(DIS)EMBODIED PERCEPTION OF THE SELF AND OTHER

ABSTRACTS

Anna Ciaunica & Harry Farmer: *Altered Self-Experiences in Depersonalisation*

Depersonalisation (DP) is a fascinating and intriguing phenomena which typically manifests as a disruption of bodily self-awareness. People with DP report feelings of being "estranged", cut-off from oneself and others, which induces a persistent and highly disturbing sense of alienation, and frequently complain going through daily life like a zombie, robot, or machine.

Here we explored the relationship between the experience of DP and sensorimotor processing of self and other. We will contrast the differences between healthy participants who have either a high or low trait occurrence of DP experiences. We examine how trait DP affects visuotactile processing using the Visual Remapping of Touch (VRT) paradigm. VRT refers to the tendency of people to detect touch on their own face more accurately when seeing touch applied to another face. We asked whether people with a high level of DP will show less of a VRT effect in general due disruption in the integration of multisensory somatic signals. In addition, given that the VRT effect has been shown to be stronger when seeing touch to one's own face, we will investigate whether the self-bias holds for individuals with high trait DP.

A better understanding of the relationship between high experience of DP and the sensorimotor representation of self and other could help to develop a better theoretical and empirical understanding of the neurocognitive processes that underlie DP as well as helping to develop interventional tools for treatment of those with clinical DP.

Harry Farmer: *Putting Ourselves in Another's Skin: Using the Plasticity of Self-Perception to Enhance Empathy and Decrease Prejudice*

The self is one the most important concepts in social cognition and plays a crucial role in determining questions such as which social groups we view ourselves as belonging to and how we relate to others. In the past decade, the self has also become an important topic within cognitive neuroscience with an explosion in the number of studies seeking to understand how different aspects of the self are represented within the brain. Here I will outline a distinction between two forms of self-representation. The "bodily self" which s grounded in the processing of sensorimotor signals and the "conceptual" self, which develops through our interactions of other and is formed of a rich network of associative and semantic information. I will then highlight new research demonstrating that the bodily and conceptual self are both plastic and malleable and that this malleability can be harnessed in order to achieve a reduction in social prejudice. In particular, I will outline evidence that modulating people's perceptions of the bodily self can lead to changes in

attitudes at the conceptual level. Finally, I place these findings in a broader social context by considering how innovations in virtual reality technology can allow experiences of taking on another's identity are likely to become both more commonplace and more compelling in the future and discuss the opportunities and risks associated with using such technology to reduce prejudice.

Katerina Fotopoulou: *Putting the Self in Perspective: Disembodied Minds and Hypermentalised Selves*

My talk will focus on experimental and neuroimaging studies on neurological and neuropsychiatric studies on patients with body unawareness, contrasting presentation where self-awareness is lost because first-person, sensorimotor experiences and feelings about the self cannot be transferred across time and space, nor form part of a coherent narrative, with presentations where such abstractions and narratives are intact but lacking anchoring to embodied experiences.

Sarah Garfinkel: *Interoceptive mechanisms underlying emotion and dissociation*

There is increasing recognition that cognitive and emotional processes are shaped by the dynamic integration of brain and body. Embodied and interoceptive mechanisms are proposed to underpin conscious self-representation and emotional experience. A major channel of interoceptive information comes from the heart, where phasic signals are conveyed to the brain to indicate how fast and strong the heart is beating. This talk will detail how cardiac afferent signals can interact with neuronal mechanisms to alter emotion processing. Moreover, this interoceptive channel is disrupted in distinct ways in first episode psychosis, schizophrenia, autism and anxiety. This talk will provide empirical examples and suggest how specific interoceptive disturbances may contribute to our understanding of distinct symptoms in these clinical conditions, including dissociation. Finally, new work will be presented on interoceptive training to demonstrate enhanced interoceptive precision following targeted feedback. The discrete cardiac effects on emotion and cognition have broad relevance to clinical neuroscience, with implications for peripheral treatment targets and behavioural interventions.

Antonia Hamilton: *Self & other in imitation & interaction*

It is now widely accepted that humans have a mirror neuron system which responds to actions by the self and by others in a similar way, and may allow us to link our own experience to those of others. However, it remains somewhat unclear how we maintain

an appropriate self-other distinction in contexts of imitation and social synchrony. This talk will review recent data on imitation in relation to the sense of self and the ability to build social relationships, and will make suggestions for how we can use new 'second person neuroscience' methods to look at these questions.

