Visuo-Vestibular and Cardiovascular Contributions to Vertical Ego-motion Representation
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Dear Science of the Self Attendees,

We hope you enjoy reading through the abstracts for the Science of the Self: The Agency and Body Representation Research Forum.

Agency and body representation are growing areas of interest in the human sciences. As a field we are trying to answer important questions about how we perceive our selves and our interactions with the world. We are thankful for your participation and contributions. These have allowed us to put together an exciting program across 3 days, where we will have 4 keynote presentations, 22 talks and 35 poster presentations.

We wish you a great conference and stimulating discussions!

The Science of the Self Organising Committee

Vince Polito  Regine Zopf  Simmy Poonian  Mariia Kaliuzhna
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Frédérique de Vignemont is a CNRS Research Director at the Institut Jean-Nicod in Paris, France where she heads the BoSS (Body, Space, and the Self) research group. Her training has been both in philosophy (at the Jean-Nicod Institute, Paris and at the department of philosophy, NYU) and in cognitive science (at the Institute of Cognitive Science, Lyon and at the Institute of Cognitive Neuroscience, London). She did her PhD with Pierre Jacob on the question of immunity to error through misidentification (Who’s who? Self, agency and ownership, EHESS, 2002). She is interested in self-consciousness and disorders of agency and ownership. Her new book *Mind the body: a philosophical exploration of bodily self-awareness* (Oxford University Press) will be out later this year. She has also edited a multidisciplinary volume on the body and the self, *The Subject’s Matter* (MIT press) to appear later this year.

**The Bodyguard hypothesis of the sense of bodily ownership**

I feel the hand that is typing as my own but what grounds such a feeling? Here I will defend a reductionist approach, according to which the sense of ownership can be reduced to some specific properties of bodily experiences. But which properties? I will first discuss Martin’s (1993, 1995) conception, according to which the sense of bodily ownership finds its origin in the spatial awareness of the boundaries of one’s body. I will argue that such spatial awareness is not sufficient. I will then analyse whether the sense of bodily ownership can borrow, so to speak, its self-referentiality from the self-referentiality of agency. More specifically, one may suggest that the sense of bodily ownership is grounded in the sensorimotor representation of the body known as body schema. However, this agentive hypothesis faces a number of difficulties that cannot be solved without further refinements. In particular, I will argue that one needs to distinguish between two distinct kinds of body schema: the working body schema involved in instrumental actions, and the protective body schema involved in self-defence. I will then propose what may be conceived as an affective conception of the sense of bodily ownership, according to which the sense of bodily ownership consists in the awareness of the boundaries of one’s body as having a special significance for the self. This will lead me to define the phenomenology of ownership as a narcissistic feeling to file with other affective feelings such as the feeling of familiarity.
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Matthew Longo studied at the University of California at Berkeley and the University of Chicago before moving to University College London as a postdoctoral researcher in 2006. In 2010 he moved to Birkbeck, University of London, where he is now Professor of Cognitive Neuroscience and Director of the Body Representation Laboratory. Prof Longo’s research investigates the psychological and neural mechanisms by which we form representations of our body, and how these representations affect all aspects of our mental lives, using a range of methods from experimental psychology, perceptual psychophysics, and cognitive neuroscience.

**Distorted body representations in healthy adults**

Misperceptions and delusions about one’s own body are characteristic of numerous psychiatric and neurological conditions. Such phenomena have long fascinated researchers, in large part because of their sheer strangeness. Our body is so ubiquitous in our perceptual experience and so intimately known to us, it is difficult to imagine not having accurate knowledge of it. In this talk, I will discuss several recent experiments that have shown, in striking contrast to this intuition, that our brain maintains highly distorted representations of the body, used for perceptual tasks including position sense and tactile size perception.

Jakob Hohwy
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Jakob Hohwy is a philosopher engaged in both conceptual and experimental research. He works on problems in philosophy of mind about perception, neuroscience, and mental illness. At the same time, he collaborates with neuroscientists and psychiatrists, conducting experiments that put philosophical ideas to the test and that bring philosophical concerns into the lab.

**Why should any body have a (real) self?**

In a recent work, John Michael and I develop a realist position about the self: the self is real, it is a set of causes in the world forming part of a model generating predictions of sensory input. In this sense, the self is a self-model and, at the same time, a set of real causes. When set in the context of the free energy principle this proposal becomes particularly appealing because several subtle aspects of the self can then emerge. In this talk I explain and elaborate on our proposal. I connect it to agency and body representations, and explore possible relations to psychopathology and false inference. I also defend it against several recent criticisms and discuss it in the context of a broader debate about narrative accounts of the self.
Neeltje van Haren
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Neeltje van Haren is an Associate Professor at the University Medical Centre Utrecht. Her research investigates the neurobiological and (social) cognitive basis of schizophrenia and bipolar disorder, using experimental cognitive paradigms, neuroimaging, and family designs. A particular interest has been the cognitive and neural basis of (abnormal) self-agency experiences in healthy individuals, schizophrenia patients and their offspring. Associate Professor van Haren’s lab has convincingly shown that patients are not using implicitly available information from the environment about action outcomes to experience self-agency over such outcomes.

Self-agency experiences in schizophrenia

The feeling that we cause our own actions and resulting outcomes is natural to us. When I shout my friend’s name, he looks over his shoulder and laughs. It is clear my actions caused him to do so. Such experiences are fundamental for social communication and interaction, are usually automatic and need no attention. However, schizophrenia patients often experience no control over their behaviour and exhibit difficulties in distinguishing one’s own actions and outcomes from those of others. They hear voices speaking to them or feel their limbs being controlled by external sources. A friend looks over his shoulder because he thinks you smell, not because you called for him. In my lab we investigate the cognitive processes and brain areas that underlie self-agency and how self-agency relates to social functioning and schizophrenia symptoms. While, most studies on abnormal agency processing in schizophrenia patients initiated from the motor prediction model and have shown impairments herein. My lab was the first to administer a self-agency paradigm in this population that was based on non-motor or cognitive processes. In my talk, I will present our findings on agency processing, its clinical and functional implications, and neural correlates in patients with schizophrenia.
Methods Workshop Speakers: 
Human Perspectives in the Science of Self

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Colin Klein is an ARC Future Fellow and a Senior Lecturer in the Department of Philosophy at Macquarie University. He is an Associate Investigator at the ARC Centre of Excellence in Cognition and its Disorders (CCD) and a member of the University Centre for Agency, Values and Ethics (CAVE), both also hosted at Macquarie University. He received his PhD in philosophy from Princeton University in 2007. He works in philosophy of mind and philosophy of science, especially where they intersect in philosophy of psychology.

**Mining Text for Fun and Profit**

Large corpora of online texts present unique opportunities for cognitive psychologists to analyse individual attitudes in natural settings. Drawing on work I and others have done on conspiracy theories, I will discuss tools and analysis strategies for psychologically-oriented corpus analysis, as well as some of the broader strengths and weaknesses of these approaches.

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Dr Melita Giummarra is a research fellow in the Pre-hospital, Emergency and Trauma Group, Department of Epidemiology and Preventive Medicine, Monash University. Since completing a Bachelor of Arts (University of Melbourne, 2002) and PhD (Monash University, 2011) in Psychological Sciences, she has published more than fifty peer-reviewed publications, received more than $1.5M in funding, and has been supported by fellowships from the NHMRC (Early Career Fellowship, 2012-16) and ARC (Discovery Early Career Research Award, 2017-20). Dr Giummarra’s research principally focusses on the social context of pain and suffering, and the persistence of pain and mental health conditions after traumatic injury. She uses a range of research methods from psychophysics and neuroimaging through to epidemiological big data analysis, geospatial mapping of population data, and narrative text analysis to better understand mechanisms of pain and mental health at a biological, psychological and social systems level. While her research predominantly involves collaboration with transport compensation systems and government health departments to bring about improvements in the systems serving injured persons, she retains a deep curiosity for the mechanisms and manifestations of phantom limb experience, which was the focus of her doctoral studies.

**Phantom limb representation: Insights from the illusion of apparent motion and solidarity constraints**

Phantom limbs are experienced as the phenomenal persistence of postural, sensorimotor features of an amputated limb. Using the paradigm of apparent motion perception, we investigated perceived limb motion through solidity constraints, examining whether the illusion varied in amputees who experience obstacle shunning in everyday life or not. The apparent motion paradigm revealed that some phenomenal aspects of phantom limb experience - especially the way that the limb is represented in relation to objects in peripersonal space - may rest on visual-sensorimotor interactions in limb representations, which could critically influence everyday phantom limb experiences (e.g., with prosthesis adjustment).
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Simmy Poonian is a postdoctoral fellow in the Belief Formation Program at the ARC Centre of Excellence in Cognition and its Disorders (CCD). She completed her PhD at the Queensland Brain Institute (QBI) at The University of Queensland and conducted a post-doctoral fellowship at Universite Paris Descartes. Simmy investigates the way in which our brain is able to plan and execute everyday movements and is particularly interested in the ways the predictions we form about ourselves and the world, influence aspects of action control, action-effect processing, observation of others’ actions and attributions of causality.

**Implicit measures of agency: Intentional binding and EEG**

Our ability to change and control our environment through our own intentions and movements has made us able to adapt the world to suit ourselves. This control or sense of agency we have over our goal-directed actions and their sensory outcomes is fundamental to human experience. Theoretical accounts suggest that the sense of agency involves an implicit, pre-reflective process and an explicit, conscious experience. In this talk I will explore behavioural and neural measures of implicit agency, which utilize the intentional binding paradigm, a temporal measure of actions and their outcomes. I will explore the distinction made between self and other actions and share insights into designing experiments to measure this phenomenon.

