's perception of its size.



Session A | Poster 15: Genaro Lopez-Martin

Integration of Bodily Signals in the Plasticity of Self-Representation

Lopez-Martin, G. [1], Gaebler M. [2], Rossello, A. [1], Suarez, J. [1], Rossello, J. [1], Kilner, J.M. [3] & Galvez-Pol, A [1]

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Our research explores the convergence of interoception and self-referential processing. We specifically investigated how interactions between our physical bodies and self-referential processing emerge from the integration of internal bodily signals and external stimuli. We used an active sensing paradigm (see Galvez-Pol et al., 2020, 2022) in which participants triggered the appearance of personality traits for 200ms. Then, they rated their level of identification with the traits using a visual analogue scale (VAS). We concurrently collected ECG recordings and alexithymia scores. Based on past research in multisensory integration during the Rubber Hand Illusion and its cardiac Virtual Reality analogue (Tsakiris, 2010; Suzuki et al., 2013), we posited that participants would identify themselves more strongly with traits prompted during the systolic phase of their heartbeat. This would suggest that external stimuli might be integrated into our self-perception when aligned with internal bodily changes (i.e., heartbeats). Data from 45 participants indicated that individuals with elevated scores on the externally oriented thinking subscale of alexithymia—which denotes a focus on external events over internal experiences—were more likely to identify with personality traits presented during the systole phase. This pattern implies an external and interoceptive influence on self-identification. Furthermore, traits displayed during systole were accompanied by faster responses on the VAS scale, suggesting a potential facilitation by interoceptive processes. These findings illuminate the significant role of interoception in self-referential processing, underlining the intricate relationship between active sensing of external stimuli, internal bodily signals, and the plasticity of the self.

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Session A | Poster 16: Marta Matamala-Gomez

Characterization of EEG neural markers in the sensorimotor cortex when using movement sonification for walking ability

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Frequency tagging measures a periodic change in voltage amplitude in the electrical activity recorded on the human scalp by using EEG when presenting stimuli repeated at a fixed rate [1]. Regarding auditory stimulation, some studies show a tonic synchronization response when using periodic auditory stimulation set at 2Hz[2]. Further, others found brain responses associated with biological motion perception by showing a point-light walker video moving at a pace of 2.4Hz[3]. Movement sonification implies the mapping of movement signals into sound, providing auditory feedback to update internal motor forward models, that can be used for motor rehabilitation[4]. To date, none have investigated frequency tagging responses related to movement sonification techniques for motor rehabilitation. **Aim:** To investigate which frequency rate, from 1 to 5Hz, generates a peak of neural responses when using movement sonification for walking rehabilitation using both auditory and visual stimuli related to walking movement displayed at the same frequency. **Methods:** 25 healthy participants were allocated to this study. The study was composed of six different conditions presented at different frequencies: Slow freq. (1 Hz), Normal freq. (2 Hz), Fast freq. (3.5 Hz); (a) audio stimuli: normal footstep sound vs. random footsteps sound, (b) Video stimuli: normal walking movement vs. random walking movements, (c) Audio + visual stimuli: normal walking movement + normal footsteps sound vs. random walking movement + random footsteps sound. Each condition will be repeated four times in a randomized order. **Results:** We expect higher frequency tagging responses with the audio-visual stimuli set at 2 Hz.

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Session A | Poster 17: Lydia Munns

The effects of pregnancy bodily experience on mother-infant outcomes

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Background: Antenatal attachment (AA) is linked to positive outcomes, like healthier pregnancy behaviours, stronger postnatal attachment, and reduced depression risk. Our bodily experience, including appearance satisfaction and interpretation of internal signals (interoceptive sensibility), intuitively connects to AA. Mixed results in the literature suggest complex relationships, necessitating a broader investigation approach.
Aims and objectives: We aim to examine the effects of pregnancy bodily experience (body satisfaction and interoceptive sensibility) on multiple mother-infant outcomes, including AA. It is hypothesised that poor body satisfaction and interoceptive sensibility during pregnancy will have negative impacts on these outcomes.
Methods: This project used cross-sectional data from a larger longitudinal study of 253 pregnant mothers (mean age=32), on levels of body satisfaction, interoceptive sensibility, AA, mood, and attitudes on parental ambivalence and touch.
Linear regressions and a network analysis were used to assess our hypotheses, the latter allowing for a more exploratory approach to understanding the importance of the bodily experience during pregnancy.
Results: Multiple regressions found low body satisfaction predicts higher levels of anxiety, depression, interoceptive sensibility and AA. A network analysis revealed relationships between body satisfaction during pregnancy and mother-infant outcomes, including depression and AA.
Conclusions: Our results suggest that an interplay between feelings towards internal and external bodily cues are important for maternal wellbeing as well as AA. Enhancing our understanding of how the pregnancy bodily experience impacts maternal wellbeing may help identify those at risk from negative outcomes as well as informing potential interventions.

Session A | Poster 18: Sarah Cooney

Investigating aspects of Interoceptive Sensibility, body shame and body surveillance in female groups of high and low negative body image: A Network Comparison Study

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Interoceptive sensibility (IS) (i.e. the metacognitive awareness of our internal states) has been linked to aspects of negative body image in individuals with negative body image (NBI) (e.g. in eating disorders) (Badoud and Tsakiris, 2017). However, high levels of NBI are prevalent in the general population, making it an important risk factor for eating disorder development. Therefore, this study investigates the organization of interoceptive sensibility and body objectification constructs (specifically, body shame and self-surveillance) within two networks of non-clinical female participants: one with high NBI (HNBI) (N=348), and another with low NBI (LBNI) (N=354). Data was collected online. Interoceptive sensibility nodes were taken from the sub-scales of the MAIA-2 (Mehling et al, 2018). Body shame and surveillance nodes were taken from the OBCS questionnaire (McKinley & Hyde,1996). Network analysis allows for the visual depiction of connections among various constructs. Data analysis was conducted on R and regularized network models were created using the *bootnet* package. The *NetworkComparisonTool* was then used to compare and detect structural differences between the two networks. Results indicated that "Listening" (Strength: 1.12) was the strongest central node in the HNBI group whilst "emotional awareness" (Strength: 1.09) was the strongest node in the LNBI group. Significant differences also emerged in global network structure (p=0.026) but not global edge strength (p=0.10). Overall, results indicate that the organization and interplay of aspects of IS, body shame and body surveillance differ depending on level of body shape concern, indicating important areas of intervention in individuals with high NBI.

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Session A | Poster 19: Sergio Navas-León

Exploring multisensory integration of non-naturalistic sounds on body perception in young females with eating disorders symptomatology

Navas-León, S. [1], Tajadura-Jiménez, A. [2,3], Morales, L. [1], Sánchez-Martín, M. [1], Crucianelli, L. [4], Bianchi-Berthouze, N. [3] & Borda-Más, M. [5]

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Individuals with subthreshold symptoms of Eating Disorders (ED) present problems in integrating auditory signals related to body weight into their body. However, it remains unclear whether these impairments are specific to auditory bodily signals or if they extend to other auditory signals. Here we investigated the "auditory Pinocchio illusion," which involves changes in the perception of finger length when a rising pitch is paired with a pulling action. Our sample consisted of 63 young females, who were pre-screened for ED symptoms using the Eating Disorder Examination Questionnaire. During the experiments, participants pulled their index fingertip (Experiment 1) or the sides of their waist (Experiment 2) while hearing rising, falling, or constant pitches. We analyzed the strength of both illusions by examining estimations of body part position/size and questionnaires. Participants perceived their finger longer while hearing a rising pitch, whereas the finger felt shorter in the descending pitch conditions. Furthermore, greater ED symptomatology was associated with sensations of elongation, shortening, and rising. In the waist illusion, participants reported feeling their waist wider in ascending pitches and narrower with descending pitches. For the finger illusion, participants with higher ED symptomatology exhibited an enhanced illusion but not for the waist. These results partially support the hypothesis of a stronger influence of external sensory signals in this population and suggest that the experience of the illusion is not linked to the nature of the auditory signals, but to the emotional salience of the body part.

Session A | Poster 20: **Ryu Ohata**

Bodily illusion enhances subjective fear of margin-of-safety invasions around the self

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All living organisms must flexibly change their defensive behaviors according to the distance between one's body and potential threats (Fanselow and Lester, 1988). This indicates that the brain represents threat locations relative to one's body and exhibits corresponding emotional responses. Previous fear research in humans has investigated fear elicited by proximal threats, simulating the distance between threats and the body within a task environment. However, the fundamental question of how humans perceive threats in close proximity to one's body is not fully understood. The present study employed the full-body ownership illusion to characterize the functional role of the sense of bodily self in the interplay between experienced fear and threat proximity (Petkova and Ehrsson, 2008). We presented threatening or emotionally neutral stimuli (realistic 3D animations of a spider or a butterfly) while manipulating participants' sense of bodily self. The stimuli appeared at different locations vertically aligned with a mannequin's abdomen. We found that subjective fear of threat stimuli was more sensitive to their locations relative to the mannequin when participants experienced illusory ownership over the mannequin (Figure). Our findings also revealed that the body ownership illusion heightened subjective fear regardless of stimulus location. Furthermore, there was a significant correlation between participants' ratings of illusion strength and the levels of their reported fear. These results suggest two aspects of how the sense of bodily self influences human fear experiences: enhancing sensitivity to margin-of-safety violations and amplifying anxiety in response to threat appearance.

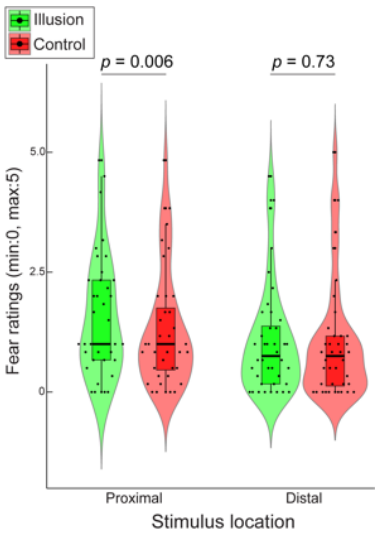

Figure. Subjective fear results. The fear ratings of proximal threat stimuli were higher in the illusion condition than in the control condition ($Z = 2.75$, $p = 0.006$), while there was no significant difference in the ratings of the distal stimuli between the two conditions ($Z = 0.37$, $p = 0.73$). In each box plot inside the violin plots, the central horizontal line indicates the median, and the bottom and top edges of the box correspond to the 25th and 75th percentiles, respectively. The whiskers of each box plot extend 1.5 times the interquartile range from each hinge. Each dot represents one participant.

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Session A | Poster 21: Paula C. Salamone

Feeling yourself when your self is altered, a study in Schizophrenia

Salamone, P.C.[1], Enmalm, A.[1], Kaldewaij, R.[1], Medley, C. [1], Johansson-Capusan, A.[1,2], Olausson, H.[1,3] & Böhme, R.[1]

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The current criteria and diagnosis of psychiatric conditions is based on symptoms rather than biological mechanisms. Science is trying to move forward towards a mechanism-based classification, which would likely improve patient care and treatment. It has been suggested that people with schizophrenia (SZ) may have altered interoceptive mechanisms and self-other distinction. In order to assess these mechanisms in SZ we designed a study including behavioral, electrophysiological and neuroimaging tasks. An easy way to study bodily self-perception is to compare self-touch with touch from others: both provide comparable stimulation of the skin, but the brain must be able to distinguish between the two types of touch. Interoception is tested using a heartbeat detection task (with EEG) and questionnaires. Preliminary results (questionnaires, behavioral and electrophysiological) show some alterations in self and interoception domains with respect to neurotypical volunteers. A disturbance of these processes can have far-reaching consequences for the establishment of an adequate bodily self-perception which may lead also to alterations in allostasis and in higher order cognitive domains. This study may increase our understanding of self-perception and body awareness in SZ. In the long run, the results may enable the development of new treatment strategies.