Pierre Jacob: *Why mindreading is unlikely to be a cognitive gadget*

On Cecilia Heyes' view, humans genetically inherit domain-general cognitive instincts that they more or less share with non-human apes. What is distinctive of human social cognition (e.g. imitation, mindreading and the language faculty) are cognitive gadgets built and transmitted by cultural evolution. I will focus on mindreading. Cecilia Heyes' view that mindreading is a *cognitive gadget*, not a cognitive instinct, involves three major claims, the first of which is that apes, preverbal human infants and human adults under time pressure cannot really read others' minds. Secondly, far from mentalizing, what apes, preverbal infants and adults under time pressure do is *submentalize*, i.e. they use a set of domain-general low-level perceptual mechanisms that simulate the effects of genuine mentalizing. Finally, human children learn to read others' minds the way they learn to read print, i.e. by explicit instruction from knowledgeable adults. My paper is a thorough criticism of Heyes' three-tiered approach to mindreading.

Pascal Ludwig: *Transparent self-knowledge and the monitoring of attention*

It is uncontroversial that we can become aware of our perceptual states. For instance, when I am looking at a woodpecker I can become aware both of the colour of the bird, and of the fact that I am seeing its color. There is no agreement on the mechanisms of sensory self-awareness, though. On the one hand, our sensory self-knowledge seems to rest on an awareness of sensory states. One the other hand, many philosophers insist that the phenomenology of introspection is transparent: we do not seem to attend to inner states when we introspect. To this extent, there is a tension between the very existence of sensory self-awareness and the phenomenology of introspection. My suggestion, in this talk, is to understand sensory self-awareness as a kind of practical knowledge. I claim that if we do not attend to sensory states (transparency of introspection), we are nevertheless aware of our attending to objects, to the extent that we monitor it. If I am right, the monitoring of perceptual attention is the source of transparent sensory self-knowledge.

Andrea Serino: *Self in (peripersonal-) space*

The experience of our embodied Self is not limited to the physical constraints of our body, but it extends into the space where the body interacts with the environment, i.e. peripersonal space (PPS). PPS is represented via the integration of multisensory-motor signals related to the body and to external stimuli in space. Normally, the boundaries of PPS are defined by the limits where our physical body can potentially interact with external objects. However, PPS boundaries can re-shape as a function of experiences, such as acting upon further locations of space via tool-use or technology, or social interactions with other people. Interestingly, PPS also reshapes during multisensory bodily illusions, that induce spatio-temporal conflicts in the processing of multisensory bodily cues (such as the rubber hand, the enfacement or the full body illusion) to affect bodily experience and self-consciousness. I will present neuroimaging data and a neural network model able to explain the link between multisensory integration in PPS and bodily-self-consciousness.

Barry Smith: *Which side of the mirror?*

Looking at yourself in a mirror you see yourself as you appear as an object from the point of view as a subject. As you look, do you feel more there or here? Or does the question not arise? In the elusive and puzzling case of Depersonalisation Disorder, it might be tempting to think of the symptoms as involving a loss of the subjective or internalised perspective, as seeing oneself to be just the person in the mirror: there for others but not oneself. Yet, those with the disorder do not typically describe derealisation about their own body: they are not necessarily cut off from bodily signals of the figure in the mirror. Derealisation about the world around them may recur but it is not the key to their altered sense of self. Instead, I shall explore the idea that Depersonalisation is a disorder in the way the sense of self and the sense of the world the subject belongs to are related that means the familiar sense of the the world as the subject finds it can no longer be sustained.

Dave Ward: *Pulling Ourselves Together: Depersonalisation and the Integrated Self*

Here are three logically distinct aspects of personhood that talk of 'the self' can refer to: 1) *autonomy* - the proper attributability of actions to a unified intentional agent; 2) *self-image* - the set of values and projects via which a person understands themselves; 3) *self-sameness through time* - the psychological relationship that connects a person to their past and future stages. The philosopher J. David Velleman helpfully pulls these three aspects of personhood apart, but unhelpfully neglects to explain how they fit back together in normal psychology. In this talk I want to sketch an account of the interrelations between these aspects of personhood, and use depersonalisation disorder (DPD) as a test case for this account. I'll argue the affective engagement with objects and events that determines our self-image is the ground of our autonomy, and that this affective autonomy

in turn grounds our ability to imaginatively project ourselves into the past and future. This account of integrated selfhood, I will suggest, is well-placed to explain otherwise puzzling relationships between depression, desomatisation, dementalisation and detemporalisation in DPD.

George Deane: *Lucid dreaming through the lens of predictive processing*

The aim of this paper is to critically assess the theoretical advantages of applying predictive processing (Clark, 2013, Clark, 2016; Hohwy, 2013), to understanding the phenomenon of lucid dreaming. Predictive processing - the view that the brain is a kind of hierarchically organised prediction machine – has recently taken precedence in the cognitive sciences, positing prediction error minimisation as the fundamental computational mechanism underpinning cognition, action and perception. Predictive processing is increasingly used as a lens through which to examine a wide variety of perceptual modes and their accompanying phenomenology – for example psychosis (Fletcher & Frith, 2009) auditory verbal hallucination (Wilkinson, 2014), autism (Pellicano and Burr, 2012), hysteria (Edwards et al., 2012) and drug induced ego-dissolution (Millière, 2017) - illuminating how the content of ordinary and non-ordinary forms of experience can be accounted for mechanistically.

