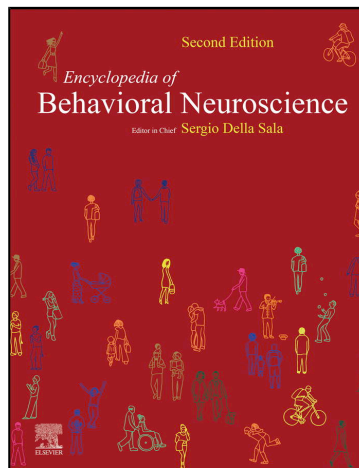


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Brain and Self – A Neurophilosophical Account

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Introduction

Background: Conceptual Determination of the Self in Philosophy

You're winning a game of tennis while your partner is watching. You feel pride. Who experiences that pride? You. Without you as subject of this experience, you could not experience anything at all, not even boredom. This subject of experience has been described as the "self". Your "self" makes it possible for you to experience things. In other words, it is a necessary condition for experience and thus also for consciousness. It is clear, therefore, that there is much at stake when it comes to the self.

The concept of self has been subject to intense philosophical discussion over the centuries. Different philosophers have suggested different concepts of self. Recent conceptual issues that have been discussed in the philosophical literature range from discussions of self-consciousness (Peacocke, 2014), the certainty of self-existence (Campbell, 2004), to questions of self-knowledge (Burge, 2013) and self-constitution (Velleman, 2006). Because of time and space constraints, we will only focus on those that are relevant in the attempt to map the interface between philosophical and neuroscientific accounts of the self. In the model of credition, the concept of self plays a central role (Sugiura et al., 2015).

There are four main concepts of self that are discussed in current philosophy. First is "the mental self," which is based on our thoughts and a specific mental substance. Second is the "empirical self"—this concept of the self represents and reflects the biological processes in one's body and brain.

Third is the "phenomenal self," from which our experience in consciousness originates. Our consciousness is accompanied by an awareness of our self, referred to as pre-reflective self-awareness or phenomenal self. Finally, and most recently, philosophers speak of a "minimal self". This concept of the self is based on our body and its physiological processes. I will discuss each of these different concepts and how they relate to the brain in this article.

Before we do this, I will shed some light on several related concepts. We experience our self in daily life during, for example, the act of perceiving certain objects, persons, or events in our environment. For example, while making a list of all the things you have to do today, you experience not only the act of thinking and writing, but an awareness and experience of your own self. Hence, your self as the very subject of experience seems to be part of that experience. In other words, your self is a content of your consciousness. This is described as self-consciousness. The concept of self-consciousness will be the focus of the next article.

However, there is more to the self than the self itself and our experience of it in self-consciousness. You wake up every morning. Every day. Every week, every year. Your body changes. You become older. You get wrinkled and your hair turns white. Despite all these bodily changes, you nevertheless have the feeling that you are the same self. You still experience your self as being the same self of 20 years ago.

You are one and the same person. Thus, there is a temporal dimension to your self that seems to be coherent and persistent across time. The temporal dimension of your self has consequently been discussed under the umbrella of what is called "personal identity" in philosophy. While our discussion will touch upon the temporal dimension of the self and thus upon personal identity, we will not explicitly discuss it.

In a world of over seven billion people, there are many, many selves: you, your friends, your family, etc. Most interestingly, you can relate to them – you can communicate with other selves and sometimes even feel their emotions as in, for instance, the grief someone might feel when they lose a loved one. Or you might experience pain when your boyfriend's arm is broken. How is this possible? In philosophy, this is called "intersubjectivity". Intersubjectivity shall be discussed in Chapter 19.

Finally, your self is not isolated from the rest of the world. You can share others' experiences and feel connected to the world. The world, with its specific objects, persons, and events, has meaning to you—you can relate to it more or less and can appropriate it for

your own self. How is such basic integration of your own self within the world possible? And how is that related to your brain and its neuronal mechanisms? This will be the focus in the fourth article in this part.

Background: Empirical Investigation of the Self in Neuroscience

How can we investigate the self? In order to experimentally address the self, we need some quantifiable and objective measures that can be observed from a third-person perspective. How can we obtain such measures? Psychologists focusing on memory observed that items related to ourselves were better remembered than those unrelated (Northoff et al., 2006). For example, as a resident of Ottawa, I recall the recent thunderstorm that wiped away several houses locally much better than a person who, perhaps living in Germany, just heard about it in the news.