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Robert Keys received a Philosophy degree from the University of Wollongong (2013), in which he wrote an honours thesis on theoretical models of perceptual experience, and received a Masters of Research in Cognitive Science from Macquarie University (2016). Robert’s research aims are to understand the cognitive processes combining sensory information across modalities, which allow us to perceive coherent representations of our bodies. In particular, he uses psychophysical methods to examine how own-body perception affects our perception of the outside world. He is also interested in non-frequentist, Bayesian statistical methods and the movement towards open science.

**Dealing with the numbers: measuring perception, behaviour, and theory in body representation research**

In order to inform scientific theory, experimental data must be interpreted. Although this presents a basic problem for all scientific disciplines, we face particular difficulties as researchers investigating agency and body representation. This is partly due to the enormous range of methods available for studying the mind—from single-cell recording to individual reports of subjective experience—and partly due to the tacit assumptions in our interpretation of empirical data. In this talk, I will discuss the use of psychophysics and proprioceptive judgments to measure aspects of own-body perception, and highlight the assumptions and reasoning behind their use. Further, I will discuss Bayesian approaches to statistical analysis, and how these methods require us to be more explicit about how experimental data support our scientific theories.
Sensory and non-sensory factors affecting hand localisation under visuo-proprioceptive incongruence
Valeria Bellan, Helen Gilpin, Roger Newport, Tasha R. Stanton, Alberto Gallace, Lilja K. Dagsdóttir, Felicity A. Braithwaite and G. Lorimer Moseley
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In the past few years, we investigated the effect of sensory incongruence on body localisation. Specifically, we employed a piece of equipment called MIRAGE (Newport & Gilpin 2012) with which we were able to create a mismatch between the ‘visually encoded’ and ‘proprioceptively encoded’ position of the participants’ hands. In other words, the participants thought their hands were close together, while they were in fact far apart, because of a strong reliance on visual cues. Over a number of different experiments, we investigated self-localisation under sensory incongruence, as well as its relationship with the sense of ownership. Importantly, we examined how different external non-sensory (Exp. 1) and sensory (Exp. 2 to 6) cues, as well as awareness of the sensory mismatch (Exp. 7) could affect the update of the sensory motor system (i.e. allowing a more accurate localisation of the hand). Interestingly enough, the only cues able to realign the proprioceptively- and visually-driven hand localisation appear to be a non-informative movement of the contralateral hand (Exp. 7) and time (i.e. over time the participants become more accurate) (Exp. 1). In our most recent study (Exp. 5-6), we delivered on the target hand both painful and non-painful stimuli. Our hypothesis was that a salient stimulus, such as a painful one, would accelerate the reliance on proprioception, therefore inducing more accurate hand localisation. Our findings did not support our hypothesis. Furthermore, exploratory analysis of the data suggests an analgesic effect during the illusion.

Sensing Touch in Empty Space: TheDisconnected Hand Illusion
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Can someone embody a “disconnected” hand, and feel touch outside of their body? We developed a novel version of the mirror box illusion to explore this question. In the large mirror condition (as in a typical mirror box experiment), participants could see the reflection of both their left hand and forearm. In contrast, in the small mirror condition, participants saw only the reflection of their left hand with empty space where their forearm should be. Bimanual synchronous finger-tapping in this condition created illusory embodiment of the mirror-reflected hand sans-forearm, and (at times) the sense that their forearm was in empty space. In a series of experiments, we presented tactile stimuli to their unseen right hand or distal forearm, and asked participants to report whether they felt touch on/near the mirror reflection of their hand, or at the actual location of their right arm. First, participants reported embodying the “disconnected” hand on more than half of the trials. However, even when the mirror hand was embodied, participants often reported touch at the proprioceptively-defined location. Interestingly, on approximately 20% of forearm stimulation trials with the small mirror, participants reported feeling touch in the empty space where the forearm would be expected. In a follow-up experiment, we found that on half of these trials, participants felt that the forearm was in its actual location, yet still experienced touch in empty space. We discuss how embodiment of the disconnected hand, combined with expectations derived from higher-order body representations, leads to this illusion.
Whose Hand? An illusion of self-touch and stubborn proprioceptive drift
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The frequency with which we experience self-touch, especially between our fingers and hands, may create a bias to perceive it even when touched by someone else. Here we describe simple stimulus conditions that reveal this bias, resulting in a peculiar experience. Method: Blindfolded participant (n=12) sat with elbows on the table, hands up in the air, and outstretched fingers. Experimenter sitting opposite had a similar posture and made contact with the participant’s hands via (a) outstretched fingers on both hands; (b) one fist, one hand with outstretched fingers; (c) two fists. The posture was maintained for 7 min, during which time participants had two tasks: 1. to report whose hands/fingertips they perceived they were touching (every 30 s); 2. to judge the relative position between light touches delivered on the back of their hands (every 6 s). The latter task was an indirect measure of illusory proprioceptive drift. Results: Self-touch illusion was reported by 75%, 50% and 25% of participants in conditions a, b and c, respectively, with shortest median time-to-illusion in condition a, 3 min. Proprioceptive drift gradually brought participants' hands opposite each other in all three conditions, while their real displacement along the midsagittal plane was more than 10 cm. Conclusion: An illusion of self-touch occurs with prolonged exposure to other hands in a symmetrical posture. This illusion would be a plausible cause of the proprioceptive drift observed, had the drift not preceded the illusion and occurred also when the illusion did not, suggesting an independent cause.

Feeling stiffness in the back: a protective perceptual inference in chronic back pain
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Bodily feelings constitute a fundamental aspect of self-awareness and provide critical homeostatic functions -- e.g., feeling cold makes one seek warmth; feeling pain makes one seek protection; feeling parched makes one drink. We assume that these bodily feelings reflect the biological state of our body tissues -- a ‘read-out’, so to speak, of somatosensory and visceral input. But do they? This research interrogates the long-held question of what informs our subjective experiences of bodily state, namely, does feeling back stiffness actually reflect having a stiff back? We propose a new hypothesis: feelings of back stiffness are a protective perceptual construct, rather than a reflection of the biomechanical properties of the back. Over three experiments, we challenge the prevailing view by showing that feeling stiff does not relate to objective spinal measures of stiffness and objective back stiffness does not differ between those who report feeling stiff and those who do not. Rather, those who report feeling stiff exhibit self-protective responses: they significantly overestimate force applied to their spine, yet are better at detecting changes in this force than those who do not report feeling stiff. This perceptual error can be manipulated: providing auditory input in synchrony to forces applied to the spine modulates prediction accuracy in both groups, without altering actual stiffness, demonstrating that feeling stiff is a multisensory perceptual inference consistent with protection. Together, this presents a compelling argument against the prevailing view that feeling stiff is an isomorphic marker of the biomechanical characteristics of the back.
How the vestibular system anchors the self to the body
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I will summarize recent evidence that the vestibular system is involved in the sense of self [1]. In a prospective study in 210 patients with dizziness and 210 healthy controls, we showed a significantly higher occurrence of out-of-body experience (OBE) in patients (14%) than controls (5%). Most of the patients experienced OBE only after they started having dizziness, and OBE were mainly related to peripheral vestibular disorders. We suggest that perceptual incoherence and multisensory conflicts, due to erroneous vestibular signals about self-motion and orientation, distort the minimal sense of self, including embodiment and spatial perspective [2]. This idea was confirmed in patients with chronic bilateral vestibular failure – which is not characterized by perceptual incoherence – reporting similar embodied experiences than controls. Finally, galvanic vestibular stimulation (GVS) in healthy participants modulated the origin of their spatial perspective [3]. Participants reported ambiguous letters (b, d, p, q) traced on their forehead while they received low-intensity GVS. GVS increased the likelihood that participants reported letters from an embodied viewpoint (i.e. first-person perspective). Low-intensity GVS may have increased the natural contribution of the vestibular system to anchoring the self to the body.


Visuo-Vestibular and Cardiovascular Contributions to Vertical Ego-motion Representation
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Vertical ego-motion, i.e., elevator movement, is an embodied representation of movement in space. It can occur in naturalistic situation when, for example, we take a glass walled elevator to move upward or downward. Though a rapid waterfall is seeable, we can have the feeling that our body is moving in the opposite direction. This ego-motion representation is a complex phenomenon which necessitates multimodal visuo-vestibular and cardiovascular interactions at least. It is considered as an archetypal form of virtual reality. The purpose of the study is to analyse visuo-vestibular and cardiovascular interactions of vertical ego-motion by investigating the latency for reporting upward and downward ego-motion as well as the variation of autonomic heart rate in healthy adults. Under the hypothesis that the intensity of the visuo-vestibular interaction would influence upward and downward ego-motion latency and cardiovascular activity, thirty-five healthy adults aged 22 years have been immersed to an optokinetic environment using a Head Mounted Display (HMD). During upward and downward ego-motion, the engagement of vestibular saccular structures seems differently contribute to latency and cardiovascular activation depending on the direction of gravitational acceleration. Downward ego-motion latency is shorter than upward ego-motion latency; cardiovascular autonomic activation is lower for downward ego-motion than for upward ego-motion. These results provide evidence that a top-down organisation associated with multimodal visuo-vestibular and cardiovascular interactions would afford a neuromorphic basis to apprehend body representation.
Loss of face: infants' recognition of headless bodies
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Infants discriminate facial identities early in the first year of life and there is mounting evidence that infants can discriminate bodies on the basis of structure, proportion of body parts, and even attractiveness. However, there is no known evidence of infants’ discrimination of bodies on the basis of identity. When facial information is obscured, can infants recognise identities from bodies alone? Nine-month-old infants were familiarised to faceless whole figures or headless bodies in an upright or inverted orientation and novelty preferences to contrasting identities were assessed. Infants demonstrated a significant novelty preference only when headless upright bodies were presented. Novelty preferences were also significantly higher in the headless upright condition compared to the headless inverted condition, which is indicative of an inversion effect. Eye-tracking data revealed that when whole figures were presented, infants looked significantly longer at heads compared to bodies suggesting that heads, despite lacking faces, drew infants’ attention from the bodies. Infants’ looking times to bodies were longest in the headless upright condition. Infants also looked longer at the feet of inverted stimuli compared to the feet to upright stimuli suggesting that infants have an upper bias when presented with human figures. The findings suggest that at 9 months of age, infants can recognise people on the basis of bodies, particularly in the absence of head information.