Lucid dreams (Voss et al, 2009), where the dreamer is aware that they are dreaming, can be as vivid (or even more vivid) than normal waking experience, despite being generated 'offline' - decoupled from the supervisory sensory signal of the world. What makes lucid dreaming an extraordinary state of consciousness is that, with training, they allow the dreamer to volitionally determine the contents of their own experience.

Here, building on the virtual reality model (Hobson et al, 2014), I sketch a predictive processing account of lucid dreaming, through an integration of the mechanisms of predictive processing with the phenomenology and cognitive neuroscience of lucid dreaming. The emergence of the 'observing self' in lucid dreams (Hobson et al, 2014) – can interpreted by considering the role of frontal lobes, typically involved in executive function. While frontal lobe activation is usually suppressed in rapid-eye movement (REM) sleep (Braun et al, 1997), there is an increase in frontal lobe activation in lucid dreams (Voss et al, 2009), and lucid dreams can be induced through frontal stimulation with TMS during REM sleep (Voss et al, 2014). These results are in accordance with the agentive control lucid dreamers report, and may have implications for 'first-order' theories of consciousness (e.g. the global neuronal workspace (Dehaene & Changeux, 2011), integrated information theory, (Tononi & Koch, 2015), recurrent processing theory Lamme, 2006) as opposed higher-order (Lau & Rosenthal, 2011) theories of consciousness, which I explore in this paper.

Laura Crucianelli: *From the body to the self: Affective touch and multisensory integration in Anorexia Nervosa*

One of the central questions in both philosophy and contemporary cognitive neuroscience is how we develop a sense of self out of our relation with others. According to embodied cognition approach, the development of selfhood can be viewed also as the consequence of embodiment within the environment. Furthermore, the involvement of neurobiological pathways implicated in stress and pain regulation as well as the formation and maintenance of close social bonds highlights the potential role of social, affective touch for the affect regulation and bodily self. This idea is supported by studies suggesting that touch-based interventions such as massage and 'skin-to-skin' contact can have positive psychological and physical effects in preterm infants and clinical conditions (e.g. Anorexia Nervosa, AN, a psychiatric disorder characterized by restricting eating and body image distortion, that has the highest mortality rate and no known etiology, although disruptions in serotonin, dopamine and more recently oxytocin have been observed). However, such clinical 'skin-to-skin studies have methodological limitations. By contrast, it has recently been discovered that affective signals from tactile stimulation are processed by a separate physiological system (i.e. C Tactile afferent fibers), projecting to the insular cortex, a core brain region for bodily self-awareness and homeostatic regulation. Recent evidence shows that affective touch, and more generally interoception (i.e. information about the physiological condition of the body) may have a unique contribution to the sense of body ownership. These findings have been extended to include other interoceptive modalities and social interactions.

Accordingly, I will present studies exploring (1) the perception of affective touch in AN; (2) body representation and particularly the contribution of both interoceptive and exteroceptive signals to the perception of a body part as belonging to the psychological self, in healthy controls and in patients with AN and concomitant disturbances of body image, and (3) the effect of intranasal oxytocin on the above mechanisms.

Such studies hold the potential to provide empirical confirmation to the idea that our self is built upon caring, embodied interactions with primary caregivers, the absence of which can lead to life-long struggles in feeling comfortable within one's own skin. Showing an effect of intranasal oxytocin on the perception of affective touch and body representation might have implication for the development of future therapeutic approaches in which a boost of oxytocinergyc mechanism could be paired with ongoing therapy to improve social processing and body image concerns

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L. Skora, D. Campbell-Meiklejohn, A. K. Seth, R. B. Scott: *Subjective visual experience is related to prediction of own responses*

Recent years have seen a renewed interest in enactive, embodied and embedded approaches to cognition and conscious experience (Seth et al., 2016). In those perspectives, agents are not passively perceiving their environment – instead, the 'inner life' is continuously shaped by dynamic interactions between the brain and the body, and active engagement with the environment. Here, we follow a proposal rooted in predictive

processing, which posits that subjective experience is constituted by the internal model that is most efficient at predicting the agent's response to a given stimulus (Clark, 2015).

We tested the idea that an internal model of cue-action relationship will shape conscious visual experience. In one experimental session, an instrumental conditioning task was used to generate the associations between distinct cues and actions, whereby participants were rewarded for a correct response to a given cue, and punished for an incorrect one. Conditioning was immediately followed by a continuous flash suppression (CFS) task, measuring the speed of breakthrough into visual consciousness, as indexed by the timing of discrimination responses made using the actions used previously. In the analysis using mixed-effects modelling, we found that speed of access to consciousness in the CFS task was facilitated by the correspondence between an action used to make the response and the cue it was conditioned on. Participants were quicker to detect the cue when using a response that matched the cue-action model (e.g. cue A – action A), than when the response used was incongruent (e.g. cue A – action B).