Thus, there is superiority in the recollections of those items and stimuli that are related to one's self. This is described as the self-reference effect (SRE). The SRE has been well validated in several psychological studies. Most interestingly, it has been shown to operate in different domains; not only in respect to memory, but also in relation to emotions, sensorimotor functions, faces, words, etc. In all these different domains (see below for details), stimuli related to one's own self, known as self-specific stimuli, are recalled much better than those that are unrelated to one's own self, known as non-self-specific stimuli.

How is the SRE possible? Numerous investigations (Klein, 2012; Klein and Gangi, 2010 for summaries) show that the SRE is mediated by different psychological functions. These range from personal memories including autobiographical memories, memories of facts (semantic memories), to those cognitive capacities that allow for self-reflection and self-representation. Hence, the SRE by itself is not a solitary function, but rather a complex multifaceted psychological composite of functions and processes.

How can we link the SRE to the brain? Before the introduction of functional imaging techniques such as fMRI in the early 1990s, most studies focused on the effect of dysfunction or lesions in specific brain regions caused by brain tumors or stroke. These revealed that lesions in medial temporal regions that are central in memory recall, such as the hippocampus, change and ultimately abolish the SRE effect.

With the introduction of brain imaging techniques such as fMRI, we could then transfer the experimental paradigms of comparing self- and non-self-specific stimuli to the scanner and investigate the underlying brain regions. The basic premise here is that if self-specific stimuli are recalled better than non-self-specific stimuli, they must be processed by the brain in a different way. This might be, for instance, by higher degrees of neural activity and/or different regions.

This led to the investigation of numerous experimental designs of SRE-like paradigms in the fMRI scanner. For example, subjects were presented trait adjectives that were either related to themselves (such as for me, my hometown, Ottawa) as opposed to (Sydney, an unrelated city for me). In other tests, the participant was presented with images of his or her own face and these were compared with faces of other people. Also, autobiographical events from the subject's past were compared with those from other people. One's own movements and actions could also be compared with those of other people, implying what is called ownership (e.g., my movements) and agency ("I myself caused that action").

The stimuli belonged to different domains such as memory, faces, emotions, verbal, spatial, motor, or social. Most of the stimuli were presented either visually or auditorily and the presentation of these stimuli was usually accompanied by an on-line judgment about whether the stimuli are related and personally meaningful or not to the research subject.

On the whole, we can see that current neuroscience can investigate the self in various experimental ways using mainly functional brain imaging. However, any empirical research relies on certain presuppositions. This also holds true for current neuroscientific research on the self, which aims to reveal the neuronal mechanisms underlying our experience, or sense of self. However, before examining the neuroscientific findings, we need to briefly shed some light on the concept of the self and how it has been defined in philosophical discussions.

Mental Self

What is the self? What must it look like in order to presuppose experience and be the subject of our experience? The self has often been viewed as a specific "thing". Stones are things, and the table on which your laptop stands is a thing. And in the same way the table makes it possible for the laptop to stand on it, the self may be a thing that makes experience and consciousness possible. In other words, metaphorically speaking, experience and consciousness stand on the shoulders of the self.

However, another question is whether the self is a thing or, as philosophers such as Rene Descartes suggest, a substance? A substance is a specific entity or material that serves as a basis for something like a self. For instance, the body can be considered a physical substance, while the self is can be associated with a mental substance.

Is our self real and thus does it exist? Or is it just an illusion? Let us compare the situation to perception. When we perceive something in our environment, we sometimes perceive it not as a real thing, but as an illusion that in reality does not exist. The question of what exists and what is real is what philosophers call a metaphysical question. Earlier philosophers, such as Rene Descartes, assumed that the self is real and exists.

However, Descartes also assumed that the self is different from the body. Hence, self and body exist, but differ in their existence and reality. Thus, from this perspective, the self cannot be a physical substance and is a mental substance instead. It is a feature not of the body, but of the mind.

However, the characterization of the self as a mental entity has been questioned. For example, the Scottish philosopher David Hume argued that there is no such thing as self as a mental entity. There is only a complex set or "bundle" of perceptions of

interrelated events that reflect the world in its entirety. There is no additional self in the world; instead, there is nothing but the events we perceive. Everything else, such as the assumption of a self as a mental entity, is an illusion. The self as a mental entity, and thus, as a mental substance, does not exist and is therefore not real.