Altered bodily sensation of emotion in schizophrenia
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Emotional deficit is a core feature of schizophrenia linked to social withdrawal and poor outcome. Emotional experiences directly impact bodily states via the musculoskeletal, respiratory, cardiovascular, gastrointestinal and endocrine systems. Conversely, bodily sensations are central to emotions. More broadly, bodily sensations form the core of self experiences. Although bodily self-disturbances and impaired emotion recognition are both central to schizophrenia, the bodily experience of emotions in relation to schizophrenia has not been extensively examined. Individuals with schizophrenia (SZ) and demographically matched controls (CO) participated in the EmBODY task to generate bodily sensation maps that correspond to bodily activation and deactivation experienced during 14 emotional experiences. Schizotypy in healthy participants was assessed with the SPQ-B. Symptoms were measured with SANS and SAPS. In the bodily maps, SZ showed less emotional embodiment compared to CO, suggesting a reduced range of bodily experience of emotion. In particular, SZ reported less activation for positive emotions and less deactivation for negative emotions than CO. Positive symptoms predicted embodiment deficit. Classification accuracy analyses revealed lower independence across emotions in SZ compared to CO, which indicates less discrete bodily sensation of emotions. When directly comparing the maps of SZ and CO, we found that bodily maps of high-arousal emotions (love, fear, anger) were more similar, while some low-arousal emotions were not correlated (sadness) or antecorrelated (depression). This suggests a specific deficit of bodily deactivation in emotional experience in SZ. Future work will examine the role of autobiographical memory and mentalization on bodily self-disturbances and emotional dysfunction in schizophrenia.
Effects of dexamphetamine on multisensory body and other illusions in healthy volunteers and their relationship to working memory
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Perception of both uni- and multi-modal multisensory events and objects involves the integration of various stimuli over time and space. This integration is critical to the perception one's self. There is some evidence that the temporal binding window for multisensory integration is widened in people with schizophrenia, which is likely a function of increased in basal and stimulated dopamine release. We investigate the effect of the dopamine release enhancer, dexamphetamine (0.45 mg/kg, po), in healthy volunteers on a variety of illusions in which the interstimulus temporal and spatial intervals of eliciting stimuli were independent variables to assess effects on binding windows. A double-blind, placebo-controlled, counter-balanced cross-over design was used, to reduce the impact of individual differences in illusion susceptibility. We observed significant dexamphetamine effects consistent widening of temporal windows after acute dexamphetamine treatment relative to placebo in multimodal illusions (rubber hand, marble hand, McGurk effect), and widened windows for both temporal and spatial binding in the unimodal tactile funnelling illusion and visual flash illusion. We hypothesised that the width of binding windows may be related to spatial working memory, and tested that hypothesis. The preliminary data on those tests, and on a test of the effect of dexamphetamine on the spatial binding window in the rubber hand illusion will be available at the workshop.

Body size perception in healthy adults can be manipulated using galvanic vestibular stimulation and distorted visual exposure
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The brain has an implicit, internal representation of the body that is maintained, adjusted, and updated in response to changes in body shape during growth and development. Here, we investigated how perceived body size accuracy may be affected when body representation is manipulated. We attempted to alter body perception by either having participants look at a distorted image of their own body for five minutes or by the use of disruptive galvanic vestibular stimulation (dGVS sum of sines). Participants were tested with the body or body parts presented in different viewpoints to see if performance changed for familiar and unfamiliar views. The Body Shape Questionnaire (Cooper et al., 1986) was also administered. Accuracy was measured using a novel psychophysical method for determining perceived body size that taps into the implicit body representation (see Harris and D’Amour conference abstract). The time course of visual adaptation effects was measured. Control experiments were also carried out using a familiar inanimate object (e.g., a Coke can). Manipulating body representation using both visual and vestibular methods resulted in changes to perceived body size accuracy. These results provide insights into how the brain represents the body, revealing that body size perception is flexible and plastic.
The Role of Gender in Fat and Muscle Aftereffects: Implications for Body Image Disturbance
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Body size and shape misperception (BSSM) is a significant component of body image disturbance. These distressing perceptual distortions are experienced by many members of the general population and constitute a risk factor for the development of eating disorders (such as anorexia nervosa) and muscle dysmorphia. For several decades, the occurrence of BSSM has been linked to consumption of mainstream media promoting unrealistic body standards, which have tended to be relatively gender specific. While male-directed content tends to emphasize the importance of muscularity, female-directed content primarily encourages pursuit of the thin (i.e. low fat) ideal. Recent visual adaptation research has successfully simulated BSSM effects in the laboratory by exposing participants to images of bodies that are high or low in body fat, causing an aftereffect such that subsequently seen bodies (including the body of the participant) appeared unrealistically thin or fat respectively. Similar effects are seen for adaptation to high or low levels of muscularity. In this study, we investigated potential gender differences in visual aftereffects to fat and muscle. It was expected that male participants would demonstrate larger muscle aftereffects, while females would demonstrate larger fat aftereffects. Although these hypotheses were not supported, results showed significantly larger fat and muscle aftereffects when participants viewed stimuli corresponding to their own gender compared to other gender stimuli. The implications of these findings for visual adaptation models of real-world BSSM will be discussed.

The body shape and volume perception
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Given the familiarity of our body it may seem surprising how distorted its representation is in healthy adults. Here, I present an investigation into distorted body representations which extends the previous literature by focusing on the three-dimensionality of the body. The first two experiments concern a metric model of the body which shows the distortions characteristic of those in early somatosensory maps and which is associated with biases in somatoperception. The internal geometry of tactile perceptual space has been investigated before in two-dimensional space with a multi-dimensional scaling technique. By extending this approach to three-dimensional space, I constructed the implicit shapes of body parts in order to quantify the role of skin-centred versus shape-centred size perception. The method has a potential to investigate, and compare between healthy and clinical populations, the role of early somatosensory representations in how body shape is construed. The third study concerns the conscious perception of body size. I expanded on the research traditionally using one-dimensional or two-dimensional measures in a study comparing the one-dimensional size judgements and a perception of body volume in three-dimensional space. Although the biases across body parts were similar in magnitude, they were in the opposite direction. Therefore, the perceived size of the body appears to be malleable depending on situational or task demands. In all, this research contributes to a growing body of evidence showing that our perception of the body size is not infallible as well as it adds novel findings by studying the body as a three-dimensional object.
Measuring and Manipulating Body Representations in Anorexia Nervosa

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Recent research suggests that anorexia patients cognitively misrepresent their bodies -- as larger than reality. In turn, this may cause them to experience their bodies as oversized, potentially playing a prominent role in disease maintenance. In this talk, I explore how we can gain a deeper understanding of these distorted body representations, using the twin methods of measurement and manipulation. Over the past few years, Longo and colleagues have developed a number of behavioural tasks for measuring the spatial content of body representations. I discuss the underlying theory behind these tasks and show how they can be applied to measuring anorexia patients’ distorted body size content. I go on to discuss the possibility of manipulating this content. It’s long been claimed that the rubber hand illusion manipulates body representation content -- specifically, body representations integrate content regarding the rubber hand. I clarify the kind of integration involved in rubber hand experiments and offer a novel definition of integration as the manipulation of stored content. Finally, I discuss a number of recent rubber hand illusion experiments, interpreting their results in light of the discussed notions of measurement and manipulation.

At Your Fingertips: The Effect of Target Finger, Task Type, and Dual Tasks on Localising Manual Tactile Stimuli

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Despite the long history of the tactile sense being studied psychophysically, surprisingly few studies have concerned identifying the location of tactile stimuli at the hand. Trojan et al. (2014) contend that even fewer studies have concerned the localisation of tactile stimuli at the fingertips. The current study features several experiments, each with an aim to add clarity to this small battery of findings -- in particular, if differences exist between fingers within a hand and when; if mislocalisation occurs in a biased manner and how; and if differential allocation of attentional resources affects given tactile tasks in ways found in tasks of other senses. Each experiment in the current study uses vibrotactile stimuli applied to the fingertips. Across all experiments, a given task could include a single touch localisation within each hand, temporal order judgments for all permutations of pairings within each hand, or a pseudorandom sequence for all fingers within each hand. In some experiments, a localisation task is conducted on one hand whilst a simultaneous task is conducted on the other -- either localisation or low-level discrimination. Overall, performance and sensitivity varies with finger - such that fingers on the periphery are localised more reliably than fingers in the centre of a hand -- and with task type -- such that an increase in the number of events and temporal cluttering results in poorer outcomes. In dual tasks, the effect of the secondary task is both severe and washes out the peripheral benefits observed in the primary task alone.

