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Bodily Selves in Relation: From mirror neurons to Embodied Simulation.

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"It is not logical, however, to oppose the mental and the physical as these are not of the same stuff. Mental phenomena are complications of variable importance in psychesoma continuity of being, in that which adds up to the individual's self"

Donald Winnicott (1975, p. 254).



However...



 According to the mainstream view, understanding others consists of interpreting and explaining in mental terms <u>intentionally opaque behaviors</u>, viewed as mere biological motion.



- This explanatory process is referred to as Theory of Mind (ToM).
- ToM, according to many, is the attribution to others of mental states, mapped in the mind of the observer as internal representations in propositional format.



- If one believes that a gap separates individual human beings, conceived of as mentalizing monads, whose only meaningful connections consist of their theoretically-driven mentalizing skills, an obvious consequence will be that of looking for the neural correlates of beliefs and desires as such.
- The reification of propositional attitudes inevitably led many cognitive neuroscientists to look for the brain areas/circuits housing desires and beliefs.



The mindreading brain (?)





The mindreading brain (?)







We do not have a clear neuroscientific model of how humans can understand the mental states of others.





• What we have is a series of brain imaging studies showing the activation of a set of cortical regions, (mesial frontal areas, the temporo-parietal junction etc.), during explicit mentalizing tasks.





No one to date was able to provide a convincing explanantion about why those specific areas do activate during mentalization, beside the tautological statement that mind reading is implemented in those brain areas.





A further problem: the mind reading specificity of the activation of these cortical regions is debatable, if not patently false.



The mindreading brain (?)







Fig. 2 Foci of ToM activations from ten different neuroimaging studies rendered onto a normalised version of GT's lesion. Note all foci are projected onto the medial surface, regardless of lateralisation to left or right hemisphere. The plotted co-ordinates are 8, 54, 12 (Gallagher *et al.*, 2002), 8, 53, 9 (McCabe *et al.*, 2001), -12, 42, 40 (Fletcher *et al.*, 1995), -12, 38, 32 (Goel *et al.*, 1995), 0, 44, 15 (Baron-Cohen, *et al.*, 1999b), -8, 50, 10 (Gallagher *et al.*, 2000), 8, 32, -4 (Brunet *et al.*, 2000), -4, 60, 32 (Castelli *et al.*, 2000), 6, 56, 2 (Vogeley *et al.*, 2001) and -8, 52, 18 (Berthoz *et al.*, 2002).



The impact of extensive medial frontal lobe damage on 'Theory of Mind' and cognition

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Summary

The ability of humans to predict and explain other people's behaviour by attributing to them independent mental states, such as desires and beliefs, is considered to be due to our ability to construct a 'Theory of Mind'. Recently, several neuroimaging studies have implicated the medial frontal lobes as playing a critical role in a dedicated 'mentalizing' or 'Theory of Mind' network in human brains. Here, we report a patient, G.T., who suffered an exceptionally rare form of stroke-bilateral anterior cerebral artery infarction, without rupture or the complications associated with anterior communicating artery aneurysms. Detailed high-resolution neuroanatomical investigations revealed extensive damage to the medial frontal lobes bilaterally, including regions identified to be critical for 'Theory of Mind' by functional neuroimaging of healthy human subjects. For the first time in such a patient, we carried out a thorough assessment of her cognitive profile including, critically, an experimental investigation of her performance on a range of tests of 'Theory of Mind'. G.T. had a dysexecutive syndrome characterized by impairments in planning and memory, as well as a tendency to confabulate. Importantly, however, she did not have any significant impairment on tasks probing her ability to construct a 'Theory of Mind', demonstrating that the extensive medial frontal regions destroyed by her stroke are not necessary for this function. These findings have important implications for the functional anatomy of 'Theory of Mind', as well as our understanding of medial frontal function. Possible reasons for the discrepancies between our results and neuroimaging studies are discussed. We conclude that our findings urge caution against using functional imaging as the sole method of establishing cognitive neuroanatomy.

How do we give sense

to the natural evidence

of the world of others?



- A common misconception of cognitive neuroscience consists in perceiving its reductionism as a sort of necessary totalitarian identity theory between brain and behavior, brain and psychology, or brain and cognition.
- Perhaps neuroscience occasionally endorses such identity theories.





Cognitive neuroscience should investigate human nature first and foremost by clarifying what human experience is made of.

A neuroscientific approach to intersubjectivity is important not because the bonds reciprocally relating human beings, their absence or deficit, can today be univocally and causally explained by a sub-personal level of description that speaks of neurotransmitters, receptors, neurons and brain neural networks.



My take

- However, these modalities all share a constitutive underpinning bodily root that maps into distinct and specific ways of functioning of brain circuits and neural mechanisms.
- Action, perception and cognition are, at the level of the brain-body system, made of the same stuff, although differently wired and differently functionally organized.



Mirror

X

Neurons

3

Action recognition in the premotor cortex

Vittorio Gallese, Luciano Fadiga, Leonardo Fogassi and Giacomo Rizzolatti





Mirror mechanisms in Humans





Mirror mechanisms in humans

The same cortical sites are activated during execution/observation of:

Object-directed actions
Communicative actions
Body movements



Cattaneo & Rizzolatti 2009



Mirror mechanisms in humans

Linguistically described actions



Tettamanti et al. J Cogn Neuroscience 2005

The same cortical sites are activated during action performance and while listening to or reading words and sentences describing actions.