Session A | Poster 22: **Federica Scarpina**

Disgust processing in Anorexia Nervosa: effects on body representation

Scarpina, F. [1,2], Vaioli, G. [2], Bastoni, I. [2], Villa, V. [2], Brusa, F. [2], Mendolicchio, L. [2], Mauro, A. [1,2], Sedda, A. [3,4]

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When somehing disgusting is near our body, our reaction is to put some distance between us and the disgusting thing. In anorexia nervosa (AN), evidence about reactions to disgust is rare, and mostly focused on food. However, disgust drivers vary, including *body-related self-disgust*, which may be more central in AN. Here, we assessed if disgust triggers affect body representation in AN. Women with AN and controls participated in our experiment, which consisted of a traditional Hand Laterality Task, and two emotionally-charged versions with pictures showing hands partially covered by faeces (body product driver of disgust) and with the index finger amputated (body violation driver). Performance was scored in terms of accuracy and reaction time for the effect of biomechanical constraints. We also measured the level of disgust sensitivity through a self-report questionnaire. Participants with AN are overall less accurate and slower compared with controls. Both groups were faster and more accurate in recognizing disgust-driving rather than traditional stimuli. No interaction between group and effects of biomechanical constraints, which would have suggested a specific effect of disgust drivers on body representation in AN, was observed. At the questionnaire, participants with AN reported significantly higher sensitivity to disgust triggers. Participants with AN may be sensitive to disgust body-related triggers as controls when experimentally tested, despite a higher sensitivity to disgust at questionnaire. Rather than disgust being processed differently, its role the pathology of AN may depend on the level of processing required, and on how much awareness the process involved requires.

Session A | Poster 23: Oscar J. Sill

"My hands are my feet, but it's still my body!" Children's developing own-body representations in virtual reality

Sill, O. J. [1], Thurlbeck, S. [1], Kentridge, R. [1,2], & Cowie, D. [1].

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How do children build coherent, interactive understandings of their body's constantly changing aesthetic and structural features? To answer this question, my project presents children (n=40, 5-10 years) with four motion-tracked virtual reality bodies with varying appearances, including non-human spatial and material distortions. These immersive virtual experiences can reliably elicit strong senses of ownership over virtual bodies that sufficiently match one's core own-body representations. My project also investigates the spatial components of children's body representations with an adapted "Body Image Task" (BIT)[1,2], using 3D motion capture measurement. Initial data indicates that children have distinct developmental trajectories for ownership over different virtual bodies. Specifically, the most and least distorted (cloud & human) bodies consistently elicit the lowest and highest ownership ratings (respectively) across all ages. This gap steadily widens by 10 years old. Interestingly, the spatially and materially distorted bodies show more nuanced development, eliciting similar medium ownership ratings in younger children before separating by 10 years to reflect higher ownership over the material body. These results indicate that children have a foundational sense of the extreme limits of their whole-body form from a young age; but consolidate more nuanced understandings regarding the body's structure and material features in distinct trajectories from 5-10 years.
Initial data from our BIT indicates clear distortions in body structural mapping across childhood, and the relation between these distortions and body ownership will be further explored at each age. This project has implications for the wider literature and applications including children's VR education and healthcare.

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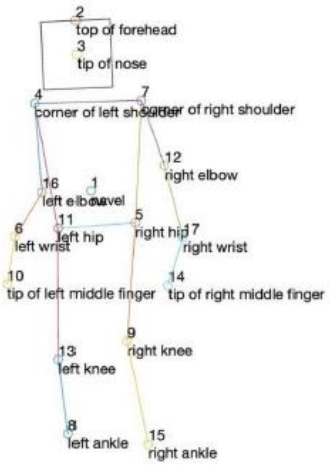
(a)



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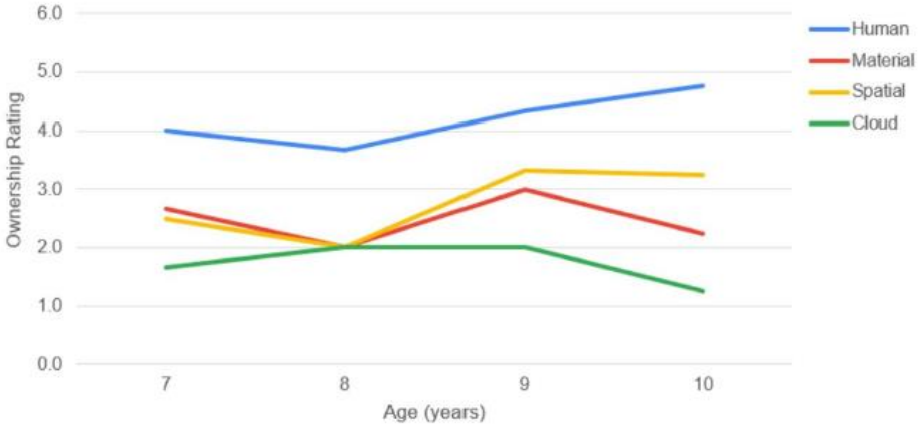

(c)

Figure 1. Experimental overview. Figure (a) shows the four virtual avatars and virtual scene. The gender and height of the virtual avatars were matched to each participant. From top-left to bottom-right, the four virtual avatars are Human, Spatial, Material, and Cloud; (b) shows a first example of a child's own-body structural map produced by the BIT, with all 17 body locations numbered and labelled; (c) shows initial ownership ratings for children (N=18, 7-10 years), split by virtual body type. 5- and 6-year-olds were excluded from this initial plot due to low N.

Session A | Poster 24: **Irene Valori**

Touch from a distance: virtual reality and wearable technologies for interpersonal virtual touch

Valori, I. [1,2], Fan, Y. [3,6], Hanisch, S. [2,5], Kirchner, R. [1,6], Papp, E. [3,6], Pogrzeba, L. [4,6], Altinsoy, E. [1,2], Krzywinski, J. [3,6], Li, S-C. [2,4,6], Strufe T. [2,5,6], Fairhurst, MT. [1,2,6]

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Interpersonal touch is one of the most personal ways that we connect with others; it has the power to define and modulate self-other representations and to shape interpersonal relationships (1). This strong social bridge is often lacking in telecommunication, which is primarily audio-visual. Despite immersive virtual reality offering possibilities to overcome physical distance and create an illusion of co-presence, the inclusion of affective touch in these digital multisensory environments is still a challenge (2). Here we present the design of a system that exploits several wearable technologies developed for applications in Tactile Internet (3,4) to bring interpersonal touch into interactive virtual exchanges, where touch is a dual-person experience of touching and being touched. It uniquely combines a motion capture suit to track the toucher's movements with a vibrotactile armband actuator to provide online tactile stimulation to the touchee. We discuss research perspectives for measuring subjective evaluation (of realness, pleasantness, perceived interpersonal connectedness, trust), neurophysiological correlates of, and behavioural effects on affective communication and interpersonal synchrony. Technical challenges are discussed to make this set-up truly multisensory, interpersonal, and interactive to serve as a research tool for studying the power of interpersonal touch. That would ultimately pave the way for the implementation of use cases for the promotion of individuals' bio-psycho-social well-being.

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Session A | Poster 25: Wen Wen

Is It Me or Is It You? Disassociated Agency and Ownership in a Face and Action Mixing Paradigm

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The ability to recognize one's own face holds a special place in our brain and is closely linked to the development of self-awareness. Previous studies have demonstrated that self-face recognition can be influenced by discrepancies in visuotactile synchronization. However, no studies to date have investigated the interplay between visual features of the self-face and the sense of agency associated with it. In the present study, we devised a novel paradigm that blends participants' facial and head motion with the motion of others in real-time, utilizing cutting-edge techniques (Figure 1). During the experiment, participants observe their own face on the screen, but the control they have over the face is combined with the motion of another participant. Remarkably, participants still experience a sense of ownership over the displayed self-face, but their sense of agency diminishes as the proportion of self-motion decreases. Conversely, when participants view another person's face on the screen, they do not feel a sense of ownership over the face stimulus, yet they are able to manipulate its motion. We propose that the initial identification of the face plays a crucial role in shaping the prior belief of agency, potentially resulting in a rapid decline in the sense of agency over the self-face when the proportion of control decreases slightly, and a gradual acquisition of a sense of agency over another person's face as the proportion of control progressively increases. The present study is currently underway, and we anticipate presenting the complete results in September.

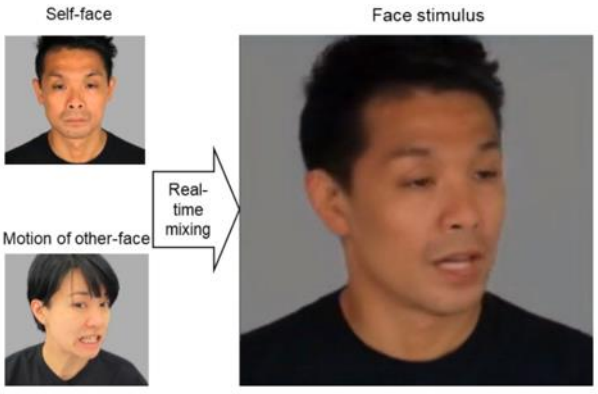

Figure 1. Example of the face stimulus.

Session A | Poster 26: Mateusz Wozniak

Identifying with an avatar face changes mental representation of one's real face

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Cognitive processing of images of one's face is to great degree special: they attract attention and people are faster and more accurate to detect and recognize them. Moreover, recent studies found that similar effects can be observed also for images of unknown faces that have been associated with the self, i.e. for avatar faces. What remains unexplored is whether, and if yes then to what extent, identifying with an avatar face changes mental representations of one's real face. In order to investigate this issue we conducted three experiments in which we presented participants with images of morphs between their real faces, self-associated unfamiliar faces (avatar faces), and stranger-associated unfamiliar faces. The participants' task was to judge to which of these identities each presented morph was most similar. Based on these responses we calculated the points of subjective equivalence (PSE) between each face. We discovered that when participants did the task in which they identified with an avatar face (a) the PSE between their real face and an avatar-face was shifted towards the real face, and (b) the PSE between their real face and a stranger-face was shifted towards the stranger-face. These results suggest that identifying with an avatar face changes the mental representation of one's real face making it less similar to the avatar-face and more similar to the stranger-face.

Session A | Poster 27: **Andrea Zaccaro**

Exploring the dynamic interplay between cardiac interoception, focus of attention, and respiration

Zaccaro, A. [1], Della Penna, F. [2], Mussini, E. [2], Parrotta, E. [2], Perrucci, M.G. [2,3], Costantini, M. [1,3], & Ferri, F. [2,3]

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The Heartbeat-Evoked Potential (HEP) is an EEG voltage fluctuation that reflects the cortical processing of cardiac signals. The predictive coding model of interoceptive perception posits that HEPs represent a precision-weighting process of prediction errors related to heartbeat sensations. Recent studies have found that HEP amplitude and cardiac interoceptive accuracy are higher during exhalation compared to inhalation, possibly since cardiac-related sensations of heartbeats occurring during inhalation are suppressed, while those occurring during exhalation are amplified by attention. To explore the dynamic interactions between cardiac interoception, focus of attention, and respiration, we developed a new experimental paradigm. We assessed HEP activity in 34 volunteers (28 ± 4 years) during four tasks involving either interoceptive or exteroceptive attention, and focused on either the cardiac or the respiratory system. The Heartbeat Counting Task (HCT) and the Breath Counting Task (BCT) were the interoceptive tasks, while the Cardiac-Tone Counting Task (C-TCT) and the Breath-Tone Counting Task were the exteroceptive tasks (B-TCT).Results showed that the HCT induced significant HEP increases compared to both the C-TCT and the BCT over frontal-central electrodes in a late HEP time-window. Crucially, observed HEP amplitude increases during the HCT compared to both the C-TCT and the BCT were driven by HEPs recorded during the exhalation phase of respiration, with minimal contributions from HEPs recorded during inhalation. These findings showed that HEP amplitude reflects a precision-weighting process of prediction errors specifically modulated by attention directed towards cardiac sensations, and that the exhalation phase of respiration enables this precision-weighting process.