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Atypical metacognition and sense of agency in high hypnotic suggestibility
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Multiple theories of hypnosis converge on the proposal that responsiveness to suggestion is facilitated by aberrant metacognition. According to such accounts, highly suggestible individuals voluntarily produce responses to suggestions but experience them as non-volitional because of impaired awareness of the intentions associated with the responses or a deficit in identifying the source of suggestion-specific representations. A corollary of this hypothesis is that highly suggestible individuals will have impaired metacognition or executive monitoring but the specificity of this effect has not yet been explored. Here I will describe multiple studies examining the breadth of atypical monitoring in this population in order to determine whether aberrant metacognition is restricted to meta-awareness pertaining to the sense of agency and motor intentions or whether it reflects a broader deficit. In particular, I will describe data from studies examining metacognition of agency, meta-awareness of attentional states and motor intentions, sense of agency, interoception, self-awareness, and source monitoring in highly suggestible individuals and controls. The results highlight the specificity of atypical metacognition and monitoring in this group and have implications for contemporary models of hypnosis and distortions in the sense of agency.

Modifying temporal expectations of self-generated sensations with training
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Forward modelling accounts of action effects suggest that predictive processes allow the sensory consequences of our actions to be anticipated and subsequently attenuated, which contributes to our sense of agency over these sensations. These sensory expectations involve temporal predictions as to the anticipated timing of self-generated sensations. It has been hypothesized that humans hold the prior belief that sounds should occur immediately after initiating actions. The current study aimed to determine whether this temporal expectation could be modified with repeated exposure to a delayed, self-initiated auditory sensation. Participants underwent electroencephalographic (EEG) recordings while undergoing a task where they pressed a button to produce a tone. The onset of the tone occurred either immediately or 100ms after the button press. Training comprised of repeated exposure to the delayed tone, and as a comparison, repeated exposure to the immediate tone. Pre- and post- training measures of the evoked response to the tone were assessed to determine the effect of training. Pre-training, delayed tones evoked a larger N1 amplitude compared to immediate tones. However, across two experiments, it was demonstrated that, in contrast to training to immediate tones, training to the delayed tone resulted in a reduction in N1 amplitude, such that there was no difference in N1 amplitude post-training between the immediate and delayed tones. These results suggest that it is possible to modify the neural assumption that sensations follow immediately from actions. This findings may have implications for disorders, such as schizophrenia, which are ostensibly associated with abnormalities in sensory attenuation.
The role of the temporoparietal junction in implicit and explicit sense of agency
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The sense of agency refers to the feeling of being in control of one’s actions and their outcomes. This can be measured explicitly, by asking people to report their experience of agency, or implicitly by recording the perceived time interval between actions and outcomes (temporal binding). The involvement of the left and right temporal-parietal junction in both implicit and explicit sense of agency was investigated in two experiments. Participants were informed that they could control the volume output of the computer with one of two buttons. However, during the experiment the volume of ensuing sound did not always follow this expectation. On each trial, participants reported both the perceived time of the tone, and the degree to which they felt like they controlled the action outcome. Participants experienced reduced sense of agency when the outcome was inconsistent with their action. In contrast, there was no difference in binding between congruent and incongruent outcomes. In Experiment 1 anodal transcranial direct current stimulation was applied to the right temporoparietal junction (TPJ), while in Experiment 2, stimulation was applied to the left TPJ. We observed significant changes in explicit reports of agency following right TPJ stimulation but not left TPJ stimulation. Implicit agency was not affected in either stimulation condition. These findings are discussed in terms of the possible neural mechanisms of implicit and explicit sense of agency.

Real and imagined walking by schizotypal individuals
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It has been postulated that efference copy constitutes an important cue for path integration, a component process of spatial navigation in which navigators derive their current location by integrating internally generated self-motion signals such as vestibular and proprioceptive cues. We sought for empirical support for this notion by capitalizing on the idea that dysfunctional efference copy may underlie schizotypal traits - that is, by examining whether low- and high-schizotypal individuals would perform path integration differently. In an experiment, participants with varying levels of schizotypal traits performed real and imagined walking tasks in which they either walked or imagined walking to a previewed target without vision and hearing. Real walking elicited vestibular and proprioceptive signals as well as efference copy, whereas imagined walking supposedly evoked efference copy only. Results showed a general tendency that high-schizotypal participants carried out the tasks more slowly than low-schizotypal participants. In particular, imagined walking was reliably slower as participants’ schizotypal traits became higher. These findings suggest that less functional efference copy in higher-schizotypal participants affected path integration in real and imagined walking, and its effect was more pronounced in imagined walking because this task was more critically dependent on efference copy. Together, they indicate the possibility that efference copy is indeed involved in human path integration.
The role of heads in body inversion effects in posture and identity discrimination tasks
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Evidence for inversion effects with complete images of people, with bodies and heads, is typically reliable, but when it comes to headless bodies, there are contradictory findings. Studies of posture discrimination indicate that the inversion effect is absent with headless bodies (e.g., Yovel et al., 2010), suggesting that heads play a vital role in body representations. However, body identity discrimination studies demonstrate that headless bodies are also subject to an inversion effect (Robbins & Coltheart, 2012) or even a reversed inversion effect with better discrimination of inverted compared to upright bodies (Minnebusch et al., 2009). To determine whether the difference is based on discriminating body postures compared to identities, a within groups design was employed where participants completed both task types in separate blocks. Participants saw a sample image for 250 ms followed by the same image paired with either a contrasting posture or contrasting identity and participants indicated which image matched the sample. Half of the images were upright, half inverted, and half were headless and half whole figures (bodies with heads). Participants were more efficient in discriminating upright compared to inverted whole figures as well as headless bodies in both the posture and identity discrimination tasks. This suggests that bodies are subject to inversion effects without the presence of heads, regardless of task type. Study design (within and between groups) as well as eye-tracking data will also be discussed.

Stimulus color has little effect on perception of visually induced circular vection
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Previous studies revealed that red dots could have effects on linear vection than the other colored dots in different experiments. Visual motion stimuli consist of red and black dots to induce circular vection (CV) have been frequently employed in vection studies. In the present study, visual motion stimuli consist of rotating dots were presented to 20 subjects, the effects of color (red and black dots; black dots; grey and black dots) and angular velocity (2, 4, 8, 16, 32, 64 degree/second) on CV were investigated. The subject’s task was to press and hold one of two buttons whenever they felt vection. The two buttons corresponded to the subjective strength of vection: full-vection and partial-vection. Results indicated there was a significant effect of velocity, but no effect of the color on CV. The subjects perceived stronger CV (duration, frequency of CV occurrence and average duration) at 8 deg/sec, 16 deg/sec and 32 deg/sec than at the other velocities. The higher CV intensity occurred at 4 deg/sec and 8 deg/sec than at the other velocities. Moreover, the shortest CV onset latency was perceived at 64 deg/sec. These results could offer optimal choices of CV with respect to different requirements for CV strength, duration and susceptibility in psychophysical and neurological studies. The findings of color effect suggested that red component of visual motion stimuli might confound with other factors (e.g., stimulus luminance, luminance contrast and field of view) to influence CV.
**Effects of body position and angular velocity on perception of visually-induced circular vection**

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Visually induced circular vection (CV) has been the subject of many functional brain studies and behavioral studies. Unfortunately, participants in functional brain studies were in supine position while participants for behavioral studies were in upright positions. Consequently, their findings are confounded with viewing positions and there is no reported study comparing the effects of upright and supine positions on CV perception. This study examines the effects of viewing positions and their interactions with different angular velocity of the stimuli (2, 4, 8, 16, 32, 64 degree/second). 16 subjects were exposed twice to the stimuli that allowed varied body positions. Conditions were counterbalanced so that half of the subjects received the supine first and the other half received the upright condition first. Results indicated that CV with the longest accumulated and average duration occurred at 32 deg/sec for supine position. In addition, at slow velocities (2, 4 and 8 deg/sec), subjects perceived CV with longer accumulated and average duration when they were sitting in an upright position than lying in a supine position. Original data on accumulated and average CV duration under different velocities and body positions provide a vital link between findings of functional brain studies and behavioral studies. The findings that different CV are generated from supine and upright positions and gender difference need to be further explored in the future.