To reject the idea of self as a mental substance and to dismiss it as a mere illusion is currently popular. One major proponent of this view today is the German philosopher Metzinger (2004). In a nutshell, he argues that through our experience, we develop models of the self, so-called “self-models”. These self-models are nothing but information processes in our brain. However, since we do not have direct access to these neuronal processes (e.g., those processes and activities of the cells, neurons, in the brain), we tend to assume the presence of an entity that must underlie our own self-model. This entity is then characterized as the self (Fig. 1).

According to Metzinger, the assumption of the self as a mental entity results from an erroneous inference based on our experience. We cannot experience the neuronal processes in our brain as such; nobody has ever experienced their own brain and its neuronal processes. Therefore, the outcome of our brain’s neuronal processes, the self, cannot be traced back to its original basis (the brain) in our experience.

Where then does the self come from? We assume that it must be traced back to a special instance that is different from the brain. This leads us to assume that the mind and the self are mental entities rather than physical, neuronal entities originating in the brain itself. Metzinger argues that the self as a mental entity simply does not exist. Therefore, Metzinger (2004) concludes, selves do not really exist. Hence, the title of his book: “*Being No One*”.

From the Metaphysical to the Empirical Self

What is the self, if not a mental entity? Current authors, such as Metzinger (2004) and Churchland (2002), argue that the self as a mental substance or entity does not exist. How do we come up with the idea of a self or the self-model as Metzinger calls it? The model of our own self is based on summarizing, integrating, and coordinating all the information from our own body and brain.

What does such integration look like? Take all that information together, coordinate and integrate it, and then you have a self-model of your own brain and body and their respective processes. In more technical terms, our own brain and body are represented in the neuronal activity of the brain. Such representation of the own brain and body amounts then to a model of your self. The self-model is therefore nothing but an inner model of the integrated and summarized version of your own brain and body’s information processing. The self is thus a mere model of one’s own body’s and brain’s processes.

The original mental self, the self as mental substance or entity, in this line of thinking is replaced by a self-model. This implies a shift from a metaphysical discussion of the existence and reality of self, to the processes that underlie the representation of body and brain as a self-model. Since this representation is based on the coordination and integration of the various ongoing processes in brain and body, it is associated with specific higher-order cognitive functions such as working memory, attention, executive function, and memory, among others.

What does this imply for the characterization of the self (presupposing a broader concept of self beyond the self as mental substance)? The self is no longer characterized as a mental substance, but as a cognitive function. Methodologically, this implies that the self should be investigated empirically rather than metaphysically.

We therefore need to search for the cognitive processes underlying the special self-representation. The self is consequently no longer an issue of philosophy, but rather one of cognitive psychology and ultimately of cognitive neuroscience. According to this model, the self is no longer a metaphysical matter, but a possible subject of empirical investigation. Metzinger’s critique of the self is directed toward the assumption of a metaphysical self as mental entity or substance. In contrast, he does not deny the experience or sense of self. Therefore, the title of his book “*Being No One*” is somewhat misleading – there is one being that we continuously experience, but it is not a mental substance or entity.

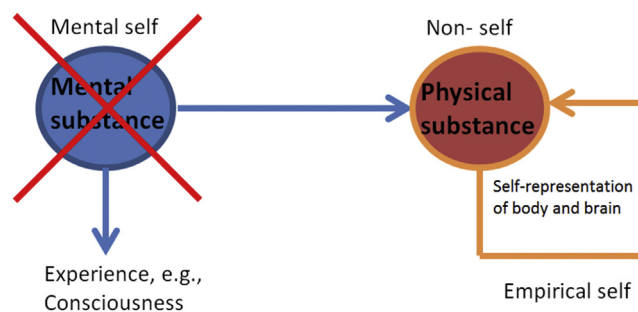


Fig. 1 The figure illustrates the rejection of any kind of special mental self (left) and defines the self exclusively as empirical self in terms of self-representation of body and brain (right).

Minimal Self

How can we describe the pre-reflective self-consciousness in more detail? It is always already there in every experience, so that we cannot avoid it or separate it from the experience. The self is always present in our consciousness and thus in our subjective experience. Even if we do not focus on the self as such, we cannot avoid or remove its presence. Hence, the term pre-reflective self-consciousness describes an implicit or tacit experience of our self in our consciousness.

Since the self as pre-reflectively experienced is the basis of all phenomenal features of our experience, it must be considered as essential for any subsequent cognitive activity. Such a basic and fundamental self occurs in our experience before any reflection. For instance, when reading the lines of this book, you experience the contents and, in addition, you also experience your self as reading these lines.