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Session A | Poster 28: H. Chris Dijkerman

Touch time: The effect of finger size distortions on tactile temporal-order judgments

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Previous studies have shown that visual distortions of a body part can affect spatial tactile judgements. For example, visually enlarging the arm results in an enhanced spatial discrimination ability (1). Others have proposed that spatial and temporal processing is highly related (2). This may also be the case for tactile perception, which is inherently a spatiotemporal modality. In the current study we therefore tested whether visual length illusions of the hand, while the tactile distance remains the same, influence temporal judgements of touches on that hand. 48 participants performed a tactile temporal order judgement task, while viewing their hand in a mediated reality set-up (MIRAGE) under two different conditions: while experiencing a finger stretch illusion (3), or with an undistorted view of the hand. 10 different stimulus onset asynchronies ranging from -200 to 200 ms were used. We fitted a psychometric curve for each participant and condition and extracted the slope at the inflection point, a measure of the discriminability of the stimuli. The results showed that when the index finger appeared to be longer, the slope was significantly steeper, suggesting that participants were better able to determine the temporal order of the tactile stimuli. This finding shows that a visual illusion of finger size, and thus body perception, influences temporal tactile processing and suggests that time perception and body size perception are linked.

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Session A | Poster 29: Natalie C. Bowling

Where do we like to be touched? Body maps of interpersonal touch preference vary according to extraversion and attachment style.

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Touch plays a fundamental role in our daily lives. Interpersonal touch can be beneficial for mental and physical health, social communication, and strengthening social bonds. However, perceptions of touch vary between individuals and contexts, meaning touch is not always welcome. The present research examined body maps of interpersonal touch preferences, and the individual difference factors that contribute to them. The study comprised a large (*N* = 11,525) UK healthy adult sample. Participants were asked to indicate on a 2D image of a human body (front and back) where they like and dislike being touched, when in a public place. The body map task was repeated for a) touch from a partner or close friend, and b) touch from a stranger. Interpersonal touch was broadly liked on some body regions, including the hands and arms. Preferences for touch on other parts of the body, including the legs and back, depended on the relationship with the toucher**.** Trait extraversion predicted touch preferences from both partners and strangers, while attachment style (avoidance and anxiety) was also an important predictor for partner touch. The results highlight the importance of context and individual differences in shaping subjective experiences of bodily touch.

Session A | Poster 30: Albert H. Van der Veer

Individual perspectives on interoception display methods

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In two online surveys, participants were asked about: (1) their perceptual associations with their own and other person's heartbeats and breathing within different modalities (visual, auditory, tactile, and visceral), and (2) the acceptability of, their affective responses to, and the perceived usefulness of externalised interoceptive signals in various social interactions in mixed reality settings (including virtual reality, video calls, and physical augmentation).
Preliminary data show that participants can imagine and report on scenarios where interoceptive signals are externalised. Survey one specifically suggests differences in the modalities associated most with interoceptive signals for self (more tactile and visceral) vs other (more visual). Survey two shows large individual differences for most measures of affect and usefulness related to externalised interoceptive signals (often large spreads and moderate means), for most social and mixed reality settings participants imagined. More specifically, it suggests externalising interoceptive signals may be considered most useful, pleasant, and connection-enhancing in dyads, personal contexts, and physical reality.
These findings will advance understanding of the role of interoception and its externalisation in social interactions and inform the design of future display technologies to compensate for reduced bodily signals in computer-mediated settings, or to enhance (largely) concealed signals in natural settings.

Session A | Poster 31: Maria R. Pasciucco

Weighting the Contributions of Interoceptive and Exteroceptive Body Representations to Schizotypy

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Schizophrenia spectrum disorders often exhibit a lack of self-awareness accompanied by abnormalities in bodily representation. These indicators are linked to the onset of schizophrenic illnesses. Previous research on schizophrenia and schizotypy has identified abnormalities in both exteroceptive and interoceptive representations of the bodily self, but separately. Exteroceptive representations involve the perception and integration of sensory information from outside the body (e.g., visual), while interoceptive representations involve information from inside the body (e.g., cardiac). Building upon this evidence, the aim of this study is to weight the contributions of abnormalities in both exteroceptive and interoceptive body representations to schizotypy, compared to anxiety and depression. We recruited 60 right-handed participants (36 females) to participate in the study. They were asked to complete various tasks and questionnaires that assessed different dimensions of the bodily self, such as body image, peripersonal space, interoceptive accuracy and awareness. Regression analysis reveals that deficient exteroceptive representations of the body alone play a more prominent role in explaining schizotypy compared to anxiety and depression. On the other hand, deficient interoceptive representations have a greater impact on anxiety and depression. Interestingly, the interaction between specific exteroceptive and interoceptive body representations significantly explains schizotypy, surpassing the explanatory power for anxiety and depression. These results provide valuable insights into the role of the body in the impaired sense of self along the schizophrenia continuum. Importantly, they highlight specific aspects of interoceptive and exteroceptive body representations that could serve as targets for early intervention in individuals at risk of developing psychotic disorders.

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Session A | Poster 32: Duangkamol Srismith

The Role of Olfaction in Body Representations within Extended Reality

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We propose that the integration of the sense of olfaction into multimodal experimental paradigms could enhance our theoretical understanding of body representations and embodiment research. Here, we will present results from a systematic review examining the role of olfaction in body representation research conducted within the realm of Extended Reality (XR), which encompasses Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) technologies. The technical feasibility, current limitations, and future directions of olfactory display technologies in XR interfaces are analysed and synthesised. Furthermore, ideas for future empirical studies within this context will be presented and discussed.

Session A | Poster 33:

Changes in metric body representations and hand ownership in healthy older adults.

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The experience of owning a body (body ownership) and the perception of our body dimensions (metric body representation, mBR) depend on multisensory processing occurring during daily interactions[1]. When those interactions are limited, as during normal aging, possible changes in mBR and ownership can occur[2,3,4]. However, to date, the driving factors of the age-related effects on mBR and ownership remain unclear. To address this issue, we compared upper-limb mBR and ownership in healthy older (O) and young (Y) adults by investigating possible underlying components associated with age-related distortions. Specifically, we assessed upper-limb mBR with the body-landmarks localization task[5,6] and we evaluated cognitive (backward and forward digit span), motor (physical activity, grip strength, walking speed), and sensory abilities (tactile acuity and proprioception) in O. Moreover, we quantified implicit hand ownership with a novel task based on visuo-proprioceptive disparity[7] in virtual reality allowing to model the contribution of visual and proprioceptive inputs. Results on mBR show that O significantly underestimate their arm length when compared to Y. Linear regression analysis suggests that this distortion is predicted by lower cognitive (backward-span), sensory (proprioception), and motor (grip strength) abilities. Further, O reported significantly higher ownership towards a virtual limb than Y by relying more on visual than proprioceptive information. The identification of the underlying factors of mBR and ownership will shed light on the still unclear mechanisms determining their plasticity and could pave the way for new interventions targeting cognitive, and sensorimotor components, in field of aging and in pathological conditions.

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POSTERS

SESSION B

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2B	**Amar D'Adamo** (Universidad Carlos III de Madrid, Spain)
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25B	**Niccolò Butti** (Scientific Institute, IRCCS E. Medea, Bosisio Parini, Lecco)
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30B	**Gaia Risso** (Institute of Health, School of Health Sciences, Sion, Switzerland)
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31B	**Justyna Świdrak** (Institute of Biomedical Research August Pi i Sunyer, Barcelona)
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	Somatic rubber hand illusion: the mechanisms underpinning proprioceptive drift in primary school children.
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	The role of somatosensory and ventral premotor cortices in recognising others' bodily interoceptive states: a transcranial magnetic stimulation study

Session B | Poster 1: **Martina Ardizzi**

The construct of the multisensory temporal binding window and its plasticity in obsessive compulsive disorder

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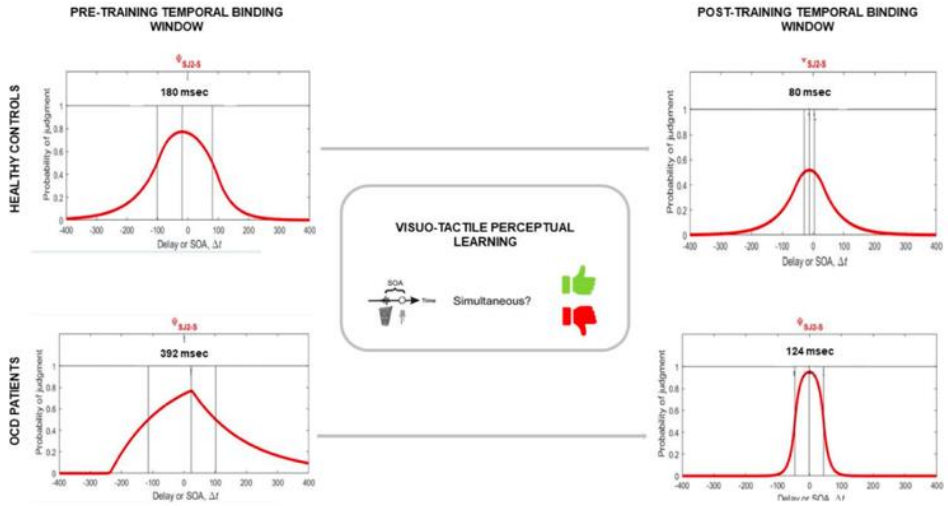
Theoretical instantiations of the free energy principle1, such as predictive processing and active inference, have been recently extended to the development and the maintenance of effective multisensory integration processes used to form a coherent experience of our body and surrounding world2. This insight has given rise to the application of predictive processing models to the study of several psychiatric disorders3, including obsessive compulsive disorder (OCD). In this field, current computational model proposes that OCD is characterized by an abnormally imprecise prediction which needs compulsive incoming sensory data to be corrected4. In the present study, we design an informative task to fit this model measuring OCD patients' (n.30) and healthy controls' (n. 33) visuo-tactile temporal binding window (TBW) plasticity induced by a perceptual learning session. Results showed that, before training, OCD patients had a significantly larger and lopsided TBW than controls fully restored by the subsequent multisensory perceptual learning session (Figure 1). Patients' clinical assessment revealed significant correlations with TWB size and proneness to plasticity. These results promisingly encourage the use of computational models conceiving the experience of our body as a changing and dynamic process in psychopathology.



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Session B | Poster 2: Amar D'Adamo

Exploring the Subjective, Behavioral, and Affective Changes in Body Perception through the Alteration of Footstep Sounds: a focus on Individual differences

Amar D'Adamo [1], Mohammad Mahdi Dehshibi [1], Marte Roel [1], Joaquín R Díaz-Durán [1], Daniel de la Prida [2], Luis Antonio Azpicueta [2], Ángel Sánchez [3,4], Fernando Díaz de María [2], Aleksander Väljamäe [5], Ana Tajadura-Jiménez [1,6]

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Mental representations of the body are influenced by motor efferents and multisensory signals. Modifying the auditory feedback of self-generated walking sounds in real time can result in people perceiving their body as lighter or heavier, as moving slower or faster, it may lead to changes in gender identity and induce variations in happiness levels. Individuals with eating disorders have shown distinct effects on body perception when exposed to acoustic manipulations. In this study, we employed an improved digital sound system together with a motion capture suit and physiological sensors, to further our understanding of subjective, behavioral, and affective changes derived from this illusion. We further investigated the influence of group differences in terms of body concerns and levels of physical activity on the effects of such an illusion. Participants underwent a pre-screening assessment. The selected sample (N=104) answered questionnaires about their body perception and emotional state and completed a body visualization task after each randomized experimental condition. The results successfully replicated previous research, with participants reporting sensations of being heavier or lighter based on the manipulated sounds. The effects on emotional valence differ according to individuals' body concerns, while dominance is influenced by the symptomatology of eating disorders. The experiment is still being analyzed for its effects on behavior, physiology, and the influence of social behavior and sensory imagery. Given the portability and transparency of acoustic transformations, this illusion is particularly relevant for health as it can be integrated in daily life and thus impact participants' habits and health.