**Representing the location of manipulable objects in shape-selective occipitotemporal cortex: is there any evidence for spatiotopic reference frames?**

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When interacting with objects, we have to represent their location relative to our bodies. To facilitate bodily reactions, location may be encoded in the brain not just with respect to the retina (retinotopic reference frame), but also in relation to the head, trunk or arm (collectively spatiotopic reference frames). While spatiotopic reference frames can be found in brain areas for action planning, such as parietal areas, the existence of spatiotopic reference frames in higher-level occipitotemporal visual areas is debated. For example, Golomb and Kanwisher (2012) did not find evidence for spatiotopic reference frames in shape-selective occipitotemporal cortex for faces, headless bodies and scenes stimuli. However, it may be possible that we tend to only represent body-centred location when viewing objects that are typically manipulated. Here, we used fMRI multi-voxel pattern analysis (MVPA) and Bayesian analyses to test if location can be encoded in a spatiotopic reference frame in shape-selective occipitotemporal cortex when using manipulable object stimuli (balls and cups). We found strong evidence for retinotopic location encoding further supporting previous findings that retinotopic reference frames are common neural representations of object location. In contrast, when testing for spatiotopic encoding that is independent of retinotopic encoding, we found conclusive evidence that objective location information for small manipulable objects is not decodable in relation to the body in shape-selective occipitotemporal cortex. Interestingly, further exploratory analyses suggest that spatiotopic location might modulate retinotopic location encoding, which may be why spatiotopic encoding has been difficult to find in other analyses.
**Judgements of object width and grasp configuration**

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When grasping objects, we are able to perceive the aperture of our hand (the distance between our thumb and fingers), even without vision. However, this perception is not stable. For example, it can be influenced by a change in the weight of the object (1). We investigated how grasp configuration and subjects’ attentional focus influence this perception. Without vision, 20 subjects grasped a 6.5 cm-stationary object with two grasp configurations; thumb with all fingers, and thumb with index finger. For both configurations, subjects were asked to attend to and report perceived grasp aperture or perceived object width using a visual chart. Additional objects of 5.5 cm and 7.5 cm were included as distractors. Overall, subjects underestimated object width and grasp aperture by 0.42 cm [95% CI 0.18, 0.67]. Across the two grasp configurations, there was a 0.38 cm [0.28, 0.47] difference in perception (thumb with all fingers: 6.27 cm [6.16, 6.38]; thumb with index finger: 5.89 cm [5.78, 6.00]). In contrast, there was no effect of attention (grasp aperture: 6.10 cm [5.98, 6.21]; object width: 6.06 cm [5.95, 6.16]). Thus, perception of the hand and object is closer to reality when grasping an object with all digits. Furthermore, judgements of hand configuration and object size may access the same perceptual ruler.


**Biological motion and belief-of-agency information elicit similar patterns of inhibition of return**

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Inhibition of return (IOR) refers to slowed to responses to targets presented at previously-attended locations. Response times are also slowed to targets that a co-actor has previously responded to (social IOR; sIOR). It is unclear what information from the social context is contributing to sIOR. We tested whether biological motion and belief-of-agency generate sIOR. Participants lifted their fingers from midsagittal starting position and touched a green target positioned on the right or left bottom edge of a monitor. Targets were cued congruently or incongruently by a white dot. There were four dot motion conditions: the dot followed the biological motion of someone pointing (biol-upright), the same motion but played upside down (biol-inverted), a non-biological motion (linear), and linear motion with the belief that it represents a pointing action of a female model. The SOA between the initiation of the dot’s movement and the presentation of the target was 200ms, 600ms, and 1300ms. Similar patterns of inhibition were observed following biological motion and linear motion with belief-of-agency at SOAs of 600ms and 1300ms. We speculate that the visuomotor system activates motor plans based on visual kinematic information and beliefs about the origin of the stimulus. This capacity may underpin IOR in social interactions.
Role of action planning in suppression of auditory evoked potentials
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It is well known that the brain processes self-produced stimuli differently from externally produced stimuli. This difference is observed in auditory event-related potentials (ERPs) which measure brain activity in response to sounds. Sounds produced by participants pressing a button elicit smaller N1 and P2 ERP peaks than the same sounds passively listened to. N1 and P2 suppression is believed to be caused by corollary discharge, a mechanism allowing the brain to predict and prepare for self-produced stimuli. Action planning is required before corollary discharge is able to occur. However, it is unclear whether N1 and P2 effects also depend on action planning. Thus, this experiment tested whether external button presses initiated through electrical and physical manipulations can cause N1 and P2 suppression. Furthermore, we tested whether using the same manipulations on oneself to produce indirect presses would result in ERPs more similar to direct (no manipulations), or external actions. We found N1 and P2 suppression for direct, but not external or electrically-induced indirect actions. Interestingly, N1 and P2 suppression effects differed for physically-induced indirect actions, such that suppression was found at P2, but not N1. My talk will discuss these findings in relation to the role of action planning in N1 and P2 suppression, and consider the implications for interpreting N1 and P2 effects.

Presence and Absence in Seeing: A Case study of Schrödinger’s kittens and Motion Induce Blindness
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Here the established illusion of Motion Induced Blindness (MIB) is presented as a way of investigation the precarious phenomenology of presence and absence in vision. This paper will investigate this precariousness with the aid of kittens. These are Schrödinger’s MIB kittens. Like the cat in Schrödinger’s thought experiment which involved investigation of the way a cat could be ambiguously understood to be alive or dead depending on the particular way a nearby radioactive isotope happened to behave, so too these kittens are either visible or invisible depending on the way the peripheral vision of the observer behaves. That is, the kittens has been put at risk of disappearing by simply being in the peripheral vision which, while the eyes are stationary, is a dangerous place to be. Moving blue dots make their disappearance more likely in an illusion know as Motion Induced Blindness (MIB). Where the cat goes is difficult to know, but like most cats it comes back when it feels like it. This illusion and exploration of presence and absence in vision is important to understanding the precarious nature of the experience of seeing. This is particularly important to understand when working with people with low or limited vision. The experiences of seeing reported when vision restoration is attempted with the aid of prototype bionic devices also has a precarious quality. Understanding the precarious nature of presence and absence in vision as ubiquitous to all seeing, can be used as a way to help describe the phenomenology of bionic vision restoration.
Allostatic regulation and the conditions of biological agency
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Traditional accounts of interoceptive processing suggest that the neural representation of bodily states serves to provide the brain with the necessary information for maintaining homeostasis. More recently, evidence implicating embodied sensory experience as a key constituent of various higher-level cognitive processes or phenomena, including emotion, selfhood, and conscious awareness, has begun to accrue. In light of these developments, we argue that the supposedly fundamental role interoception plays in signaling the current physiological status of the internal milieu ought to be revised in favour of a more nuanced understanding of biological regulation. On this account, interoceptive information from the viscera and perceptual data from the external environment are integrated in the context of the agent’s prior experience. The dynamic unfolding of internal and external sensory events over time precipitates the emergence of sophisticated, anticipatory modes of physiological regulation (‘allostasis’). To date, most investigators have sought to understand how such allostatic control processes might contribute to the overall health and wellbeing of the individual, and how the dysfunction of such mechanisms might give rise to a range of physical and mental disorders (e.g., cardiovascular disease, anxiety, depression). We argue however that a deeper analysis of allostatic regulation discloses insights that help us to understand fundamental aspects of adaptive biological agency across multiple scales of spatiotemporal complexity.

The Mirror Rubber Hand Illusion: Blurring the Sense of Self
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The rubber hand illusion (RHI) paradigm has been used to explore body ownership, demonstrating that participants may misattribute a touch they feel on their own hand to a rubber hand that they see in front of them. This occurs when the rubber hand is stroked synchronously with the participant’s hidden hand. Mirrors have been used to explore many aspects of self-awareness, such as, theory of mind, body schema and motor agency, but there has been limited research into how mirrors influence body ownership in the RHI. In the current study, the RHI paradigm was used in the traditional method without a mirror, and also with a mirror placed in the sagittal plane. We tested participants with Vision Touch Synaesthesia (VTS), who are particularly susceptible to body ownership illusions, and control participants, using three stroking conditions -- synchronous, asynchronous, and no-touch (i.e., the rubber hand was stroked but the participant’s hand was not). In everyday encounters, individuals with VTS describe feeling touch when they observe others being touched, which is the reason we included a no-touch RHI condition. We found that, compared to the no-mirror condition, a mirror in the sagittal plane attenuated the RHI in the synchronous condition for both participant groups, and also in the no-touch and asynchronous conditions for VTS participants. These findings demonstrate that a sagittal mirror can significantly decrease the strength of body ownership illusions. Our preliminary research indicates that sagittal mirrors emphasise visual capture of proprioception, which may conflict with the illusory properties of the RHI.
How does attention affect perceived finger location and ownership in a grasp illusion?
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Passively grasping an unseen artificial finger causes the index fingers to feel ~5 cm closer (from 12 cm) and induces a sense of ownership over the finger (Héroux et al. 2013, J Physiol). This study determines how attention influences this grasp illusion. In 30 naïve subjects, the effect of attentional focus was investigated under three conditions: (1) auditory-guided cueing to increase upper extremity awareness, (2) touch-guided cueing to increase upper extremity awareness, and (3) watching a silent film (control). Each condition lasted 3 min, followed by measures of perceived index finger spacing and perceived ownership of the artificial finger (7-point Likert scale). Interoceptive awareness was measured by heartbeat tracking and an interoception questionnaire. Compared to control, auditory- and touch-guided cueing did not influence index finger spacing or perceived ownership. However, after adjusting for interoceptive awareness, the auditory-guided cueing caused the index fingers to feel an additional 1.3 cm closer [0.1 to 2.6] (mean [95% CI]) and perceived ownership to increase by 3.3 points [2.6 to 3.9]. The regression model retained heartbeat tracking performance for measures of perceived spacing, and questionnaire scores for perceived ownership. Thus, stronger grasp illusions were experienced by individuals with lower interoceptive awareness. Overall, attention modulates the strength of the grasp illusion when individual differences in interoceptive awareness are considered. Future studies of body representation should take into account the effect of interoceptive awareness on perceived body location and ownership.