Hence, your immediate experience and consciousness comes with both the content and your own self. Since the experience of such self occurs prior to any reflection and recruitment of higher-order cognitive functions, the concept of self is sort of a minimal version of the self. Current phenomenological philosophers such as [Gallagher \(2000\)](#) and [Zahavi \(2005\)](#) speak therefore of a “minimal self” when referring to the self as implicitly, tacitly, and immediately experienced in consciousness.

How can we describe the concept of the “minimal self”? The minimal self refers to a basic form of self that is part of any experience. As such, it is not extended across time like it is in the experience of the self that has continuity across time in personal identity. Instead, the minimal self describes a basic sense of self at any particular given moment in time, but does not yet provide a link between different moments in time and thus continuity across time.

How can such continuity across time be constituted? Cognitive functions such as memories and autobiographical memories in particular may be central. In this model, the self may become more complex. One might speak of a cognitive, extended or autobiographical self, as does, for example, the Portuguese-American neuroscientist, [Damasio \(2010, 1999\)](#).

Another important feature of the minimal self is that although we experience it, we may not be aware of it as such. This means that we might not be able to reflect upon it in order to gain knowledge of it. We are, to put it in technical terms, only pre-reflectively aware of the minimal self. In contrast to such pre-reflective awareness, there is no reflective awareness of the minimal self. How can we become reflectively aware of the minimal self? For that to be possible, the different moments or points in time need to be integrated and, as philosophers say, represented. For such representation to occur, cognitive functions are needed which make it possible to link together the different time points.

Finally, the minimal self may also occur prior to verbalization and thus linguistic expression. Rather than being tied to specific linguistic concepts, as is the case with more cognitive concepts of the self, the minimal self must be considered pre-linguistic. It is an experience, a sense of self that can barely be put into concepts. We can experience the self but are not really able to describe these experiences in terms of concepts and articulate them in a linguistic way.

Thus, the minimal self is pre-linguistic and pre-conceptual and will therefore, speculatively, not be affected by second language acquisition. It is the kind of experience, an implicit sense of self, which most likely subjects will take with them as more or less stable when moving to a new country where they have to acquire a new language. However, at the same time, the minimal self provides the essential basis upon which more cognitive forms of self are developed. These are then central and instrumental in providing the ability to learn a second language.

Social Self

How does the self interact with other selves? So far we described the self in an isolated and purely intra-individual way. However, in daily life, the self is not isolated from others, but always related to other selves. This is called inter-individualism rather than intra-individualism. This raises questions about what is described as the “problem of other minds” or, more generally, questions concerning intersubjectivity. Here we will here give a brief description of the problem of intersubjectivity.

How can we make the assumption of attributing mental states, and thus self and mind, to other people? Philosophy has long relied on what is called the “inference by analogy”. What is the “inference by analogy”? “Inference by analogy” goes like this. We observe person A to show the behavior of type X. And we know that in our own case, the same behavior X goes along with the mental state type M. Since our own behavior and that of person A are similar, we assume that the other person A to show the same mental state type M we experience when exhibiting behavior X.

What kind of inference do we draw here? There is similar or analogous behavior between ourselves and the other person. In addition, my own behavior is associated with a particular mental state. Since now the other person shows the same behavior, I infer that she also experiences the same mental state that is associated with my own behavior. Hence, by indirect inference and analogy via our own case, we claim to obtain knowledge of the other person’s mental state. How can we make such an inference? We may make it on the basis of our own mental states and their associated behavior. And what we do may also hold true for the other person who in the same way attributes mental states to us by inferring them from the comparison between our behavior and their own mental states.

Why do we make such inferences? Because it seems to be the easiest and best way for us to explain other people’s behavior. The assumption of mental states thus seems to be the best explanation for your behavior. The “inference by analogy” may thus be considered an inference to the best possible explanation.

The inference by analogy describes intersubjectivity in a very cognitive and ultimately linguistic way when attributing mental states and a self to other persons. There might be, however, a deeper level of intersubjectivity. We also feel the other persons’ mental

states when sharing the emotional pain, for example, that one's spouse experiences when her father died. Such sharing of feeling is described as empathy and sheds light on a deeper pre-cognitive and pre-verbal dimension of intersubjectivity. This has been emphasized especially in phenomenological philosophy (see for instance Zahavi, 2005; Metzinger, 2004).