Session B | Poster 3: Maren Born

Sensitivity to disgust predicts immune response when exposed to a virtual infection entering the peripersonal space

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After exposure to a pathogen, the immune system should react rapidly. Peripersonal space (PPS) acts as a sensorimotor interface between the body and the environment, serving also a defensive purpose, and therefore potentially anticipates immune responses. Recent research showed that approaching infectious avatars, entering the PPS in virtual reality (VR), modulate innate lymphoid cell (ILC) activation [3]. These immune responses to virtual infection were accompanied by changes in PPS representation. Ontogenetically, disgust develops to avoid threats and therefore prevents contamination, and thus acts as the experiential counterpart of the immune system [2, 4]. Therefore, we hypothesize that the observed ILC activation markers might be related to the individual susceptibility to disgusting stimuli (disgustability). Indeed, we found a significant interaction between the ILC activation markers and the disgustability, measured through the disgust sensitivity questionnaire [1]. Participants with higher susceptibility to disgust elicited higher ILC activation when exposed to neutral avatars. Surprisingly, this correlation was reversed when an infectious threat entered the PPS (Fig. 1), meaning that participants with higher disgust susceptibility showed less ILC activation. Our findings suggest that individuals who are more prone to experiencing disgust have likely encountered fewer pathogens, leading to a weaker immune response. On the other hand, individuals who are less disgustable possess an immune system that is more prepared to react to pathogens. We then analyzed via metabolomics eicosanoids, neuroinflammation, and hormones from blood samples taken after VR exposure and used a neural network to predict the elicited ILC activation [3]. By adding a layer that captures the relationship between disgustability and metabolomics, we simulated the observed pattern of dependence between disgust and immune response. These preliminary findings highlight a complex relationship between high-level personality traits such as disgust, PPS representation, and the signaling cascade triggering an immune response after exposure to virtual infections.

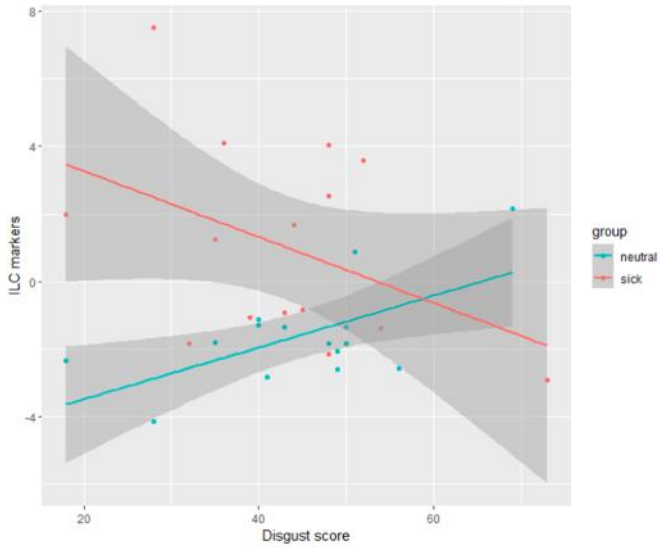

Figure 1: Disgust scores interact with the elicit immune response (ILC markers) when subjects are exposed to neutral and sick faces entering the peripersonal space in virtual reality.

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Session B | Poster 4: Giulia Brizzi

PeriPersonal Space: The Role of Bodily Cognitive and Emotional Factors

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The representation of our body extends beyond its physical boundaries and encompasses the multisensory integration of information from the surrounding area, known as the PeriPersonal Space (PPS), which plays a crucial role in mediating interactions between individuals and their environment (1). While previous studies have examined the plasticity of the PPS using virtual reality techniques - such as Full Body Illusions (FBI) (2) - the contribution of cognitive and emotional factors related to body perception in this process remains relatively unexplored. Therefore, the aims of the present study were (a) to investigate whether the boundary of the PPS could be manipulated through the use of allocentric (i.e., third-person perspective) FBI in a virtual reality (VR) setting, and (b) whether body-related cognitive (i.e., objectification) and emotional (i.e., body satisfaction) factors influence the PPS estimation. To achieve these, participants completed questionnaires assessing their levels of body satisfaction and objectification before engaging in a visuo-tactile task presented in VR to measure the PPS (3,4). Synchronous visuo-tactile stimulation was then employed to induce the FBI, while asynchronous stroking served as a control condition. All participants underwent both types of stimulation and performed the PPS task after each condition. Our findings revealed that the PPS expanded only following synchronous stroking. Furthermore, objectification was found to be associated with a smaller PPS, while body dissatisfaction did not show a significant association with the PPS. Thus, our results suggest that objectification, but not body dissatisfaction, influence the representation of the PPS.

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Session B | Poster 5: Sofia Seinfeld

Virtual body swapping and self-distancing to improve self-assessment in job interview trainings

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Swapping visual perspectives in VR provides a unique means for embodying different virtual bodies and for self-distancing1. Moreover, VR is also a powerful tool for experiential learning and for simulating realistic scenarios, with broad potential to improve the training of soft skills2. However, there is scarce knowledge on how changes in visual perspective and swapping virtual bodies in VR might be used to improve the training of soft skills. In this talk we present preliminary results of a study in which we have investigated how virtual body swapping and visual perspective changes might impact self-assessment in the context of training for a job interview in VR. More specifically, we researched how re-experiencing oneself performance to different questions in a simulated job interview in VR, either from a non-embodied external point-of-view or from a different embodied perspective (i.e., interviewer avatar), impacted trainees' self-assessment of their verbal and non-verbal language. The study also included a control condition where participants did not swap virtual bodies nor had an external perspective, but only answered job interview questions from the perspective of their self-avatar (i.e., interviewee). The results indicate that being able to swap virtual bodies and self-distancing in VR, when training for a job interview, provides further advantages for self-assessing verbal and non-verbal language, when compared to only practicing from the first-person perspective of an interviewee avatar. The present findings advance knowledge on the potential benefits of exploiting virtual body swapping in VR to improve the training of soft skills.

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Session B | Poster 6: Lara Coelho

Beyond Vision: Exploring Haptic Body Representations in Blindness and Sightedness

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Body representations are defined as the mental processes involved in understanding one's own body size and shape. These representations are the product of multisensory integration although is believed that vision plays a key role in the creation of body representations. One previous study argued that when visual experience is limited or absent all together (i.e., in blind individuals), body representations are distorted and do not align with the anatomical characteristics of the body (Kinsbourne & Lempert, 1980). To investigate if this is the case, we presented sighted controls (blindfolded) and blind participants (11 late blind, 3 early blind) with various sized clothing items (gloves, shoes, and belts). Using haptics, participants judged if the various items were bigger than the size of their body part (hand, foot, and waist). We calculated the point of subjective equality (PSE) for each item. PSE refers to the value at which the participant judged the clothing item as being equal to their body part. Our results showed that both sighted and blind individuals had significant PSE biases, both groups overestimated hand and feet size. For the waist however, blind individuals showed accurate estimates while sighted participants showed overestimation of waist size. Overall, our results support an anatomically inaccurate haptic representation of the body. We address the possibility that the somatosensory homunculus influences conscious haptic body representation. Furthermore, we discuss the social pressures (i.e., looking thin and fit) that may influence body representation in sighted individuals.

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Session B | Poster 7: Mohammad M. Dehshibi

From Sound to Sensation: Machine Learning Unravels the Influence of Auditory Cues on Body Representation

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Body representations emerge through the integration of multisensory cues, facilitating interaction with the internal and external world. In this study, we empirically investigate the influence of integrating auditory cues with other multisensory and sensorimotor cues on perceptions of body size/weight. Participants (N=104) wore motion capture suits and wearable sensors while walking six times along a 10-meter-long trail and listening to their footstep sounds through headphones. We used low and high-pass filters during different trials to modulate the footstep sounds to create the illusion of heavier or lighter bodies. Additionally, a control condition without any filtered sound was included. Participants rated perceived weight on a scale of 1-7, completed an avatar task to assess their sense of embodiment concerning weight changes, and marked body maps to indicate changes in body perception. We employ cutting-edge Machine Learning (ML) methods to construct a discriminative latent space to establish associations between sensor data and self-reports. The results will present scientific findings concerning the influence of modulated footstep sounds on subjective experiences. The study will specifically examine participants' perception of weight, their evaluation of their avatar's body size, and the altered sensations experienced in various regions of their body maps. Our findings highlight the transformative potential of ML methods in creating a dynamic and individualised blueprint of people's body representations, opening possibilities to develop a real-time measure of changes in body representations. This research paves the way to support the development of new health strategies for people with body representation disorders and related concerns.

Session B | Poster 8: **Harry Farmer**

Using narrative virtual reality as a tool to promote breast self examination

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This experiment investigated the effectiveness of virtual reality embodiment as a tool for public health communication. Specifically we examined the effect that viewing the 360° documentary The Waiting Room VR had on female viewers' sense of identification, attitudes to breast cancer screening and mortality salience. A key part of the documentary places participants in a viewpoint ambiguously aligned to that of the film's director and subject, Victoria Mapplebeck (VM), in a scene that recreates her radiotherapy treatment for breast cancer. Eighty female participants watched the documentary either sitting upright with the chair back set at a 90° angle or reclining with the chair back set at a 140° angle (consistent with VMs posture). The effect of posture type was measured explicitly using questionnaires on presence, identity and breast self-examination and implicitly using a lexical decision task to measure death thought awareness. Reclined posture led to a higher sense of spatial presence but no increase in identification with VM. Significantly increased identification with VM led to greater intention to conduct breast self-examination. There were no effects of posture or identification on death thought awareness. The implications of these results for using VR as a behaviour change tool, the effects of the COVID-19 pandemic on the terror management manipulation and the relevance of spatial viewpoint in VR will be discussed.

Your space or mine: trait anxiety shapes the peripersonal space expansion in a social context

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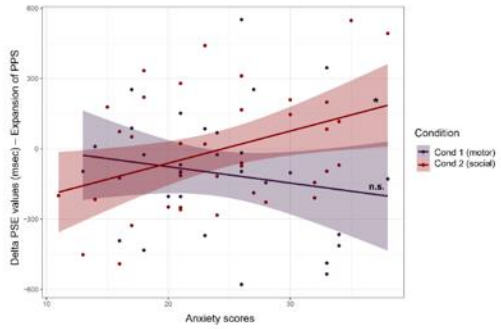
Peripersonal space (PPS) is a highly plastic sector of space surrounding our body whose boundaries are mapped through multisensory integration1-3. Although several studies have investigated the relationship between PPS extent and several personality traits4-6, including anxiety, little is known about the relationship of the latter with PPS plasticity. Here we investigated whether trait anxiety could influence PPS plasticity after two different motor trainings. Specifically, PPS plasticity was tested after a classical non cooperative motor training (Condition 1)7 and after a social motor training in which participants moved some small objects within their PPS with the cooperative help of a female confederate who used a tool in her extrapersonal space (Condition 2). Participants underwent a visuo-tactile task8 to estimate PPS boundary before and after the two trainings. Results show the expansion of PPS after the classical motor training, confirming previous evidence, but not after the social one. Interestingly, we find that anxiety shapes the boundaries of PPS only in a social context, showing that those with high anxiety trait show PPS shrinkage following the social training, whereas those with low anxiety trait show PPS expansion (Figure1). These results suggest that when the space around the body is shared with others during a social - and cooperative – motor interaction, high levels of trait anxiety influence the plasticity of the self-space, moving the other-space away from the self-space.