Sense of Agency Confidence and Body Image Perception: Evidence from The Alien Hand Experiment
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Body image perception comprises stable and dynamic representational features. Recent literature in the field has investigated whether whole body representational features predict sense of agency and perception of movement. Here, we examined whether a stable body image measure correlates to a sense of agency score extracted from an experimental task. Moreover, we tested whether differential body image perception scores predicted sense of agency performance under sensory conflict conditions. A total of 21 non clinical university students (age M=25.9, SD=9.29) completed the Brazilian version of the Silhouette Figures Scale and participated in The Alien Hand Experiment. The experiment comprises a task that manipulates participants’ sense of agency by means of a conflict between visual arm movement input and proprioceptive arm movement input. We tested three experimental conditions: (a) control condition - seeing own real arm movement, (b) convergent condition - seeing alien arm movement mimicking own real arm movement, and (c) divergent condition - seeing alien arm movement deviating from own movement trajectory. A Bayesian correlation matrix revealed substantial negative correlation probability between body image distortion and sense of agency confidence in accuracy responses, specifically in experimental conditions where agency was manipulated. Based on the Silhouette Figures Scale scores, participants were divided into groups with (n=12) and without (n=9) evidences of body image distortion. Bayesian Independent Samples T-Tests evidenced substantial differential probability between groups. Analyzes confirmed lower sense of agency confidence among subjects with body image distortion greater than ±3 kg/m². No differences between groups were observed regarding sense of agency accuracy.
Boundary Exploration in Enactivist Artificial Agents
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Enactivism has established itself as an alternative to the computationalist-representationalist paradigm largely used in modelling and developing artificial agents. Enactive cognition does not rely on computational processing and instead emphasises the dynamics of agent-environment sensorimotor coupling. Enactivist principles provide a research agenda that ranges from the most basic forms of behaviour to the highest end of human consciousness. Such principles displace the explanatory focus from internal representations to direct sensorimotor interaction. This shift of focus, I argue, should also occur in the development of artificial agents that could learn to interact with people in a manner that is consistent with the human body and social psychology. This development would have applications in areas like robot-assisted healthcare or in treating people with developmental disabilities.

The present paper proposes an agent framework where agency is defined on the basis of the regularities of interactions within an abstract environment. I particularly develop artificial agents that explore, learn, and exploit regularities in their milieu. Such interactionally motivated agents follow decision mechanisms that rely on the agent's capacity of anticipation to choose interactions that have positive valence and avoid interactions that have negative valence. Using the same enactivist paradigm, I characterise the functional boundaries of the agent and examine if the status of its internal subsystems could predict spatial regularities on the frontiers of its external milieu. Identifying the processes that give rise to such boundary would refine our understanding of the emergence of the self in simulated environments.

Baseline perceived size of the arm, hands, palm, and full body in healthy adults
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The perception of body size has traditionally been studied using subjective, qualitative measures that assess only one type of body representation - the conscious body image. Previous research has typically focused on measuring the perceived size of the entire body rather than individual body parts, such as the arms and the hands. Here, we used a novel psychophysical method for determining perceived body size that taps into the implicit body representation. Using a two-alternative forced choice design, participants were sequentially shown two life-size images of either their arm, hand, palm, or full body. In one interval either the horizontal or vertical dimension of the image was varied using an adaptive staircase, while the other interval contained the full-size, undistorted image. Participants reported which image most closely matched their perceived size. The staircase honed in on the distorted image that was equally likely to be judged as matching their perception as the accurate image from which the perceived size was calculated. The orientation of the image was varied to compare performance for familiar and unfamiliar views. The Body Shape Questionnaire (Cooper et al., 1986) was administered in order to determine if body dissatisfaction affected perceived size accuracy. Participants were not accurate at judging their size, and differences occurred depending on the viewpoint. These results provide psychophysically robust baseline measurements of how accurately healthy participants perceive the size of their body and body parts, revealing distortions of the implicit body representation independent of the conscious body image.
Time, touch and temperature affect perceived finger position and ownership in the grasp illusion
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Perceived body position and ownership are fundamental to our ability to sense and interact with the world. Previous work indicates that dynamic multisensory stimuli are needed to alter the sense of body ownership. In the present study 30 subjects passively grasped an artificial rubber finger with their left index and thumb while their right index finger, located 12 cm below, was lightly clamped. Fingers with varied physical characteristics were also passively grasped to determine how these characteristics influenced perceived body position and ownership. Subjects immediately felt their hands to be 5.3 cm [3.4 to 7.3] (mean [95%CI]) closer, a feeling that remained after 3 min (6.0 cm [4.5 to 7.5]). By the end of the trial, perceived ownership increased by 1.2 [0.6 to 1.9] points on a 7-point Likert scale, with the group average moving from 'neither agree or disagree' at the start to 'somewhat agree' at the end. Compared to grasping a control rubber finger, grasping a cold, rough, oddly shaped or rectangular shaped finger-like object reduced perceived ownership. These results provide new insights into the role of cutaneous sensory receptors in defining these aspects of proprioception, and the speed with which these effects occur. Touch rapidly induces large, sustained changes in perceived body position and prolonged exposure to these cutaneous inputs, alone, can induce a sense of body ownership. Also, certain physical characteristics of grasped objects influence the sense of body ownership.

When the body is the target - the role of body representations in non-accidental self-injury: A systematic review
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Background: Typically, we try to protect our own bodies and this is supported by internal representations that specify one’s body identity and location. But in self-harm, the body becomes the target. One possibility is that body representation disturbances contribute to self-harming behaviour. During adolescence, the body becomes more salient to one’s self-concept, and it is also the age at which first acts of self-harm are typically reported. Thus, the link between body representation disturbances and self-harm could be especially prominent in adolescence.

Methods: We conducted a systematic review to critically examine the potential role of body representation disturbances in non-accidental self-injury (with/without suicidal intent) in adolescents and young adults (12-25 years). Several international databases (PubMed, PsycINFO, EMBASE, Social Science Database, Web of Science) were searched, and then the literature was reviewed via a narrative synthesis of the data.

Results: The search strategy identified 64 studies reporting on 275,183 participants from 20 countries. Overall, participants reporting non-accidental self-injury reported greater levels of body dissatisfaction, body disownership, somatic complaints, and interoceptive deficits compared to non-injuring control groups; however, there was subscale variability, gender and race differences. The quality of evidence was highest for body image studies and lowest for body ownership studies, with small samples and no adjustment for confounders.

Conclusion: There was consistent evidence of disturbances across several different body representations (image, ownership, sensations) in adolescents and young adults who engage in non-accidental self-injury. This points to a need for investigating self-harm therapies that take body image and awareness into account.
The selfless self
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There are two fundamental models to understand the self, one is the neurobiology of consciousness and the other is the phenomenological approach. In Damasio’s neurobiology, consciousness is enabled by the result of a procession of neural maps of inner and outer worlds, that is what he names, self-consciousness. Without a self the mind would lose its orientation, thoughts would be freewheeling, unclaimed by an owner, and we would certainly look unconscious (Damasio, 2010, chap. III). Damasio makes a distinction between three levels of “self”. I will attempt to show this theory is mostly centred on the notion and levels of self as archetyped by the brain. While Damasio rejects dualism by bringing consciousness back to the body (brain function), he is also rejecting phenomenal aspects of consciousness, and bringing the discussion back to a physicalist view of the self. Can the self be thought in a non-reductive model? I will make the case for the notion of a self as process, as it is thought in the enactive approach. Finally, I will conclude that the self in these terms can be accommodated by a non-cognitivist view of the free energy principle, which implies that mentality is nearly everywhere. I expect being able to make the case for the enlightening role of a strong continuity view on particular concepts of life (autopoiesis and adaptivity) and mind (basic and non-semantic), that enable the process of a selfless self.

Measuring the Sense of Self in Brain-damaged Patients
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Researchers have recently focused on the embodied sense of self (ESS), which consists of the minimal and narrative self. Although a study demonstrated that the ESS is related to brain dysfunction empirically, the subjective aspects of the ESS and a systematic approach to it have not yet been examined in brain-damaged patients. To examine this issue, we measured the ESS of patients with brain tumors before and after awake craniotomy. A self-reported questionnaire called the Embodied Sense of Self Scale (ESSS) was used to measure the ESS in patients with brain tumors before and after surgery. For comparison, age-matched controls also completed the ESSS. The ESSS scores of the patients with brain tumors before surgery were higher than those of the controls and improved after surgery. Sensory deficits induced deteriorated agency. Episodic memory disturbance was highly correlated with malfunction of narrative self and ownership. Brain lesions caused an anomalous ESS, which was related to the patient’s cognitive and physical dysfunction.
**Relationship between agency judgment and intentional binding**
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Sense of agency stems from the action-effect congruency based on internal prediction. Explicit measure of sense of agency includes self-report judgment. Implicit measure of agency includes the degree of intentional binding, in which the temporal action-effect interval is perceived as shorter than the actual interval. We examined whether agency judgment and intentional binding correlate while being modulated by the action-effect temporal congruency. Participants performed voluntary keypresses that triggered a tone after variable delays (100-900 ms). Subsequently, participants rated their agency over the tone using a 9-point scale and estimated the keypress-tone interval. The agency rating and the degree of intentional binding decreased with increasing tone delays. Importantly, there was a moderately positive correlation between the slopes of linear regression for agency rating and intentional binding with the tone delay as an independent variable, indicating that agency rating and intentional binding were modulated by action-effect temporal congruency in a similar manner. These results suggest that the explicit and implicit sense of agency moderately correlate and are commonly based on temporal prediction.