As such, it appears that conscious experience is facilitated through activation of a corresponding prediction of own response associated with a given stimulus in the environment, highlighted by slower breakthrough times under incongruence. This is supportive of the notion that conscious experience provides a stable, egocentric frame of reference for navigating the world, by virtue of facilitating experience as contingent on the agent's interactions with the environment.

Klaus Gärtner & Robert W. Clowes: *The 'Self' in a Dynamical Environment*

It is often held that to have a conscious experience presupposes having some form of implicit self-awareness. The most dominant phenomenological view usually claims that we essentially perceive experiences as our own. According to the theory, this so called "mineness" character is not only vital to conscious experience, it also grounds the idea that pre-reflective self-awareness constitutes a minimal self. One important consequence of this view is its profound impact on theoretical psychopathology, especially on the ipseity hypothesis of schizophrenia. However, it seems that the phenomenological view of pre-reflective self-awareness largely ignores the dynamical role of the self within dynamical physical and social world. We therefore postulate an alternative idea, namely the notion of pre-reflective situational self. To do so, we will analyze the dynamical nature of the relation between self-awareness and the world, specifically through our interactive inhabitation of the social world and conclude that our sense of pre-reflective self is better understood as labile and situational.

On these grounds, we will argue that our sense of pre-reflective self is dynamic. In order to reflect our fluid embedding in shifting social contexts we will develop a situated account of pre-reflective self-awareness. In this context, we will demonstrate such a situational notion does not obviously amount to a form of narrative self. We will show this by considering, in part how the situational self helps us negotiate the complex social world we inhabit. Further, we will examine how this capacity is illuminated when our normal interactive social fluidity is compromised in conditions such as schizophrenia and

perhaps related disorders of presence. Especially, we shall see that people suffering from this condition often have a hard time coping with interpersonal relations that were once transparent to them, as well as general difficulties in attuning toward and appropriately responding to everyday social situations and engaging with their interpersonal environment. In the end, we want to argue that the self in a dynamical environment is necessarily functionally sensitive to context.

Sonia Ponzo, Luise P. Kirsch, Aikaterini Fotopoulou, Paul M. Jenkinson: *Balancing body ownership: visual capture of proprioception and affectivity during vestibular stimulation*

The experience of our body as our own involves integrating different sensory signals according to their contextual relevance. Both vestibular and interoceptive (in the form of affective touch, a reclassified interoceptive modality manipulated by applying touch in a slow, affective vs fast, neutral fashion) manipulations, separately, have been showed to modulate body ownership. However, the role of the vestibular system in balancing sensory modalities has not been clearly defined, with studies showing different weighting in favour of either vision or proprioception and no study investigating the combined effect of vestibular and interoceptive systems on ownership. Hence, we devised a first study using Galvanic Vestibular Stimulation (left, right and sham) in a Rubber Hand Illusion task with 26 healthy participants to investigate how vestibular stimulation of the right hemisphere (LGVS) affects body ownership following visual exposure to a rubber hand and manipulations of synchronicity and affectivity of touch (affective, slow vs neutral, fast). Our results show that LGVS significantly increased proprioceptive drift towards the rubber hand during mere visual exposure to it (i.e. visual capture of proprioception). Moreover, it also enhanced participants' proprioceptive drifts towards the rubber hand during synchronous affective touch (i.e. visual capture of affectivity). In a second study, 36 healthy participants underwent vestibular stimulation during visual exposure to the rubber hand and stroking (affective vs neutral) applied on participants' hand only, with the rubber hand in view. We replicated the aforementioned findings, with LGVS increasing proprioceptive drift during visual exposure to the rubber hand, and we found that in both touch conditions LGVS decreased proprioceptive drift. These findings suggest that the vestibular system influences multisensory integration in a dynamic fashion, according to the relative contextual relevance of sensory signals. In study one, the vestibular system influenced body ownership by re-weighting proprioception and vision, as well as proprioception, vision and affective touch, in favour of vision. In study two, the vestibular system promoted a dynamic shifting between vision and proprioception (in favour of vision during visual conditions and proprioception in touch conditions) according to their contextual relevance (with no effect of affectivity). In conclusion, the vestibular system plays a crucial role in multisensory integration by resolving perceptual ambiguity and promoting the formation of a coherent representation of our body. Vestibular and interoceptive systems may interact in a combined fashion only when both felt and seen components of affective touch are available to be integrated in a coherent percept.