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Session B | Poster 10: Celia Foster

Sensorimotor transformations underlying eye movements to tactile and visual stimuli on the body

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Different spatial transformations are required to make movements to tactile and visual stimuli on the body. Tactile location on the skin must be combined with body posture to program a movement to the target location in external space. Visual stimuli are initially encoded retinotopically, but are also encoded relative to the body in frontoparietal regions. In this study, participants made eye movements to visual and tactile stimuli presented on their hands, while we recorded brain activity using fMRI. Participants' hands were positioned in uncrossed and crossed postures, allowing us to distinguish between coding of sensory stimuli relative to the hands and relative to their position in external space. We further distinguished brain responses involved with sensory processing and saccade planning using a delayed anti-saccade paradigm, in which participants only learned the final saccade target location after a delay. We decoded tactile stimulus location relative to the hands in bilateral somatosensory, motor and insular cortex, and right inferior frontal cortex. We could not decode visual stimuli relative to the hands from any regions. External-spatial stimulus location was encoded in a multisensory, modality-independent coding in medial posterior parietal to occipital cortex and bilateral lateral occipital regions. Once the saccade movement goal was specified, a broad network of occipital, parietal and frontal brain regions encoded the movement target location, independent of the spatial cue's sensory modality. Thus, our results demonstrate that external-spatial tactile and visual stimulus location, and the movement goal derived from these sensory cues, are mediated by a common sensorimotor network.

Session B | Poster 11: Aikaterini Fotopoulou

Social and Technological Biofeedback and the Regulation of Body Representation Following Stress

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It is increasingly recognised that one of the most fundamental innate abilities of humans is to detect contingencies in sensory stimulation and use such contingencies to build inferential models of their own body and of other entities in the world. It is also recognised that in human development a significant part of this contingent sensory stimulation is social, under a perspective that has been called 'social biofeedback', and more recently 'mentalising homeostasis'. However, there is less understanding about how the provision of such biofeedback in adulthood could influence the inferential models of one's own body. There are also many cross-sectional studies and very little interventional and longitudinal research. Here, I present the results of a preregistered, Randomised Control Trial (N =100) including individuals with subclinical levels of somatisation and disordered eating comparing (target arm) the role of biofeedback following stress-induction vs. the role of mental imagery following stress-induction (active control arm) in interoceptive perception (Heart Rate Discrimination Task; Legrand et al., 2022), metacognition and the updating of prospective interoceptive self-efficacy beliefs about one's ability to use biofeedback to regulate their own cardiac signals. I discuss these findings in the context of broader cross-sectional findings on the relation between interoception and body representation in healthy individuals, as well as in somatic symptom and eating disorders.

Changing the body to change the moral mind. Does the illusion of embodiment affect the resolution of moral conflicts?

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The bodily representation people have of themselves profoundly influences the decisions, behavior, and social interactions they unconsciously make on a daily basis. This has proven to be particularly true in immersive virtual environments, where merely embodying the physical features of artificial agents (i.e., avatar) may lead to attitudinal and behavioral changes, a phenomenon called the Proteus effect (PE). Whether the PE can extend to the moral sphere is currently unknown. To deal with this issue, we investigated if embodying avatars with different bodily features modulates people's moral standards. We hypothesized that embodying an entity with the right to interfere with the humans' fate, would lead participants to choose the utilitarian resolution more frequently, to present shorter decision times, to experience less negative post-decision feelings, to be less activated in terms of both skin conductance and heart rate. To test the hypothesis, we implemented a text-based version of incidental and instrumental moral dilemmas in a virtual environment and measured decisions, physiological responses, and decision-related feelings while participants embodied an avatar resembling the Christian God in His anthropomorphic appearance versus a control human avatar. Although we found compelling results on variables of interest driven by dilemma type, chosen option, personality traits and religion affiliation, we found that the embodied avatar did not affect participants' responses. We discussed this result by examining the constraints and limitations of the experimental task, reasoning about the conditions under which embodiment illusions might work.

The virtual body of the God-avatar and the Control-avatar that participants embodied and observed from 1PP (first person perspective) in an immersive virtual environment

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Session B | Poster 13: **Marika Mariano**

How physiological ageing shapes sense of agency

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The sense of agency refers to the feeling of controlling one's actions and their effects on the external environment[1]. Here we tested whether and how the physiological process of ageing affects the different dimensions of the sense of agency[2] (i.e., the implicit sensorimotor feeling of agency and the explicit metacognitive judgment of agency).
We tested 30 young and 30 older adults during active and passive button-press movements, causing, after a variable time delay, an external sensorial event (the lightening of a light bulb). We assessed participants' explicit and implicit sense of agency by collecting overt agency judgments and measuring the perceived compression of the time interval between the active/passive movements and outcomes[3] (index of the feeling of agency). See the figure below.
At the explicit level, we observed a reduced sense of agency in older participants. Moreover, in young participants, the sense of agency reduced with the increase of the temporal delay between the action and the outcome, as if they feel more agents of effects close in time to their actions. This temporal modulation was not present in older adults. At the implicit level, elderly subjects did not show the expected intentional binding effect observed in younger subjects when the sensory outcome was temporally contingent on the movement.
These results show that the sense of agency significantly changes across the adult lifespan, both at the explicit and implicit levels, suggesting that elderly adults are more reliant on internal predictions, making them less sensitive to cognitive biases and external (temporal) manipulations[4,5].

Experimental paradigm. During the active trials, participants pressed a button with their right index finger at their own time after the presentation of the cue. In the passive conditions, participants were instructed to stay still while an experimenter pressed their finger to produce a button with their right index finger at their own time after the presentation of the cue. In both conditions, after a variable delay of 200, 400 or 600 ms, the button press caused an action-consequence: the lightening of the lightbulb. Participants judged the perceived time interval between button press and the lightening of the lightbulb (to measure the intentional binding phenomenon, an implicit measure of agency) and how much they felt to have caused, with their action, the lightening of the lightbulb (judgment of agency, explicit agency dimension).

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Session B | Poster 14: Elena Mussini

"Follow your heart, it knows the way": Unveiling the Impact of Heart-Brain Interactions on Free-Choice Actions

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Brain-body interactions have a significant influence on various perceptual and cognitive processes, particularly decision-making in uncertain situations. Here, we specifically examine how brain-heart interactions impact voluntary decisions to initiate or refrain from actions. Our focus lies on investigating whether the Heartbeat Evoked Potential (HEP), which reflects the neural processing of cardiac signals and increases in amplitude when attention is internally directed, can predict voluntary actions. We hypothesized that a stronger modulation of the HEP would precede the execution of a free-choice action, while weaker modulation of HEP would predict action withholding. This hypothesis is based also on the observation that individuals exhibit heightened internally-directed attention during free-choice actions compared to externally-guided actions. To test this hypothesis, we conducted a study in which we simultaneously recorded cortical and cardiac signals during a modified version of the Go/No-Go task. Participants were presented with traffic lights displaying green (Go), red (No Go), or yellow (Free Choice) signals. They were instructed to freely decide whether to respond or refrain from responding to the yellow light. To introduce uncertainty, the yellow light would change to red in fifty percent of the trials after a variable time interval, and participants would receive an auditory feedback signal if they had chosen to respond. Consistent with our hypothesis, we discovered that the amplitude of the HEP was higher when participants chose to act rather than withhold an action. These findings provide evidence that cardiac interoception plays a role in modulating the voluntary decision to initiate an action.

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Session B | Poster 15: Maria E. Navarra

Rubber Hand Illusion: the role of the physical appearance of the plastic hand in healthy weight individuals and anorexia nervosa

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The previous evidence reported in the literature about the embodiment of fake hands with different physical appearances is controversial, mainly because hands with no ecological dimensions have been used. Healthy individuals seem to embody only larger, but not smaller, hands. No evidence is reported about eating disorders, in which we observe an altered body representation. We test the illusion of embodiment of fake hands (i.e., Rubber Hand Illusion), whose width and thickness (mirroring weight gain or loss), but not height, are modified. In the first study, we enrolled healthy individuals. They experienced a successful embodiment (i.e., according to the proprioceptive shift and the illusion questionnaire) towards under-, over- and normal-weight hands. In the second study, we enrolled women affected by Anorexia Nervosa. We tested the underweight hand (i.e., resembling the physical dimension) and the normal-weight hand (i.e., larger than the real one) as between-subjects factors. Both hands can be successfully embodied (i.e., significant proprioceptive shift and the illusion questionnaire). Our two studies point out a successful embodiment of hands with dimensions recalling different weights, with a recalibration of hand position and an explicit illusion experience. Crucially, in Anorexia Nervosa, participants embody hands that are over the physical dimensions: this is in line with the pathological tendency to cognitively imagine their own body larger as with the observation of a very malleable body representation.

Biases in hand perception are driven by proprioceptive computations, not distorted representations

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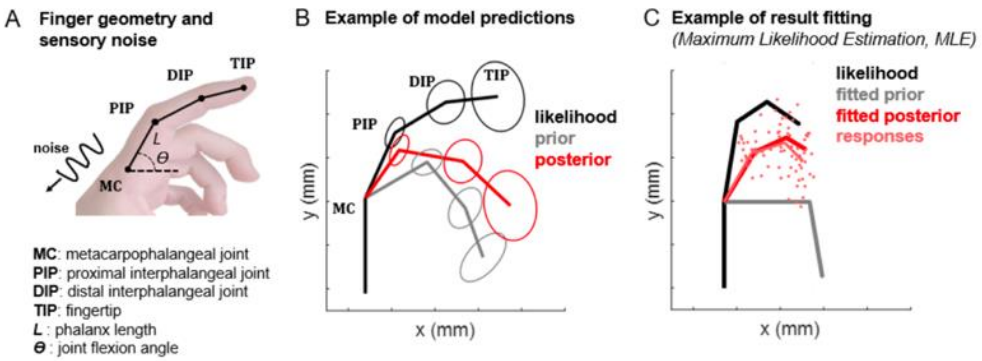
While we can effortlessly configure our fingers to grasp an object, research on hand perception suggests that we systematically underestimate the length of our fingers. This perceptual bias has been taken as evidence that the brain's internal representation of the hand's geometry is distorted[1], leading to an apparent paradox[2]. Here, we put forward an alternative explanation: Perceptual biases stem from optimal integration of noisy, but unbiased sensory signals and internally stored priors of finger size, according to Bayes' rule. We developed a geometric Bayesian model where finger perception results from integrating current information about intersegmental angles and phalanx lengths (likelihoods) with stored information about finger geometry and posture (priors) (e.g., Fig1A). We operationalized the Bayesian integration either in early sensory coordinates or in transformed, Cartesian coordinates. The latter variant led to distorted perception of finger length, despite accurate priors on phalanx length (e.g., Fig1B).
We tested the model by asking twenty participants in VR to indicate the perceived position of their joints and fingertips using a virtual pointer, while keeping the hand in different postures. Model fits (e.g., Fig1C) provide evidence that body part localization is well- described by Bayesian computations occurring in Cartesian space. Priors over joint angles elicit perceptual biases affecting overall finger geometry, despite accurate but noisy priors over phalanx length. Our modeling and experimental approach provides a new perspective on biases in body perception, suggesting that they may stem from probabilistic processing of noisy, but unbiased signals, rather than distorted representations of body geometry.



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InMotion – Mixed physical exercise with creative movement as an intervention for people with schizophrenia

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Schizophrenia (SCZ) is among the world's top ten causes of long-term disability (World Health Organization, 2004). The major symptoms of SCZ include hallucinations, delusions, affective flattening, and cognitive impairment, and their treatment with antipsychotic medications is far from optimal. Creative and body awareness training (dance/movement therapy, body psychotherapy) and physical training (aerobic and strength training) improve SCZ symptoms (e.g Martin et al., 2016, 2017; Girdler et al., 2019; Millman et a., 2021). In our novel intervention, we bring together creativity and self-awareness with physical training. The 12-week 24-session intervention with 30 participants (Figure 1) includes components like visualization, cardio and strength training, and social interaction. We will measure the impact with standardized clinical questionnaires, EEG-fNIRS, motion capture, and cognitive, affective, and physical tests. We expect our intervention to improve the quality of life and negative symptoms of SCZ by balancing the brain functions and bodily state related to self-awareness, social interaction, and physical fitness. In my talk, I will cover brain dysfunctions related to self-awareness in SCZ (Ferri et al., 2012; Ebisch et al., 2013) and describe the scientific rationale for each component included in our novel intervention (e.g. Lee et al., 2015; Firth et al., 2017).