However, both empathy and the attribution of mental states to another person are puzzling: despite the fact that we do not experience the other's mental states and consciousness, we nevertheless either share them (as in empathy) or infer them (as in inference by analogy). We have no direct access to other persons' experience of a self and its mental states in first-person perspective, yet nevertheless share their mental states and assume that they have a self. How is that possible?

This is where we need to introduce yet another perspective. There is first-person perspective – tied to the self itself and its experience or consciousness of objects, events, or persons in the environment. Then there is the third-person perspective— this perspective allows us to observe the objects, events, or persons in the environment from the outside, rather than from the inside. The picture is not complete.

What is second-person perspective? Second-person perspective has initially been associated in philosophy with the introspection of one's own mental states. Rather than actually experiencing one's own mental states in first-person perspective, second-person perspective makes it possible to reflect on and introspect about one's own mental states. An example of this is when you ask yourself whether the voice you heard was really the voice of your good friend (see also Schilbach et al., 2013).

The second-person perspective thus allows us to put the contents of our consciousness as experienced in first-person perspective into a wider context, the context of oneself as related to the environment. In other words, the second-person perspective makes it possible to situate and integrate the purely intra-individual self with its first-person perspective into a social context. This transforms the intra-individual self into an inter-individual self. Another way of thinking of second-person perspective is to call this concept of the self, the "social self".

How can we define the concept of the social self? The concept of the social self describes the linkage and integration of the self into the social context of other selves. This shifts the focus from experience or consciousness in the first-person perspective to the various kinds of interactions between different selves as associated with the second-person perspective. As we already indicated, there may be different kinds of social interactions, including affective pre-cognitive and more cognitive ones, that involve meta-representation as described above.

Neuroscientific Findings: Spatial Patterns of Neural Activity During Self-Specific Stimuli

How can we relate the various philosophical concepts of the self to the neuroscientific findings of self-reference? Above, we discussed that psychology, and later neuroscience, quantified the self in terms of the self-reference effect (SRE). The SRE describes the different impact of self-referential and non-self-referential stimuli on psychological (e.g., reaction time, recall, etc., see above) and neural (e.g., degree of activity, regions, etc. see below) measures. Below, we want to briefly highlight some of the main findings of recent imaging studies on the self-reference effect.

What results did the various imaging studies yield in the fMRI? Two different kinds of regions showed up. First, one could see that the regions specific for respective domains like emotions or faces were recruited. For instance, there is a region in the back of the brain that specifically processes faces (as distinguished from, say, houses); this is called the fusiform face area. This region is obviously active during the presentation of faces, no matter whether it is one's own face or another person's face. Importantly, clear differences between self- and non-self-specific stimuli could not be observed in these domain-specific regions in most studies (see Northoff et al., 2006).

What about other regions that are not specific to particular domains (also known as domain-independent regions) involved in the neural processing of the self? Meta-analyses of the various studies demonstrated the involvement of a particular set of regions in the middle of the brain. These regions include the perigenual anterior cingulate cortex (PACC), the ventro- and dorsomedial prefrontal cortex (VMPFC, DMPFC), the supragenual anterior cingulate cortex (SACC), the posterior cingulate cortex (PCC) and the precuneus. Since they are all located in the midline of the brain, they have been coined "cortical midline structures" (CMS).

The self-specific stimuli—those that were personally relevant for the subjects— induced higher neural activity in these regions than non-self-specific stimuli, or those that remained irrelevant and unrelated to the person. This was observed in the various domains for faces, trait adjectives, movements/actions, memories, and social communication. Therefore, the CMS seem to show a special significance to the self and self-reference.

However, there is also some differentiation within the CMS. The self-specific stimuli may be presented in different ways to the subject in the scanner. If subjects have to make judgments requiring cognitive involvement, the dorsal and posterior regions such as the SACC, DMPFC and PCC are recruited to a stronger degree. If, in contrast, stimuli are merely perceived without any judgment, and thus without any cognitive component, the ventral and anterior regions such as the VMPFC and PACC were highly involved (Fig. 2).

This led to the assumption that the different regions mediate different aspects of self-reference. The ventral and anterior regions, such as the PACC and VMPFC, may be more involved in the representation of the degree of self-reference in the stimulus. However, dorsal regions, such as the SACC and the DMPFC, may be related to monitoring and reflection of the stimulus and its self-reference when we become aware of the stimulus as self-specific.