Cosimo Urgesi, Giulia D'Argenio, Dusana Dorjee, Paul E. Downing: *Effects of self-transcendence on the embodied understanding of others' emotional states*

Mental representation of ourselves and of others is strongly linked to mapping our bodily states (embodiment). Such bodily instantiation of cognitive operations allows the apprehension of others' mental, perceptuo-motor and emotional states through simulative representations of external events into internal, bodily states. At the same time, the ability to assume an external perspective on actual body perceptions and actions (self-transcendence) is inherently linked to human spirituality. How does transcending the bodily self affect empathic abilities? Here, we tested the effects of activating self-transcendent/spiritual representations on the ability to recognize emotions in others' faces. In two experiments, participants were presented with faces depicting positive (happy) or negative (fearful) expressions and were asked to either recognize the emotional valence (i.e., positive vs. negative) or the gender of the faces. Before each picture a prime word was presented that could be associated with spiritual or non-spiritual concepts. The prime was forward and backward masked by a string of Xs beside a central fixation point and was task irrelevant. In experiment 1, participants responded by means of speeded manual key presses and accuracy and responses times were collected and analysed. Results revealed that the presentation of spiritual prime words reduced emotion recognition performance as compared to non-spiritual prime words, while gender recognition remained unaffected. In experiment 2, we used the same trial procedure but rather than requiring an explicit motor responses we recorded motor evoked potentials from arms and forearm muscles. Results showed that presentation of spiritual words reduced motor facilitation during emotion perception, suggesting that priming spiritual representations alters the mapping of others' emotions on the observer's motor system. Overall, these findings point to the role of sensorimotor embodiment on social perception.

Martina Fanghella, Sebastian Gaigg, Tina Forster, Matteo Candidi, Salvatore Maria Aglioti, Beatriz Calvo Merino: *Embodied representations of emotional expressions in ASD: a study with SEPs*

Autism Spectrum Disorder (ASD) is a group of neurodevelopmental disorders characterised by social interaction and communication impairments, as well as repetitive and restricted patterns of behaviour (American Psychiatric Association, 2000). Recent research suggests that differences in representations of emotional expressions might play a role in ASD. Evidence for early atypical modulation of emotional expressions in visual areas has been shown (Batty et al.,2011). Moreover, recent research has highlighted that impaired embodied representations of emotions might also be atypical in ASD. In fact, reduced embodied simulation of emotional expressions in ASD has been highlighted by neuroimaging studies (Dapretto et al., 2006) and physiological responses to social stimuli seem to be atypical in ASD individuals (Hirsten & Ramachandran, 2001). Nevertheless, a selective impairment of embodied representations of emotional expressions in the somatosensory cortex in ASD has not been investigated yet.

Our methodology combines Visual and Somatosensory Evoked Potentials (VEPs and SEPs) to isolate embodiment effects driven by somatosensory or visual processing. This

methodology has already provided evidences of the involvement of the somatosensory cortex in processing emotional expressions in typical populations (Sel et al., 2014), and we are now interested in investigating whether ASD population show different patterns of responses compared to typical population. We are measuring visual and somatosensory responses in two groups of ASD and TD while they perform visual emotion recognition task and a control gender recognition task. Preliminary data will be presented, we expect to find a differential modulation of emotional expressions in the visual and somatosensory evoked potentials across the two groups.

Alessandra Finisguerra, Louise Kirschm Sonja A. Kotz, Emily S. Cross, Luca F. Ticini, Cosimo Urgesi: *Dissociating embodied aesthetics and emotional reactivity in motor responses to artworks*

Previous studies have shown that the perception of artworks elicits activation of the motor cortex in the observers' brain. This activation was initially interpreted as reflecting a covert approach response associated with the emotional value of a piece of art. However, recent hypotheses have proposed that aesthetic experiences are grounded in an embodied simulation of the actions, emotions, and corporeal sensations represented in the artwork or experienced by the artist in producing art ("embodied aesthetics"). To shed new light on this issue, we capitalized on recent single pulse transcranial magnetic stimulation (spTMS) evidence showing a two-stage motor coding of emotional body postures: an early, non-specific activation related to emotion processing and a later action-specific activation reflecting motor simulation. In our work, we asked art-naïve individuals to rate how much they liked a series of canvases painted with a Pointillist- or a Brushstroke-like style; photos of artistic gardens served as control natural stimuli. After an early (150 ms) or a later (300 ms) delay from stimulus onset, spTMS motor evoked potentials (MEPs) were recorded from a wrist extensor muscle, which we found to be more involved in painting with a Brushstroke-like than Pointillist style, and a control finger muscle. Results showed that observing canvases elicited overall greater motor activation for both muscles than observing garden pictures. Importantly, a further increase of motor response to Brushstroke-like canvases was specifically obtained at the later delay for the wrist-extensor, but not finger muscle. This is consistent with previous literature regarding earlier, non-specific emotional coding of stimuli and later encoding that relates specifically to action processing. Furthermore, this selective activation correlated with participants' subjective aesthetic ratings of Brushstroke-like canvases and with individual Perspective Taking abilities, supporting the embodied-aesthetics claim that simulation of the painter's movements plays a crucial role in aesthetic experience.