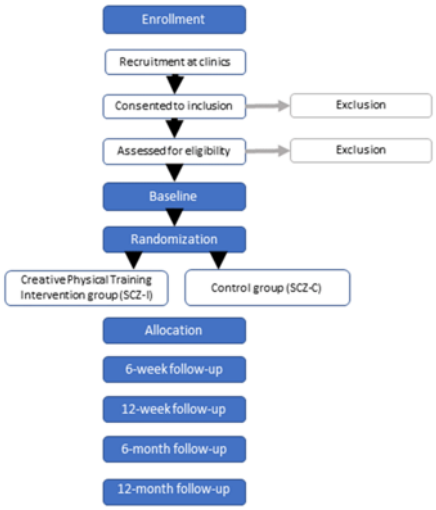

Figure 1. Flowchart of the protocol.

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Session B | Poster 18: **Karol Poles**

‘Catching the (fetal) eye’: a sonographic recording of fetal lens movements for face-like stimuli since 26 weeks of gestation

Poles, K. [1], Ronga, I. [1], Pace, C. [2], Fantoni, M.[1], Chiesa G.[1], Luppino, J. [2], Gaglioti, P. [2], Todros, T. [2], Garbarini, F.[1]

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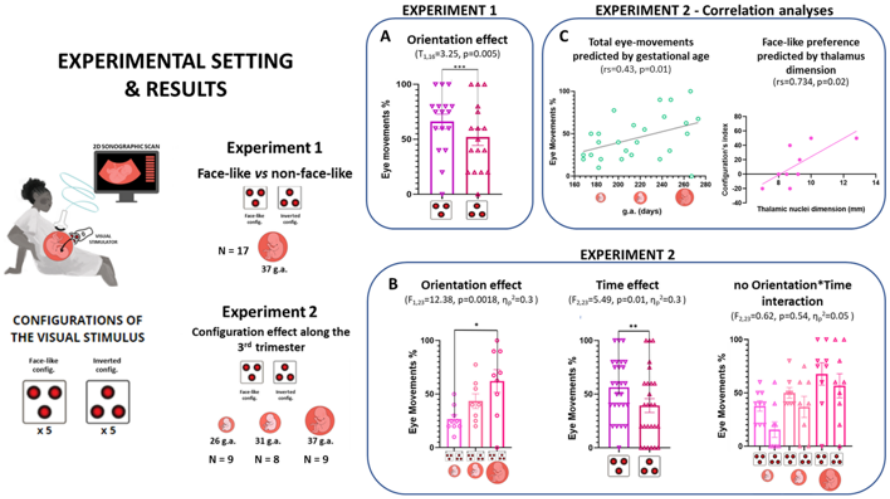
Privileged attention to face-like stimuli is a well-grounded mechanism, observed not only in human adults and newborns1,2 but also in other non-human species3. Moreover, a previous sonographic study successfully recorded fetal head turns to face-like and non-face-like light stimuli projected through the maternal abdomen, unveiling that face-like preference is present even prenatally, at least from the second half of the third trimester4. Here, in Experiment 1, we further investigate the pre-natal face-like preference by exploiting fetal eye movements in 37-weeks fetuses (N=17) as a measure of attention orienting, likely more sensitive than head turns. Furthermore, to describe whether this preferential effect can be observed along the whole third trimester, in Experiment 2 we compared responses of 26 weeks fetuses (N=9) to those of 31 (N=8) and 37 (N=9) weeks. Finally, we tested whether the presence of differential responses might be predicted by the development of specific neural structures. In both experiments we found that fetuses preferentially respond to face-like stimuli (Panel A-B), validating the monitoring of fetal eye-lens movements as a reliable stimulus-locked measure. Specifically, we showed that the preference for these highly salient stimuli is detectable as early as 26 weeks GA, with lens movements linearly increasing within the third trimester (Panel B-C) and with the thalamic growth as a predictor of such preferential responses (Panel C). In conclusion, by recording eye-lens movements we reliably measured fetuses responses in all the selected timepoints and as early as 26 weeks of gestation, as soon as thalamocortical projections are established.



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Session B | Poster 19: Inmaculada Riquelme

A multidimensional investigation of the relationship between skin-mediated somatosensory signals, emotion regulation and behavioral problems in autistic children

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Recent theories consider the skin as a sensory organ contributing to monitoring the physiological state of the body and the construction of body consciousness (Crucianelli & Ehrsson, 2023). On the other hand, the perception of bodily signals facilitates the use and flexible selection of emotional regulation strategies in neurotypical individuals (Njardvik et al., 2022). Autism is characterized by an abnormal sensory perception of the body, emotion dysregulation and behavior problems. Objective. The aim of this cross-sectional study was to explore the relationship between skin-mediated somatosensory signals and emotion/behavior difficulties in autistic children and adolescents, in comparison to typically developmental peers (TDP). Methods. Thirty-eight autistic children and adolescents and 34 TDP completed a multidimensional assessment consisting on the measurement of somatosensory thresholds of skin-mediated signals (touch, pain and temperature), a task on emotion knowledge and parent-reported questionnaires on sensory reactivity, emotion regulation and behavior problems. Results. Autistic children had higher pain sensitivity, less sensory reactive behaviors and more behavior problems than their TDP. Correlations between sensitivity to bodily signals and emotional/behavioral regulation were significant only in autistic children, suggesting that sensorio-cognitive integration processes differ between autistic children and adolescents and their TDP. Conclusion. Abnormal skin-mediated somatosensation may affect the development of emotional processing and behavior in autistic children and adolescents. This knowledge can lay the foundation for future studies on co-occurring alterations in these neural networks and for the implementation of early interventions, including skin-mediated body representation, for promoting regulated behaviors in autistic children and adolescents.

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Session B | Poster 20: Daniele Romano

A Psychometric approach to the subjective experience of embodiment phenomena

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Body illusions are specifically created to temporarily modify the perception of one's body by incorporating artificial bodies or their individual parts. Although these experiences are predominantly evaluated through questionnaires, the lack of validation studies for embodiment questionnaires is evident. In the first study (Romano et al., 2021), evidence will be presented to establish the validity of a multidimensional questionnaire (Longo et al., 2008). This questionnaire will be employed in the rubber hand illusion (RHI), involving a considerable sample size (N=298). Additionally, the study investigated the influence of individual differences in the RHI experience. In the second study (N=118) (Tosi & Romano, 2022), evidence will be presented to broaden the scope of the multidimensional embodiment experience questionnaire and establish its validity in the context of the full-body illusion. Two shared dimensions arise in both illusions: a) the embodiment of the external object and b) the disembodiment from one's actual body. However, the relationship between these two components appears to differ between the two illusions. The studies offer compelling evidence supporting the utilization of the embodiment scale as a standardized questionnaire for future studies on the embodiment phenomena Furthermore, by exploring the influence of individual differences, such as personality traits, on embodiment experiences, the research suggests that the embodiment induced by these illusions is more than a perceptual illusion and intricately intertwines with individuals' complexity and variations.

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Session B | Poster 21: Marcella Romeo

I am as I see myself: bodily-self recognition is modulated by the perceived body image

Romeo, M. [1,2], Galigani, M. [2], Italia, B. [2], Fossataro, C. [2], Longo, P. [3], Bruno, V. [2], Clocchiatti, A. [4], Murtas, V. [4], Lauro, V. [4], Ricciardi, E. [1], Abbate-Daga, G. [3], Garbarini, F. [2]

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Body image disturbance is a key feature in pathologies involving alteration of body representation, such as eating disorders1, but also healthy subjects may exhibit a dysmorphic perception of the own-body2. Here, we asked whether dysmorphic behaviours impact on the implicit bodily self-recognition. To this aim, we exploited the well-known self-advantage-effect3 (i.e., better performance in discriminating self- than other-body-parts) and 25 healthy subjects were presented with images of self and stranger's thighs either with the real or the perceived size (assessed before the experiment with a body-size-estimation task fig1A). Visual stimuli were presented in pair and the subjects had to report whether the stimuli were identical or different (fig1B). We anticipated a modulation of the self-advantage-effect due to a mismatch between real and perceived body size. Subjects were divided in two groups according to the degree of dysmorphism (above or below the group median-value = 13%, fig1C). By analysing reaction times, we found a significant Identity*Size*Group interaction ($p=0.048$), revealing that subjects with a low-level of body-dysmorphism showed the self-advantage-effect both with real ($p=0.02$) and perceived self-images (that nearly matched each other) ($p=0.02$). By contrast, individuals with a high-level of dysmorphism exhibited such behavioural facilitation with the perceived self-image ($p<0.001$), but not with the real one ($p=0.2$) (fig1D). These results suggest that, in healthy subjects with dysmorphic traits, the perceived body image modulates the bodily self-recognition. This evidence opens new perspectives in the study of bodily-self-recognition in individuals with eating disorders presenting an altered perception of the own-body size.

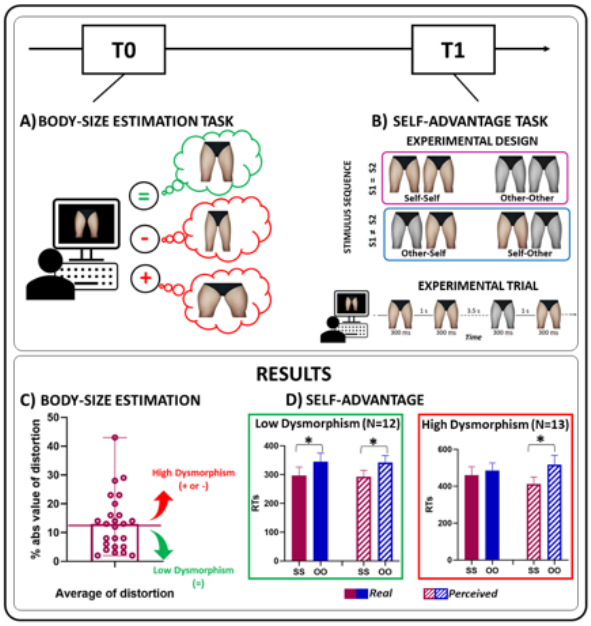

Figure 1. **A)** Body-size estimation task in which subjects can either augment (+) and diminish (-) the inner and outer thighs separately, or do not modify them at all (=). **B)** Representation of the self-advantage paradigm in which subjects have to report whether the second stimulus matched or not the first one. **C)** Degree of dysmorphism, obtained as the mean of the absolute value of distortion of both inner and outer thighs. **D)** Results of the self-advantage task, with the reaction times on the y axis and the experimental conditions on the x axis.

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Session B | Poster 22: Milagrosa Sánchez-Martín

Examining the Link between Body-Image, Interoceptive Awareness and Sensory Processing: Insights from Body Illusions

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Body illusions could serve as valuable tools to identify individuals who are most likely to benefit from therapies due to their heightened body-image flexibility. However, little is known about the association between body-image flexibility and key psychological factors related to eating disorder (ED) symptomatology such as hypersensitivity and deficits in interoceptive awareness. We conducted a study with 63 young females using the "auditory Pinocchio illusion," which involves changes in the perception of size of a body part when a rising pitch is paired with a pulling action. We employed the "Spanish version of the Highly Sensitive Person Scale" (HSPS) to assess sensory-processing sensitivity, and "The Multidimensional Assessment of Interoceptive Awareness" (MAIA) to assess interoceptive body awareness. During the experiments, participants were instructed to either pull their index fingertip or the sides of their waist while simultaneously being exposed to sound pitches. We analyzed the strength of both illusions by examining participants' estimations of body part position/size, alongside the questionnaires. Regarding the finger illusion, the HSPS results revealed a moderate negative relationship between tip position estimations and physiological discrimination. For the waist illusion, the HSPS results indicated a positive relationship between sensitivity to overstimulation and the perception of waist width for the descending sound. The MAIA results demonstrated a negative relationship between the perception of waist width for the descending sound and self-regulation and trusting. These findings shed light on the intricate connections between body-image flexibility, sensory processing, and interoceptive body awareness.