"Thus we discover the important principle that every language, no matter how copious and learned, encounters the hard necessity of expressing spiritual things by means of relationships with corporeal things."

G.B. Vico, The New Science (1725-1744)



The tip of the iceberg





In fact, we posit that MNs could be just one instance of a much more general matching mechanism that uses internal representations of goals, emotions, body states and the like to map the same states in other individuals. Following the suggestion of Adolphs that the somatosensory-related cortices of the right brain might be relevant for social cognition¹¹, one could speculate that this is so because of the presence of 'somatosensory MNs' that allow the observer to map other individuals' body parts on his/her own body parts. A possible suggestion, therefore, is that by means of such diversified matching systems, the observer is able to 'recognize' other individuals as his/her social partners. Future experiments will have to be developed to test this hypothesis. (from Goldman and Gallese, TICS 2000)

Varieties of putative mirror mechanisms

The same cortical sites are activated during the first-person experience and the observation of

Emotions (Carr et al. 2003; Wicker et al. 2003; Leslie et al. 2004; Pfeifer et al. 2008).

•Sensations Touch (Keysers et al. 2004; Blakemore et al. 2005; Ebisch et al. 2008, 2010, 2011, 2012).

> Pain (Hutchison et al. 1999; Morrison et al. 2004; Singer et al. 2004; Botvinick et al. 2005; Jackson et al. 2005; Avenanti et al. 2005).



What is so special about embodied simulation?

Vittorio Gallese^{1,2} and Corrado Sinigaglia³

- ES theory provides a unitary account of basic social cognition, showing that people reuse their own mental states or processes represented with a bodily format in functionally attributing them to others.
- ES does not provide a general theory of mental simulation covering all kinds of simulational mindreading.
- It aims to explain the MM and related phenomena



The mirror mechanism

Maps the sensory representation of the action, emotion or sensation of another onto the perceiver's own motor, viscero-motor or somatosensory representation of that action, emotion or sensation.

This mapping enables one to perceive the action, emotion or sensation of another from within.



What is so special about embodied simulation?

Vittorio Gallese^{1,2} and Corrado Sinigaglia³

- ES is characterized by one's reuse of her own bodily formatted representations in functionally attributing them to others.
- By accounting for the simulational nature of mirroring phenomena in terms of mental states reuse, ES makes reference to the <u>intrapersonal</u> resemblance or matching between one's mental state when acting or experiencing an emotion or a sensation and when observing others' actions, emotions and sensations.





What is so special about embodied simulation?

Vittorio Gallese^{1,2} and Corrado Sinigaglia³

- MM-driven ES plays a constitutive role in a basic form of mind-reading.
- This form of mind-reading does not require the involvement of any propositional attitude, being mapped onto mental representations with a bodily format (i.e. motor representations of goals and intentions as well as viscero-motor and somatosensory representations of emotions and sensations).



We do not necessarily experience the specific contents of others' experiences, but experience others as having experiences similar to ours.

Demographic information about the First Episode Schizophrenic (FES) Patient group and Control group

	Patients (N=24)	Controls (N=22)
Age	27.3 ± 4.8	27.5 (±3.3)
Mean time from psychotic episode	7.5 ± 4.7 months	n.a.
Handedness score	65.3 ± 18.1 %	69.3 (±15.8) %
Male/female	16/8	12/10
Diagnosis	First Episode Psychosis	n.a.
SCID-II Cluster A	n.a.	negative
SCID-II Cluster B	n.a.	negative
SCID-II Cluster C	n.a.	negative
PANSS Positive scale score	10.4 ± 6.2; min. 0, max. 21	n.a.
PANSS Negative scale score	9.9 ± 6.8; min 0, max. 24	n.a.
PANSS General Psychopathology scale score	19.3 ± 11.1; min. 0, max. 37	n.a.
SPI-A total score	61.1 ± 38.4; min. 0 max. 138	n.a.
Medication	Quetiapine, Risperidone, Paliperidone, Aripiprazole, Olanzapine	n.a.

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- The borders of the bodily self appear to be blurred in schizophrenic patients.
- This is epitomized by a lack of self-other differentiation in the domain of affective tactile experiences, given the lack of deactivation of pIC in patients during touch observation.

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 Reduced activation in RH vPMC, and consistent correlations between BOLD response and Basic Symptoms, could reflect the neural basis of a reduced sense of a coherent bodily self in schizophrenia.



Conclusions

- FES patients show reduced activation in ventral premotor cortex for observed bodily tactile stimulations, in addition to anomalous differential activation in posterior insula for first-person tactile experiences and observed affective tactile stimulations.
- These results could provide the neural basis of a reduced sense of a coherent bodily self in schizophrenia.



The Theory of Embodied Simulation can be relevant to psychoanalysis and psychotherapy for three main reasons:

- 1. Because it provides a unified account of preverbal aspects of interpersonal relations that likely play an important role in shaping the Self.
- 2. Because it can contribute to a new definition of psychopathological processes.
- 3. Because it enables to analyze the interpersonal pre-verbal dynamics of the therapeutic setting from a different perspective.





"What does the baby see when he or she looks at the mother's face? I am suggesting that, ordinarily, what the baby sees is himself or herself. In other words the mother is looking at baby and what she looks like is related to what she sees there."

(1972, p. 151)



THE BIRTH OF INTERSUBJECTIVITY

Psychodynamics, Neurobiology,

and the Self

MASSIMO AMMANITI & VITTORIO GALLESE

Thank you!

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