Natalie C. Bowling, Vanessa Botan, Jamie Ward & Michael J. Banissy: *Atypical Bodily Self-Awareness in Vicarious Pain Responders*

Vicarious perception refers to the ability to co-represent the experiences of others. For instance, seeing another person in pain elicits activity in brain regions associated with first-hand pain sensation. Prior research has identified considerable variability in the vicarious perception of pain between individuals, with some experiencing a conscious sensation of pain on their own body when viewing another person in pain. Self-Other Theory proposes that this conscious vicarious perception may result from impairments in self-other distinction and in maintaining a coherent sense of the bodily self. In support of this, past research has indicated increased susceptibility to illusions of body ownership and agency in individuals who experience conscious vicarious perception. However, little work has been done to assess whether trait differences in bodily self-awareness are associated with conscious vicarious pain. The present study compared trait depersonalisation (associated with a detachment from the bodily self), interoception (associated with a focus on internal bodily signals) alexithymia (associated with a focus on external stimuli and a difficulty identifying and labelling own emotions), and trait anxiety in conscious vicarious pain responders and control participants. Increased self-reported depersonalisation as well as interoceptive sensibility was found for conscious vicarious pain responders compared with controls, in addition to lower reports of externally-oriented thinking (a component of alexithymia). There were no significant differences in trait anxiety between the groups. Evidence is provided for trait differences associated with self-other distinction in conscious vicarious pain, supporting a Self-Other account. The results indicate that maintaining a stable sense of one's own body states may be necessary to regulate vicarious perception of pain in the wider population without conscious experiences. A broader focus, beyond somatosensory mirroring, is therefore needed in future research on vicarious perception.

Vanessa Botan: *Atypical Bodily Ownership in Vicarious Pain Responders Interpreted through Bayesian Sensory Inference*

The Rubber Hand Illusion (RHI) paradigm has been widely used to investigate the sense of body ownership and the Bayesian causal inference model has been used to explain this phenomenon. In this research, we tested predictions of this model by exploring both group differences and individual differences in susceptibility to the RHI.

With regards to group differences, we studied people who report consciously feeling the pain of others localised on their own body ('vicarious pain responders') who have been shown to be more susceptible to the RHI, indicating a general tendency to treat other bodies as their own.

According to the Bayesian model, one possibility is that increased susceptibility reflects less precise information about the position of one's own limb (proprioception) and another possibility is that the visually perceived position of the dummy hand is over-weighted. We find no evidence for the later (their drift in the visual condition does not differ), and therefore favour the former.

With regards to neurotypical individual differences, we found that individuals with lower proprioceptive accuracy (i.e. more drift towards the dummy hand before stroking) showed greater proprioceptive drift in the RHI after asynchronous stroking ($p=0.03$) or merely viewing the dummy hand ($p=0.002$) and this was driven mainly by the vicarious responders group.

The Bayesian causal inference model explains the RHI indicating that the illusion can occur in the absence of tactile stimulation (vision-only) and that the synchronous condition enhances it. Vicarious pain responders show greater susceptibility to the RHI and these differences may be explained by the model and would translate into higher susceptibility to lower proprioceptive accuracy and stronger priors.

Ivan Patané, Claudio Brozzoli, Eric Koun, Francesca Frassinetti, Alessandro Farnè: *Object ownership modulates peripersonal space during observed and executed actions*

Tactile and visual events occurring on or near our body are integrated in a multisensory representation of the space surrounding us, called peripersonal space (PPS, Rizzolatti et al., 1997). This body centered space is involved in the motor control of goal-directed actions, inasmuch as grasping objects triggers online modulations of PPS (Brozzoli et al., 2009). As acting upon one's own or somebody else's object has been reported to alter movement kinematics (Constable et al., 2011), here we tested whether the concept of object ownership may differentially modulate PPS when acting or merely observing another person acting on a personal property. To this aim, dyads of participants took turns to grasp an object, whose attributed ownership was manipulated in two experiments. To assess PPS, visuo-tactile interactions were probed either before or at movement onset by a task known to modulate tactile perception on the grasping hand. Stronger interaction between touches on the grasping hand and visual distractors from the target object served as a proxy of PPS modulation (Brozzoli et al., 2009). Importantly, visuo-tactile stimulation was also delivered during observation of grasping actions: prior to or at the onset of a grasping action performed by the participant sitting in front. When ownership was equally shared by the two participants (Exp1), similar PPS modulations arose, regardless of whether action toward the owned object was executed or observed. When examining individual personal property (Exp2), PPS was dynamically modulated only when grasping one's own object. Mirroring such an effect, similar PPS changes emerged when observing the other grasping his/her own property. These findings show that object ownership is critical in shaping everyday sensorimotor and social interactions, thus revealing how deeply property can impact on social human behavior.