Session B | Poster 23: Chiara Verga

Time matters: exploring the onset-timing of vicarious touch sensations over an embodied virtual avatar

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Immersive virtual reality (IVR) studies indicate that merely observing a virtual body from the 1st Person's Perspective (1PP) is a sufficient condition to give people the illusion of ownership over an artificial agent [a] and of vicariously feeling on one's body the somatosensory stimuli seen on the avatar [b,c,d,e]. What remains unclear concerns the temporal features of these illusions, i.e., how long it takes to start experiencing vicarious touch sensations.

To explore this issue, 34 healthy participants were asked to observe a virtual body presented from a 1PP or a 3rd Person Perspective (3PP) continuously stroked on the hand and foot by a virtual avatar and report the onset time of virtual-body ownership and vicarious touch sensations. Subjective illusory sensations and physiological measures were taken.

Participants reported stronger ownership and vicarious touch sensations in 1PP compared to 3PP. Moreover, both illusions arose earlier in 1PP compared to 3PP. The onset time became shorter with the trial progression, suggesting that repeated exposure may facilitate the vicarious feelings. Moreover, individual differences resulting from questionnaires concerning current intimate touch experiences and attachment style and resting heart rate variability modulated the onset of the vicarious touch illusion.

Our data add new valuable information to the limited literature on the temporal development of the full-body illusion and vicarious touch phenomena, that could be relevant for both applied research and future studies investigating these illusions.

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Session B | Poster 24: Lettie Wareing

Understanding Representations of Body Part Width in Healthy Populations: The Relative Proportions of the Body

Wareing, L. [1], Readman, M.R.[1], Lin, P. Y. [1], Crawford, T. J. [1], Longo, M. R. [2] & Linkenauger, S. A. [1].

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When estimating the relative proportions of their body part lengths using the hand as a metric, individuals' estimates are highly distorted. However, whilst extensive research has focused on length representations, less is known about how body part width is represented. Therefore, the current study investigated representations of the relative proportions of body part width across three experiments. Experiment One found that width estimates for the self were distorted, with overestimation of the shoulders, back, hips, and torso. No relationship with eating or shape concerns was observed. In contrast, Experiment Two found individuals self estimates were mostly accurate when using both the hand and a hand-sized stick. Finally, Experiment Three found greater overestimation of the thigh relative to that of the head or shoulders when estimating the width of an other. Given the findings of Experiment One, it is possible that width overestimation represents a perceptual buffer which aids optimal navigation of our environments. Alternatively, the discrepancies between the first and second experiment indicate a potential effect of the differing postures (sitting versus standing) between conditions. Further investigation is required to ascertain the support for these two hypotheses.
Moreover, results suggest that we rely on visual experience when forming width representations of another, with participants overestimating the width of body parts which are typically fixated upon less during social interactions. Findings may have implications for understanding body distortions in eating disorders where individuals may represent the body from a third-person perspective.

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Body representation and social functioning in adolescents with overgrowth syndromes: preliminary evidence from a stop-distance task and a full-body illusion paradigm in virtual reality

Butti, N. [1,2], Montirosso, R. [1] , Cartaud, A. [3], Coello, Y. [3], Bellazzecca, S. [1], Biffi, E. [1], Urgesi, C. [1,4]

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Sotos and Beckwith-Wiedemann syndromes are known as Overgrowth Syndromes (OS) as they involve an excessive growth of the whole body or of specific body parts. Importantly, these syndromes are associated also with altered social functioning [1,2]. This study investigated how these structural alterations of the body may affect different aspects of body representation, and their impact on socio-cognitive abilities and emotional-behavioural functioning. Adolescents with OS and age-matched healthy controls were administered with a computer-based stop-distance task assessing reaching- and comfort-distance as proxy of, respectively, peripersonal space (PPS) and interpersonal distance (IPD) [3], and with a full-body illusion paradigm in virtual reality [4]. For the latter, spatial drift measures and a questionnaire of touch referral and embodiment were administered after synchronous and asynchronous visual-tactile stimulation. Adolescents with OS displayed overall higher distances than the control group. Despite a shorter distance for human-like compared to non-human-like stimuli was found in both groups, this advantage was stronger in the OS group. Furthermore, PPS and IPD were differently associated with emotional-behavioral problems and social perception skills in adolescents with OS. As concerns the full-body illusion, both groups showed a positive spatial drift after synchronous visual-tactile stimulation. However, in the questionnaire control participants reported higher levels of touch referral after synchronous compared to asynchronous stimulation, while this difference was not found in the clinical group. These preliminary findings shed light on how atypical bodily growth could shape the interplay between body representation and perception of social stimuli, thereby affecting socio-cognitive abilities and emotional-behavioural functioning [5].

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Session B | Poster 26: Letizia Della Longa

Touching emotions: the role of tactile interactions in shaping emotional processing among adolescents

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In an embodied perspective, different sensory information originated both from inside and outside the body need to be integrated to give sense to emotional experiences and to interpret ours and other's feelings [1]. This process is crucial during adolescence, a period of critical bodily and socio-emotional changes. Indeed, adolescents are at risk of experiencing a sense of disconnection from their bodily self and from the others, with important implications for their psychological wellbeing and social interactions [2]. In the present study we ask adolescents (N=30) to distinguish between positive and negative emotion facial expressions. Each face presented was preceded either by a tactile stimulation (direct experience - Study 1) or by a video clip showing a tactile interaction (vicarious experience - Study 2). We manipulated both the valence (positive - affective vs negative - non affective) and the sociality (human touch vs human-object interaction). The results revealed an interaction effect between valence of touch and valence of facial expression, suggesting that adolescents were sensitive to congruent tactile information, both in the direct and vicarious experiences. The present findings indicate that tactile interactions carry important socio-affective meaning and can act as an emotional cue that modulates adolescents' emotional processing across different sensory modalities. Thus providing positive experiences of interpersonal physical contact plays a crucial role during adolescence with potential cascading effects for the development of personal identity, body awareness and social relationships.

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Session B | Poster 27: Francesca Frisco

Multisensory conflict affects Body Schema and Reaching Space

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Multisensory integration plays a crucial role in building the sense of body ownership, i.e., the perceptual status of one's body for which the body is perceived as belonging to oneself1,2. Temporal and spatial mismatching of visual and tactile signals coming from one's body can reduce ownership feelings towards the body and its parts3, i.e., produce disownership feelings. Here, we investigated whether visuo-tactile conflict also affects the sensorimotor representation of the body in space (i.e., body schema4) and the perception of the space around the body in terms of action potentiality (i.e., reaching space5). In two experiments, body schema (Experiment 1) and reaching space (Experiment 2) were assessed before and after either synchronous or asynchronous visuo-tactile stimulation on the hand. Results showed that the asynchronous condition, provoking multisensory conflict, caused disownership over one's hand and concurrently affected the body schema and the reaching space. Indeed, a visuo-tactile conflict would effectively alter the representation of body ownership and make the representation of one's body in space less defined, decreasing also the potentiality to act in space. These findings would suggest that body schema and reaching space are dynamically shaped by the multisensory regularities that build up the sense of body ownership.

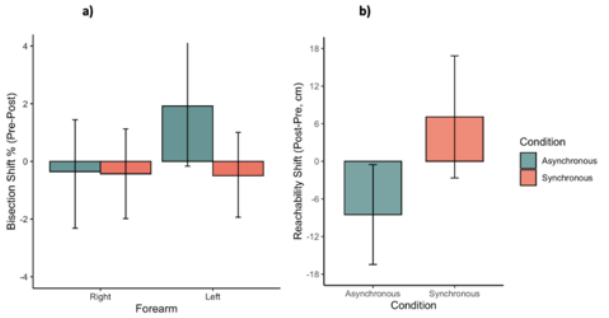

Figure.
a) Results of Experiment 1: effects of the visuo-tactile stimulation on Forearm Bisection Shift (Pre visuo-tactile stimulation forearm midpoint estimation - Post visuo-tactile stimulation forearm midpoint estimation). Comparison of the percentage of the Forearm Bisection Shift between Condition (Synchronous and Asynchronous) and Forearm (Left and Right). Positive values indicate a distal shift (toward the fingers), negative values indicate a proximal shift (toward the elbow).
b) Results of Experiment 2: effects of the visuo-tactile stimulation on Reachability Shift (Post visuo-tactile stimulation reachability threshold - Pre visuo-tactile stimulation reachability threshold). Comparison of the Reachability Shift between the two conditions (Synchronous and Asynchronous), only for the Left arm. Positive values indicate an extension of the reaching space after the visuo-tactile stimulation, while negative values indicate a reduction.
Lines indicate Confidence Intervals set at 95%.

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Session B | Poster 28: Judith G. Ley-Flores

A 4-week home study investigating the effects of movement sonification on body perception to support adherence to physical activity in real-life contexts

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Negative body perceptions are linked to physical inactivity, which is a significant health concern. Recently we reported a new approach, using metaphorical movement sonification (real-time auditory feedback of body movement), which exploits bottom-up multisensory mechanisms related to body perceptions to ultimately support physical activity (PA). This study aims to examine the impact of movement sonifications on body perception and PA in everyday contexts, while also exploring the evolution of these effects and the potential maintenance of PA adherence over time through repeated exposure. We conducted a 4-week home study with physically inactive participants who were asked to perform squat and back bend stretching exercises using SoniBand, a wearable device that sonifies movements. Participants performed these exercises with two different metaphorical sonification (Wind and Water sounds) and with no sonification (2 weeks for each condition). We collected self-reports of body perception and emotional feelings using questionnaires and contextual body maps in a diary, and behavioral movement data from SoniBand's sensors. Further, measures of changes in tight width and force, and back flexibility, and qualitative data from interviews with participants were collected weekly. We aim to discuss the key elements of the study, including the participant selection, data collection tools, and measurements, as well as the study findings. The findings contribute to a better understanding of the effects of movement sonification on body perception, PA levels and adherence in physically inactive adults, and its potential to modify mental body representation in the long term and in real contexts of use.

Session B | Poster 29: **Francesca Rastelli**

Unravelling the impact of body postures on peripersonal space representation and plasticity

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Peripersonal space (PPS) represents the surrounding plastic area around the body, encoded by a set of neurons in frontoparietal areas of the brain and anchored to bodily receptive fields[1]. Whereas the properties of PPS extension have been extensively investigated, there is still little knowledge about the characteristics of PPS plasticity. Indeed, there is accumulating evidence showing how the direction of approaching stimuli[2] or different body coordinates[3,4] can influence PPS extension. Nevertheless, no research has investigated how different body postures we assume in everyday life can influence PPS representation and plasticity, relevant considering the key role of PPS in the daily body–environment interactions. To this purpose, we investigate the impact of three different body postures (sitting, standing up, and lying down) on the plasticity of the peri-hand space following a classical motor training in the far space[5]. Specifically, participants underwent a visuo- tactile task to estimate PPS boundary before (Session1) and after (Session3) the tool-use, while seated behind a table (Experiment1) or standing up (Experiment2) or laying down (Experiment3). Our findings provide the first evidence of a comparable PPS extension and expansion in all body-posture conditions following the motor training. Interestingly, we find blurred PPS boundaries demarcation both in Session1 and 3 only for Experiment1. This might suggest a facilitation of PPS plasticity in the sitting position, potentially due to the broad range of actions typically performed in this posture. Given these premises, we speculate a more global somatocentred plastic representation of the PPS, independently from the body effector position.