**Mutual responsiveness in action and embodied cognition**
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According to a leading philosophical account of small-scale cooperative joint action (Bratman 1999, 2014: 78), central instances of it require from participants to be mutually responsive in action to one another, i.e. they demand the flexible tracking and adjustment of an agent’s actions to the actions of co-agents during joint action execution. This leading account has been criticized for not being informative about the “body glue” required by mutual responsiveness in action (Pacherie 2015, 24). Therefore, it has been suggested that more attention should be given to some cognitive mechanisms that plausibly enable joint action execution, such as co-representation of tasks, co-representation of perceptions, and alignment mechanisms (Pacherie 2015, Knoblich et al. 2011, Gallotti et al. 2017). The aim of my presentation is to map out and examine some theoretical perspectives for researching how bodily information concerning a co-agent may be integrated by an agent in the context of activities involving mutual responsiveness in action. Following the proposal that joint action execution is supported by a “shared action space” (Pezzulo et al. 2013), I examine some ways of framing the interpersonal integration of bodily information that differ because of their commitment to different understandings of what embodied cognition amounts to: ‘weak’, functionalist, biological or enactive embodied cognition (see Gallagher 2017, Ch. 2).
Loudness judgements are not necessarily affected by visual cues to sound source distance
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The intensity of the auditory signals at the ear depends both on the intrinsic capacity of the emitter to produce sound and on the distance of the emitter from the listener. Loudness constancy requires that our perceptual experience of intensity, loudness, corresponds to the source intensity by remaining invariant to the confounding effects of distance. In this experiment using a healthy university population, we tested the hypothesis that visual cues to sound source distance are capable of supporting a degree of loudness constancy when the auditory stimulus does not contain environmental cues. We presented human participants with a simulated visual environment, on a computer monitor, which contained a visible loudspeaker at a particular distance and was accompanied by the auditory delivery, via headphones, of anechoic sounds (pure tones, pink noise bursts, and speech utterances) of a particular aural intensity. We measured the point of subjective loudness equality for sounds associated with loudspeakers at different visually depicted distances. Contrary to our hypothesis, we found such loudness judgments to be closely aligned with the aural intensity rather than being affected by the apparent distance of the sound source. We conclude that the loudness of anechoic sounds are not necessarily affected by indications of the sound source distance as established via the visual-modality. In the future, if clinical conditions associated with deficits in self-suppression, also demonstrate deficits in their ability to discount the affect of an emitters’ distance on auditory intensity, this may have implications for how we interpret these differences in amplitude responses.

The Role of Social Engagement during Interpersonal Coordination: Sensorimotor Synchronisation with an Adaptive Rhythmic Robot
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The ability to coordinate movement between multiple actors is important in many domains of human life, but the role of social factors (e.g. partner agency or how interactive the partner is) are not fully understood. We used an adaptive drumming Nao robot that modulated the timing of its drum strokes in response to participants’ drum timing to investigate synchronisation with an interactive social partner versus a static non-interactive partner. Participants (n = 33) drummed with either ‘SocialBot’, a robot that used speech and eye gaze to interact with participants, or ‘MetroBot’ a non-interactive robot that remained static except for the drumming movement. Both conditions included three levels of robot drumming adaptivity, from minimally to moderately adaptive. Results firstly indicated that overall human-robot synchronization was more accurate when the robot was more adaptive. Secondly, while SocialBot was rated more anthropomorphic, animate, and likeable, there were differences in participant’s perceptions of which robot was easier to synchronise with (despite identical objective difficulty across conditions). Interestingly, participants who rated MetroBot as easier to synchronise with were more accurate than those who found it easier with SocialBot or those who found the conditions equally difficult. Individuals who were better at the task thus found it easier to synchronise with the less interactive robot. Furthermore, participants who did not perceive any difference in difficulty between the two interactivity conditions synchronised more accurately with SocialBot. These findings suggest that individual differences in personality or partner preferences may interact with external social factors during interpersonal coordination.
Temporality: the predictive landscape of selfhood
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The concept of “time” has been given numerous treatments by various thinkers, including St. Augustine, William James, Edmund Husserl, Maurice Merleau-Ponty, and Francisco Varela. Most conceptions of temporality view it as a moving stream observed through an individual’s window of experience, with debate over the demarcations between versions of past, present, and future. I argue that temporality may be more precisely viewed as a unitary ‘pre-spatial’ field in which the sense of self is dissolved and reconstructed; time does not move, only self does. The perceived continuity of time (subjectively) is a symptom of the recursive (re)construction of self, or “selfing”, that produces a perceived continuity of self, ‘over time’. A static self-sense allows for an agent to exert greater overall lifetime prediction error minimization and thus maximise survival. A simple way for consciousness to deal with a fluid constructional process (selfing) is to construct a model that (1) indexes the projected spaces of memory and potentiality as coordinates along a linear dimension and (2) construes a static self-sense that traverses it subjectively. This results in the sense that there is a dimension of time along which one can “move” (projecting into past or future space), wherein each “move” is the enactment of a space by calling coordinates from a modelled index. This account offers an initial attempt at addressing the ontology and phenomenology of subjective temporality in a way that is commensurate with a predictive coding view of selfhood, with implications for research in philosophy and cognitive neuroscience.

Modelling me, modelling you: The Autistic Self
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The stereotype of Autism Spectrum Conditions (ASC or “autism”) focuses on the social and communicative elements of the diagnostic criteria. In this review, we step back from autism as a social and communicative disorder and focus on the autistic self. The autistic self is a key component of the condition which has nevertheless received comparatively little attention. We provide a taxonomy for experimental paradigms in the cognitive sciences that aim to address questions related to the self in the areas of action, memory, attention, recognition, body-representation, awareness of internal states, language and self-knowledge. We critically evaluate their relationships to philosophical conceptions of the self including Bayesian accounts, narrative, minimal and embodied selves. Further, we articulate reasons why the self might differ in ASC drawing from the empirical evidence presented. We emphasize the possible impact of a predictive processing account of autism on conceptualizing the autistic self, with a focus on context sensitivity, model complexity, learning, integration, active inference and precision. This opens up large scope for future research on unique differences in the autistic self, which is intended to be extended as a framework for understanding the condition as a whole in a new and unified way.
Can we afford a new approach to the virtual memory palace?
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Even though the memory palace technique has been around for millennia and has proven to be a powerful way of remembering, it faces two problems. First, cognitive scientists are currently unable to explain why it works so well. Second, the technique faces significant practical challenges to its users: they need to have access to a suitable training environment and have lots of time in order to practice the technique. Virtual reality devices are sometimes presented as a way to face these practical challenges, but currently fall short of delivering on that promise. We aim to address both issues in this talk. First, we argue that an enactive-ecological approach to memory can help us understand the effectiveness of memory palaces as an embodied technique. Second, we present design recommendations from an enactive-ecological perspective for those virtual reality devices that aim to support the memory palace technique -- our prediction is that this will help the effectiveness of such devices.

Dancing bodies, shaped minds: an ecological approach to expert stage presence
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In Western culture, the concept of presence holds a cluster of different connotations. Theatrical and performance studies have generally focused either on the intrinsic ability of the actor to capture the audience’s attention, or on the mutual relationship with the audience, which Zarrilli (2012) refers as the ground for the emergence of presence as experience. Is presence then a state that our minds can regularly experience, or is it a special condition that can be accessed only under very particular circumstances? What is the role played by a larger ecology that includes other performers on stage, different technologies and unusual environments, in shaping the experience and perception of presence? We investigate presence’s variations by tackling the phenomenon of stage presence. We are developing a cognitive ethnography (Hutchins 1995) that addresses questions of embodied cognition in three different dance forms: Contemporary Ballet, in the case of the National Ballet of Marseille and the staging of the piece ‘Passione’; Contact Improvisation, a duet-system based practice, aimed at fostering interkinaesthetic awareness and challenging habits of movement; and BodyWeather, a dance training originating from Butoh, significant for its relationship with nature (Fraleigh 1999). By adopting a phenomenological approach, which requires a direct engagement with the different dance trainings and contexts of practice analysed, we tackle the diversity of the cognitive ecologies in which stage presence is understood and performed, addressing the variations in which embodied skills are enacted, and emphasizes how different aesthetics and cultural factors shape habits, social cognition and perception of self.
Modulating sensory responses with hypnotic manipulations of the sense of agency.
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Highly hypnotisable people often describe their actions during hypnosis as occurring without effort. Similar shifts in the sense of personal agency are described in clinical conditions such as alien control delusions and in certain symptoms of schizophrenia, such as passivity phenomena. I am interested in exploring the mechanisms which lead to these agency alterations. As a way of better understanding the features and processes involved, I have been using hypnosis to create analogues of clinical agency disruptions in the lab. Experiments with hypnotic analogues involve suggestions for highly hypnotisable participants to experience an altered sense of control over their body or actions. In a study investigating tickle responses highly hypnotisable participants were given a hypnotic suggestion to experience alien control over the movements of their hand and arm. Following this suggestion they exhibited significantly increased response to their self-generated tickle movements. Based on these findings, I will highlight the features of agency disruption common to hypnosis and clinical cases and discuss the implications for theories of agency and hypnosis.

Horizontal Grasp Illusion: Effect of Distance and Limb Crossing on Perceived Hand Spacing and Ownership
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Our recent study found that hands, which are 12 cm apart vertically, are perceived much closer together when passively grasping an unseen artificial finger-like object. Also, participants report some ownership over the ‘rubber finger’ (1). The present study aimed to investigate this grasp illusion in the horizontal plane. Thirty healthy participants were tested in two conditions (grasp and no grasp). Their right index finger was positioned in the midline of the body. Participants grasped the rubber finger passively with their left thumb and index, with the rubber finger in one of four locations (15 or 24 cm on either side of midline). Hands were perceived 3.2 cm [0.7 to 5.7] (mean [95% CI]) closer together during the grasp condition compared to no grasp condition when the left hand was 15 cm across the midline. For this trial, a separate measure found that the left hand was perceived 2.0 cm [0.6 to 3.4] closer to the right hand, while the right hand was perceived 0.4 cm [-0.6 to 1.4] closer to the left hand. Perceived ownership (rated on a 7-point Likert scale) was between ‘Disagree’ to ‘Somewhat Disagree’ for all hand locations. With the hands apart horizontally, grasping a rubber finger reduces perceived spacing only when the hands are moderately crossed. Contrary to when the hands are apart vertically, the illusory coming together of the hands in the horizontal plane is not associated with an increased sense of ownership.