James W.A. Strachan, Merryn D. Constable, Günther Knoblich: *Ownership Effects Across Territory Boundaries*

Self-relevant information is subject to privileged processing over information related to other people. Object ownership is a way of making otherwise neutral objects self-relevant, and therefore giving these items access to the same privileges as other self-relevant stimuli. Previous research has shown that object ownership effects (faster processing of self-owned over other-owned items) are reliable and consistent across a range of tasks.

One dimension of ownership that has yet to be explored, however, is the role of territory. We know that space and territory play a role in terms of the physical environment – people show privileged processing for items that are accessible to them (peripersonal space; Constantini et al., 2011) – but we can also conceptualise territory in more abstract terms. For example, you do not need to be physically present in your own house for it to be your house. The question is, does territory affect processing even when it is an abstract, arbitrary compartmentalising of space that does not impact physical affordances? And how does ownership of territory interact with ownership of objects?

We explore how territory affects ownership effects in an adapted trolley-sorting paradigm. Participants sort items that belong to them or to another person into relevant baskets or trolleys. The key manipulation is that items can appear in a territory belonging to the self or to the other. Across three experiments we find that territory does affect ownership effects, as the privileged processing of self-owned items disappears when those items appear in another's territory. This indicates that people are not just responding to the ownership status of items in a universal way, but are taking into account how these items are embedded within the social environment.

Alessandro Montia, Giuseppina Porcielloa, Gaetano Tierib, and Salvatore M. Agliotia: *Embreathment' illusion gauges impact of respiration on embodiment*

Combining immersive virtual reality with physiological recordings in a passive observation task, here we describe a new bodily illusion that maps real respiratory patterns onto a virtual body in an ecological fashion. In analogy with terms like embodiment, enfacement, and engazement, we refer to the illusion as 'embreathment'. The creation of an avatar that breaths in or out of synchrony with our participants allowed us to measure how breathing, one of the most prominent signals coming from within the body, impacts on corporeal awareness - the basic feeling that one has a body (body ownership) which acts according to one's will (body agency) and which occupies a specific position (body location). In particular, we showed that breathing significantly contributes to the sense of body ownership and body agency. We then ranked breathing against the two fundamental signals that constantly represent the body to the brain, scilicet visual appearance and spatial perspective. The ranking unveiled the hierarchical role of visual, spatial and respiratory signals on different components of corporeal awareness. Furthermore, thanks to the analysis of participants' performance on a new self-breathing discrimination test, we showed that the effects of both visceral and non-visceral cues on embodiment depend on the ability to perceive visceral signals. These

results reveal the crucial role of breathing in self-consciousness and pave the way for a comprehensive model of corporeal awareness.

Martina Fusaro, Matteo Lisi, Gaetano Tieri: *Vicarious experience of (intimate) touch in Immersive Virtual Reality*

Studies indicate that seeing other people being touched or painfully stimulated activates similar brain areas as when we experience actual touch or pain ourselves (Blakemore et al., 2005, Singer et al., 2004). Immersive Virtual Reality (IVR) is an emerging, powerful tool that allows researchers to generate sensory environments that can duplicate reality and create extremely veridical vicarious experiences. To explore the behavioural and bodily reactivity to observed pain and touch, we performed a series of studies based on a novel paradigm we devised (Fusaro et al., 2016) in which healthy participants immersed in a virtual reality scenario observed a virtual needle penetrating (pain) or a virtual hand stroking (pleasure) the hand of an avatar seen from a first (1PP)- or a third (3PP)-person perspective. Behavioral results showed that the virtual touch could elicit lifelike sensations (i.e., the pleasant touch was perceived more pleasant and intense than a neutral touch). Capitalizing on these findings, in the current study, 44 healthy, heterosexual, male and female participants embodied an avatar from 1PP and then underwent touches on different parts (including breast and genitalia) of a virtual body in underwear. In addition to the strong feeling of being touched and of owning the virtual body, participants reported about the different aspects of the experience (social acceptability, sexual arousal, reactivity, pleasantness). Results indicate that the vicarious experience in virtual reality allows to address more directly delicate issue that can otherwise be explored only through imagination (Suvilehto et al, 2015). In particular, touches on different body parts elicited lifelike sensations that were dependent upon the gender of the participants and of the toucher. IVR may offer unprecedented opportunities to explore the effect of somatosensory stimuli (like pain and touch) even when they are not actually delivered on the body.