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Session B | Poster 30: Gaia Risso

Self-body perception at awakening: reshaping of metric body representation during sleep

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Background: The implicit knowledge about one's own body dimensions, i.e. the metric body representation (mBR)[1], is built-up and maintained updated through multisensory information during everyday interactions[2,3]. When the stream of multisensory information is modified[4], changes in mBR are observed also in healthy participants[1,5–7]. Noteworthy, sleep has been recognized as a condition lacking sensory interactions[8], where external stimuli are not consciously processed and do not trigger overt behavioral responses[9]. This would suggest that mBR can be dynamically modified after sleep. Methods: To test this hypothesis, we evaluated the upper-limb mBR of healthy participants with the body landmarks localization task[5,10] before and after a typical night of sleep. Moreover, we repeated the same experimental design, but stimulating the participants through audio-tactile cues while sleeping. To monitor the sleep goodness and phases, participants underwent EEG recording during the whole night. Results & Perspectives: Preliminary results reveal modifications in the implicit perception of arm length after sleep. Correlations between behavioral and neurophysiological sleep parameters are investigated to disentangle the role of sleep and of stimulation affecting mBR. These findings will clarify the impact of sleep on self-body perception and will open up new possibilities for the use of sensory stimulation during sleep to modulate the perception of one's own body in pathologies[11–13].

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Session B | Poster 31: Justyna Świdrak

Virtual embodiment in fibromyalgia

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The sensation of body ownership is a stable experience critical for sensorimotor interactions with the environment. Chronic pain alters this experience and leads to disturbances in body perception 1. For example, people with fibromyalgia often present with an unstable body schema, negative attitudes toward their bodies, and hypervigilance to their bodily signals 2. Hyper-embodiment, a feeling of physiological experiences being 'too real', is a daily experience of patients with FM, with their bodies often felt to be an unavoidable obstacle, rigid and heavy 3. We tested whether women with fibromyalgia are receptive to bodily illusions in virtual reality (VR) 4 and what modulates this experience. Moreover, we investigated whether the hyper-embodiment can be broken by removing the body in a progressive invisibility illusion 5.

Twenty patients participated in two experimental VR sessions; each included two conditions (visible, invisible) in a counterbalanced order. Most participants could indeed experience certain levels of virtual embodiment, although several participants reported no ownership. A linear mixed model revealed that the strength of embodiment was positively associated with body perception disturbances and negatively associated with fibromyalgia symptoms intensity. Progressive invisibility triggered diverse reactions, including a feeling of weightlessness and relief, but also an unpleasant drawing of attention to symptoms. The results indicated that women with fibromyalgia are receptive to bodily illusions, but there are large interpersonal differences. Virtual embodiment is a promising tool for studying some of the least understood symptoms of fibromyalgia related to the bodily self which severely impact patients' quality of life.

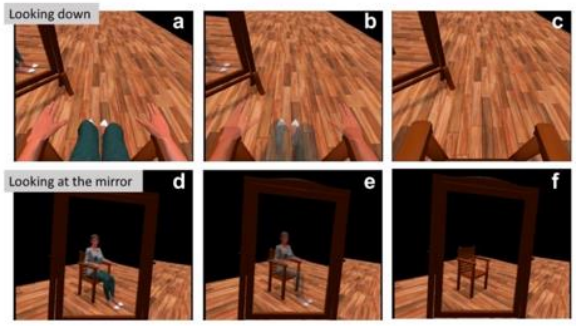

Fig. Virtual body becoming progressively invisible.

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Session B | Poster 32: Carolina Tammurello

Somatic rubber hand illusion: the mechanisms underpinning proprioceptive drift in primary school children

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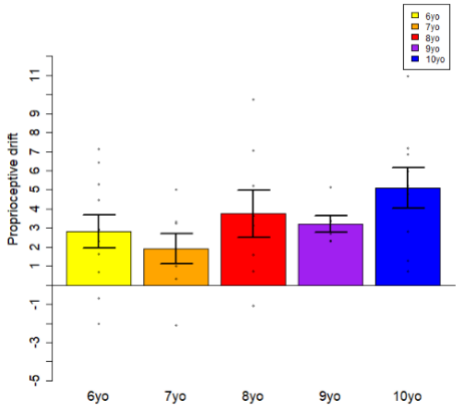
The somatic rubber hand illusion (SRHI) is an experimental paradigm which introduces a discrepancy between proprioceptive and tactile signals. The experimenter guides a blindfolded participant in brushing a dummy hand, while synchronously brushing the participant's real hand. This scenario is known to induce proprioceptive drift (a shift in the perceived position of the participant's hand towards the fake hand). Proprioceptive drift has been reported in children as young as six and has been shown to increase with age. There are different possible reasons as to why this increment takes place: 1) proprioceptive drift is caused by tactile-proprioceptive integration, which improves with age; 2) this relationship is merely the result of hand growth, in which case hand size would be a better predictor than age. To address this conundrum, 51 healthy children (6-11 yrs) were administered the SRHI, with a dummy hand placed along the body midline. Before SRHI, perceived position (mean error) was assessed through three pointing trials. The SRHI effect was replicated. While we found correlations between age and hand size, proprioceptive drift was only predicted by age. Additionally, the initial perceived position was a significant predictor. In other words, the farther from the body midline was the initial perceived location, the larger the proprioceptive drift would be. These results clearly support the view that proprioceptive drift results from integration of multisensory signals, which in turn explains the age-related increase in proprioceptive drift.



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Session B | Poster 33: Gabriele Vercelli

"Interoception and Dissociative Experiences: Unveiling the Relationship Between Bodily Awareness and Altered Sense of Self"

Vercelli, G. [1], Ciccarone, S. [1], Porciello, G. [1, 2] & Bufalari, I. [3]

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A stable and coherent representation of the bodily Self arises from integrating internal (interoceptive) and external (exteroceptive) signalsa. Dissociation (depersonalization) is a deficit of self-awareness that may affect the whole sense of selfb. The aim of the present study is to observe whether scarce interoceptive abilities are associated with a higher tendency for spontaneous and induced dissociative experiences. 83 healthy participants (age=24.11±2.31) completed the Dissociation Questionnaire (DIS-Q)c and the Dissociative Experiences Scale (DES)d to measure dissociative traits, and the MAIA-IIe to assess interoceptive sensibility. To induce state dissociative experiences, participants performed the Mirror Gazing Task (MGT)f in two conditions: under poor lighting (to induce dissociative state) and normal lighting (control condition). Before and after the MGT conditions interoceptive accuracy was measured using the Heartbeat Counting Task (HCT)g and the Clinician-Administered Dissociative States Scale (CADSS)h was filled out after each condition to assess participants' state dissociation and bodily self-consciousness (details in Fig.1). Results showed that the MGT was effective in inducing state dissociation, as indexed by CADDS scores. Furthermore, under poor lighting, dissociative feelings (CADSS-Depersonalization) negatively correlated with interoceptive sensibility (MAIA Emotional-Awareness:$r=-0.23$, $p=0.04$; and Trusting:$r=-0.23$, $p=0.04$), and positively with trait dissociation (DIS-Q:$r=0.37$, $p<0.01$; DES:$r=0.31$, $p<0.01$) and Negative Affective States (PANAS-I:$r=0.51$, $p<0.01$). There was no modulation in the HCT across MGT conditions. These findings identify a relationship between non-pathological state dissociation and interoceptive sensibility, specifically interoceptive components related to affective and emotional aspects of visceral signals. Further studies on clinical populations are needed to shed light on the interoception-dissociation relationship.

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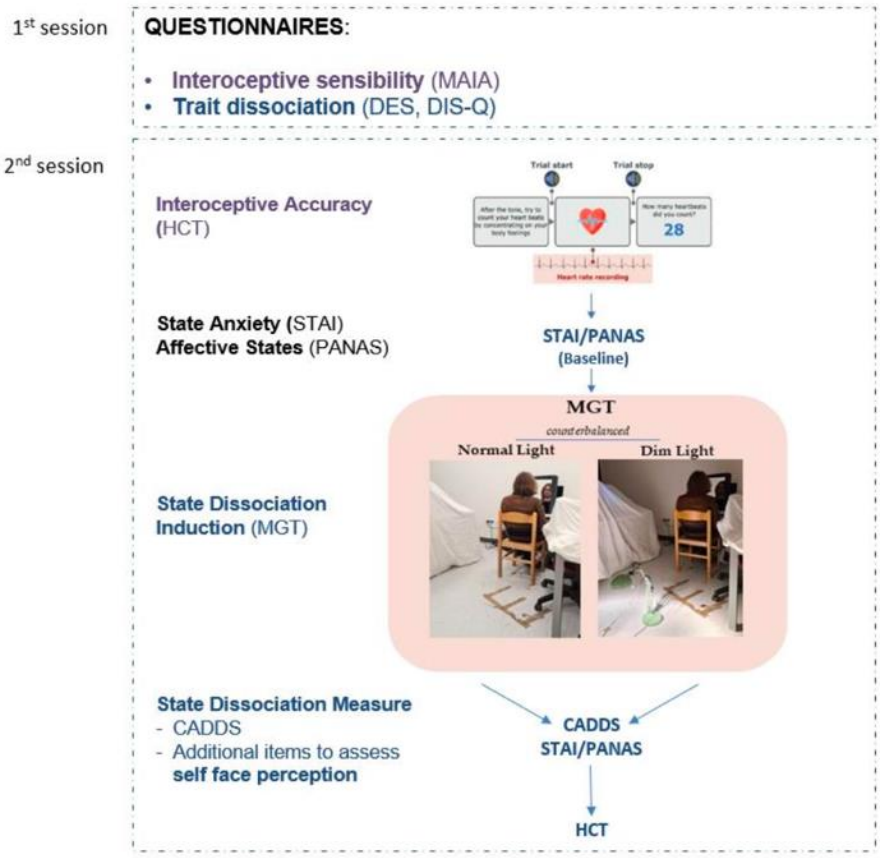

Fig. 1: Experimental Procedure

Session B | Poster 34: Valentina Cazzato

The role of somatosensory and ventral premotor cortices in recognising others' bodily interoceptive states: a transcranial magnetic stimulation study

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Accurate recognition of interoceptive bodily signals in the self is intimately related to emotional processing and mental health. Recent neurophysiological studies provide evidence of the involvement of interoceptive network, i.e., the anterior insula and the somatosensory cortices in interoceptive processes. However, the neural underpinnings of recognition of these states in others has not been investigated yet. Here, we applied online five 10-Hz repetitive transcranial magnetic stimulation (rTMS) pulses over right somatosensory (S1), ventral premotor cortex (vPMC) and vertex to investigate the contribution of these brain areas to recognition of others non-affective internal states. Whilst receiving online rTMS, participants (n = 20, 11 women, 9 men) completed an implicit task consisting of visual matching of non-affective internal states in others (cold, fatigue, itch, and pain) or control actions (clapping, walking, waving, and running). Self-reports of interoception awareness (MAIA) and eating disorders symptomatology (EDE-Q) were also collected. Overall, participants were faster in recognising control actions compared to internal states stimuli. Furthermore, women were faster than men in recognising both control actions and internal states. Crucially, women, but not men, were slower in recognising non-affective internal states during vPMC-rTMS compared to S1- and to vertex-rTMS. Our results provide preliminary evidence that premotor and not somatosensory areas are necessary for the recognition of others' internal states. Our findings have important implications from a clinical perspective, where non-invasive stimulation is a promising tool in those mental health conditions (for e.g., eating disorders) which show atypical perception of interoceptive states.

Additional info:

- GoogleMap with additional info (locations of interest and venue): https://www.google.com/maps/d/viewer?mid=1j2SnmTbhozh9FcHA17GXNa8IXi1MyTk&ll=39.571545292439694%2C2.6579395999999855&z=13
- Events in the island: http://youthing.es/
- Emergency number: 112
- Taxis: +34 971 40 14 14
- Bus and timetables: https://www.emtpalma.cat/en/lines-timetables