Predictive agents, precision-weighting, and modelling the body
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Hohwy (2017; 2016) has recently defended an account of active inference (henceforth AI) on which the embodied agent continually acts on “massive hierarchical representations of the world external to the brain and its sensory organs” (2016, p. 19). AI, so contends Hohwy, supports a picture of the mind as “more neurocentrically skull-bound than embodied or extended” (ibid. 1). Hohwy appeals to Friston’s work on Markov blankets in order to characterise cognitive processing in relation to a form of Bayesian inference, executed with multi-level, richly structured representations. On this vision, successful action is seen as providing evidence for the existence of the agent, understood as a model of the world (ibid.) Recently, Clark has criticised this highly inferentialist rendition of AI, claiming that the criteria Hohwy employs in characterising cognitive processing are absurd, since they seem to preclude even the brain from functioning as a cognitive resource (2016 p. 12). In this presentation, I show that Clark’s attempted reductio is unsuccessful, and that he crucially misunderstands how Hohwy appeals to Markov blankets in delineating cognitive processing. In closing, however, I criticise Hohwy’s highly inferentialist interpretation of AI. Drawing appeal to literature on Bayesian and post-Bayesian perceptual models, I argue that Hohwy’s claim that AI does not sit well with certain embodied views rests on an understanding of (precision-weighting) attentional processes that might well commit him to precisely the kind of ‘overly-intellectualised’ picture of cognitive processing and mental representations that he looks to distance his predictive story from.

Oscillatory Networks Of High-Level Mental Alignment: A Perspective-Taking MEG Study
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Mentally imagining another’s perspective is a high-level social process, reliant on manipulating internal representations of the self in an embodied manner. Recently Wang et al., (1) showed that theta-band (3-7Hz) brain oscillations within the right temporo-parietal junction (rTPJ) and brain regions coding for motor/body schema contribute to the process of perspective-taking. Using a task requiring participants to engage in embodied perspective-taking, we set out to unravel the extended functional brain network and its connections in detail. We found that increasing the angle of disparity between self and other perspective was accompanied by greater reaction times and increases in theta power within rTPJ, right lateral pre-frontal cortex (PFC) and right anterior cingulate cortex (ACC). Using nonparametric Granger-causality, we showed that during later stages of perspective-taking, the lateral PFC and ACC exert top-down influences over rTPJ, indicative of executive control processes required for managing conflicts between self and other perspectives. Finally, we quantified patterns of whole-brain phase coupling (imaginary coherence) in relation to rTPJ during high-level perspective taking. Results suggest that rTPJ increases its theta-band phase synchrony with brain regions involved in mentalizing and regions coding for motor/body schema; whilst decreasing its synchrony to visual regions. Implications for neurocognitive models are discussed, and it is proposed that rTPJ acts as a ‘hub’ to route bottom-up visual information to internal representations of the self during perspective-taking, co-ordinated by theta-band oscillations. The self is then projected onto the other’s perspective via embodied motor/body schema transformations, regulated by top-down cingulo-frontal activity.
Object attention mediates the relationship between body dissatisfaction and susceptibility to the body size adaptation effect

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Body size and shape misperception (BSSM) is common in people with eating disorders. Exposure to thin idealised bodies in the media, or obese bodies in economically deprived neighbourhoods have been associated with BSSM. Recently, studies have shown that exposure to extreme body stimuli results in a shift in the point of subjective normality, suggesting that visual adaptation may be a mechanism by which visual norms are determined in everyday life. Yet, within a given geographical area, some individuals will develop BSSM and others will not. The reason for these individual difference is currently unknown. While attention has been shown to enhance adaptation effects in low (e.g. rotational and linear motion) and high level stimuli (e.g., facial gender), women with greater body dissatisfaction (BD) have been found to pay more attention to images of thin bodies. Here, we test the hypothesis that there is an indirect effect of BD on the direction and magnitude of the body fat adaptation effect, mediated via object attention (i.e., selectively attending to images of thin over fat bodies or vice versa). Significant mediation effects were found in both men and women, suggesting that observers’ level of BD may influence selective attention to thin or fat bodies, which in turn influences the magnitude and direction of body fat adaptation.

Dynamical modulation of corticomotor excitability during rhythmic movement observation

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Action observation modulates corticomotor excitability. Such modulation has been understood to be the result of a simulation of the observed action. Alternatively or complementary to this perspective, growing evidence in behavioral research shows that changes in motor activity during observation of rhythmic movements can occur via direct visuomotor couplings and dynamical entrainment. In-phase and anti-phase entrainment spontaneously occur, characterized by movements proceeding simultaneously in the same or opposite direction, respectively. Here we investigate corticomotor excitability during the observation of vertical oscillations of an index finger using Transcranial Magnetic Stimulation. Motor Evoked Potentials were recorded from flexors and extensors of participants’ right index finger, placed in either a maximal comfortable flexion or extension position, with stimulations delivered at maximal flexion, maximal extension or mid-trajectory of the observed finger oscillations. Facilitation was found in participants’ flexors for in-phase and anti-phase coordination but not for unstable 90° coordination, supporting the occurrence of dynamical motor entrainment. Interestingly, anti-phase motor facilitation contrasts with action simulation predictions as it involves activity in the motor system different from the one needed for the execution of the observed movement. These findings open new perspectives for understanding motor activity during action observation and the processes underlying interpersonal coordination.
Effects of stimulus strength and timing synchrony on the salience of the rubber hand illusion
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Body ownership involves the integration of multiple sources of sensory input to produce the subjective feeling of self. The rubber hand illusion (RHI) has been used to examine how the feeling of self can be manipulated and transferred away from one’s own body to a fake hand. Previous studies have shown that components of multisensory integration, namely the timing and spatial relationships of visual stimulation of the rubber hand and tactile stimulation of the subject’s hand are important for the transference of body ownership underlying the illusion. However, inverse effectiveness, or the phenomenon where stimuli are integrated inversely proportional to their unisensory strength, has gone unstudied. In the present study, we manipulated stimulus strength in addition to stimulus synchrony to investigate inverse effectiveness. The experiment utilized a 2 x 2 x 2 factorial design with factors: timing (synchrony/asynchrony), light amplitude (low/high) and tactile amplitude (low/high). Visual stimuli was delivered with an LED on the rubber hand and tactile stimuli delivered with a vibro-tactile motor on the subject’s hand. Proprioceptive drift was used to measure illusion salience. A repeated measures ANOVA revealed significant main effects for timing (F[1, 19] = 7.68, p < 0.05), light strength (F[1, 19] = 4.51, p < 0.05) and an interaction effect between tactile strength and timing (F[1, 19] = 7.49, p < 0.05) on proprioceptive drift. Together, these results suggest the RHI is similar to other known multisensory integrative processes that depend on the effectiveness of stimuli in addition to their timing and spatial relationships.

Dissecting self-prioritization effect
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Familiar self-associated stimuli such as own face and own name are processed faster and more accurately than other familiar stimuli. Moreover, recent research on the “self-prioritization effect” has shown that similar bias can be observed in a perceptual matching task for a wide range of unfamiliar stimuli which have been rapidly associated with the self, such as geometric shapes, objects, and human faces. I will present the results of two studies investigating this effect in more detail using faces in a sequential matching task. In a sequential task participants are first presented with a label and then after a short delay they see a face. Their task is to judge whether the face matches with the label. By introducing a delay between presentation of labels and faces it was possible to separately investigate top-down and bottom-up contributions to the self-prioritization effect. Our results suggest that there are at least two distinct processes underlying self-prioritization reflecting these two contributions. The first one can be called a self-boost effect and manifests itself by generalized facilitated processing of the second stimulus if the first stimulus in a sequence was self-associated. The second effect is represented by faster processing of the second stimulus, irrespective of what proceeds it. While the latter probably reflects increased familiarity, the first may reflect activation of an abstract self-concept, which in turn biases subsequent processing.
Investigating body distortions in Anorexia Nervosa with action-based paradigms

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Body self-perception involves the integration of multisensory signals with stored body information to construct models of one’s own body identity, shape and location. Patients with Anorexia Nervosa (AN) report body perception distortions - they perceive their bodies as fat, but are objectively very thin. One hypothesis is that AN involves a change in the processing of multisensory bodily signals which causes discrepancies between how the body is perceived and what the body is physically like. Our research uses action-based paradigms to investigate body perception changes in AN. In this set of studies, we combined the Rubber Hand Illusion paradigm with a reaching paradigm to test if the impact of visual-proprioceptive and visual-tactile signals on body location perception differs between AN and healthy control groups. For current AN patients we found significant group differences in shifts of reaching trajectories, indicating that the influence of proprioceptive signals on hand location estimates is reduced. Hand location estimates were relatively more biased towards external visual information. Data from a second study suggest that there are no group differences between recovered AN patients and healthy controls. Overall, our findings indicate that multisensory body location perception -- specifically the processing of visual-proprioceptive signals -- is changed in AN and is similar to healthy controls for recovered patients.
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Vince Polito, Regine Zopf, Simmy Poonian, Mariia Kaliuzhna