Duangkamol Srismith: *Investigating changes in body image & interoceptive abilities as individual response to physical activity*

Body image is one of the fundamental components of our sense of self. It is crucial to the formation and maintenance of both our mental and physical wellbeing. The influence of an individual's body image could motivate or impede engagement in physical activity. Physically active individuals report a more positive attitudinal body image. At the same time, one's motivation to initiate and maintain physical activity might be to influence disturbed body image in a positive manner. There is little evidence on individuals' responsiveness to physical activity with respect to body image. As such, this bi-directional relation between body image and physical activity remains poorly understood.

The current study is part of the iReAct project, which assesses the individual response to two standardized training regimes in healthy adults who previously led sedentary lifestyles (N = 60). iReAct is headed by the Departments of Sports Medicine and Sports Science at the University Tübingen, as well as the Department of Psychosomatic Medicine and Psychotherapy at the University Hospital Tübingen. The main goal of the current study is to investigate body image and its dynamic changes following the uptake of regular physical activity on a longitudinal basis. In cooperation with the Max Planck Institute for Intelligent Systems, Tübingen, we utilised the 4D body scanning technology, as well as editable biometric 3D avatars and established questionnaires, to investigate changes in body image due to physical training. Interoceptive awareness, as well as accuracy, are also tested throughout.

In doing so, we would like to address the following questions: (i) What role does the individual concept of one's own body (the satisfaction with the own attractiveness, the perception of the own physical efficacy, or the degree of body acceptance in general) play with regard to individual physiological and affective responsiveness to physical activity in sedentary adults? (ii) Which individual characteristics (e.g. gender) significantly moderate body image dynamic response to exercise? (iii) Which bodily components affected by physical activity are significant in the positive modulation of the body image? I.e. the effectiveness of shifting visual components of the body (actual and perceived body shape), as compared to changes in non-visual functional variables related to the anatomy (interoceptive awareness and accuracy, physiological changes in the body component) in terms of body image.

Rebecca Böhme, Markus Heilig, Håkan Olausson: *Distinction of self-produced touch and social touch at cortical and spinal cord levels*

Differentiation between self-produced tactile stimuli and touch by others is necessary for social interactions and for a coherent concept of "self". The detailed mechanisms for this distinction are unknown. We performed three studies (n=27, 17, 10) investigating self- and other-produced gentle touch. In study 1, volunteers stroked their own arm, an object, or were stroked during functional magnetic resonance imaging (fMRI). In study 2, we measured detection thresholds and manipulated the salience of tactile stimuli during self-touch. In study 3, we measured somatosensory evoked potentials (SEPs) at spinal and cortical levels during the same three conditions.

Self-other-differentiation was driven by activation during being touched and deactivation during self-touch. Deactivation extended into low level sensory representations, including thalamus and brainstem. This was replicated in the second cohort, and not affected by salience manipulation. During self-touch, the sensorimotor cortex was functionally connected to the insula, and tactile detection thresholds were elevated. Accordingly, cortical SEP amplitudes were lower during self-touch, while latencies for being touched were faster at cortical and spinal levels. fMRI and SEP measures related to self-other-distinction correlated with the individual self-concept strength.

We have thus demonstrated a robust self-other distinction, evident at the spinal cord, related to limbic processing, and social cognitive and interoceptive abilities. Our results provide a framework for future studies in autism, schizophrenia and borderline-disorder, where symptoms include social touch avoidance and poor self-vs-other discrimination.

Liam Cross, Liam Whiteman, Sarah Ward: *From I to We: Shifts in salient identities following interpersonal coordination*

Many studies have explored how interpersonal coorindation fosters changes in individual and group level processes, such as cooperation, conformity affiliation and overlap (Wiltermuth 2012, Wiltermuth & Heath 2009). However, relatively little work has explored changes in how individuals view themselves following coordination, though some have shown people are more likely to change from individual to group level terms when defining themselves post coordination (Cross, Atherton, Wilson & Golonka 2017; Good, Choma & Ruso 2017). This mixed methods study explored how people construed their identities post coordination. Specifically, after engaging in a coordination task moving joysticks either in a coordinated or uncoordinated way, participants then generated up to twenty identity-related statements by responding to the question "Who Am I? (Kuhn & Mc Partlan 1954)" This data was then analysed by independent coders using qualitative and quantitative methodologies. Results showed that post coordination people reported more interdependent (i.e. Mother, Muslim) than independent (Spiritual, Lazy) identifiers. This was driven by a greater proportion of items relating to broader social constructs (Socialist, Republican) rather than more close/spefic social relations (Mother, Friend). Further analysis also indicated people generated more item relating to sexual/ romantic constructs (Bisexual, Lover) and less items relating to mental states (Smart, Moody) following coordination. These results suggest that people experience a shift in salient identities from independent to more interdependent, which may explain why coordination fosters a range of social consequences from conformity to cooperation.