Finally, the posterior regions, such as the PCC, may be implicated in integrating the stimulus and its degree of self-reference into the autobiographical memory of the respective person. These regions seem to be implicated in the recall and retrieval of especially

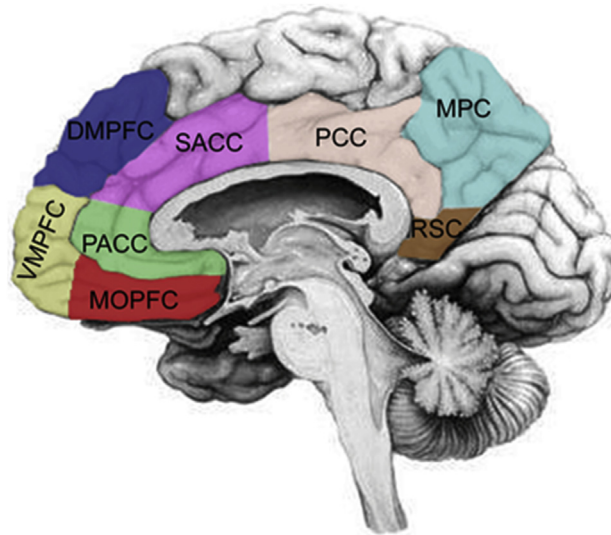


Fig. 2 Overview of regions included in the cortical midline structures (abbreviations in text).

personally relevant and autobiographical information from the past of that person. Thus, it can be concluded that specific regions in the midline of the brain, the cortical midline structures, seem to be involved in the neural processing of self-reference or attributing personal relevance or self-relevance to stimuli.

Neuroscientific Findings: Temporal Patterns of Neural Activity During Self-Specific Stimuli

In addition to the spatial patterns of self-reference, its temporal patterns have also been investigated using EEG. Again, self-specific and non-self-specific stimuli have been compared to each other while the subjects undergo EEG measurement. This revealed early changes during self-specific stimuli at around 100–150 ms after stimulus onset.

More specifically, self-specific stimuli induced different electrical activity changes already at 130–200 ms after their onset when compared to non-self-specific stimuli. This was accompanied by later changes around 300–500 ms. Hence, the temporal pattern between self- and non-self-specific stimuli shows both early and late differences.

In addition, different frequencies of neural activity were investigated. The neural activity oscillates rhythmically in different frequency ranges in the fluctuations of the neuronal activity.

One frequency often induced by stimuli are gamma frequencies in the range of 30–40 Hz. Interestingly, some EEG (and MEG) studies observed higher power in the gamma range in anterior and posterior midline regions during self-specific stimuli than non-self-specific stimuli. The question though is whether such increases in gamma power is specific to self-specific stimuli since it can also be observed in other functions independent of self-reference (see below).

Neuroscientific Findings Ic: Social Patterns of Neural Activity During Self-Reference

How can we investigate the social nature of the self described earlier? Various studies have been conducted to investigate different kinds of interaction between different selves. Pfeiffer et al. (2013) and Schilbach et al. (2012) distinguish two different methodological approaches. One investigates social cognition, the cognition of mental states in other people, from a third-person perspective. Here, social cognition is investigated in an “offline” mode. More recently, this “offline” methodological strategy has been complemented by an “online” mode. In the “online mode,” social interaction is investigated from the “inside,” by taking on the perspective of the interacting selves (rather than the observer’s point of view).

Besides conducting several studies, the same group has recently investigated the neural overlap between emotional processing, resting state activity, and social-cognitive processing (Schilbach et al., 2012). They conducted a meta-analysis including imaging studies from all three kinds of investigations: resting state, emotional, and social-cognitive. First, they analyzed the regions implicated in each of the three tasks. This yielded significant recruitment of neural activity, especially in the midline regions like the ventro and dorsomedial prefrontal cortex and the posterior cingulate cortex (bordering to the precuneus). In addition, neural activity in the temporo-parietal junction and the middle temporal gyrus was observed.

In the second step, they overlaid the three tasks, emotional, social-cognitive, and resting state, in order to detect commonly underlying areas. This indeed revealed the midline regions, the dorsomedial prefrontal cortex and the posterior cingulate cortex, to be commonly shared among emotional and social-cognitive tasks and resting state activity. Based on this neural overlap, the authors concluded that there may be an intrinsically social dimension in our neural activity which might be essential for consciousness of both our own self and other selves. If this is true, it will have radical consequences, not only for the concept of the self, but also for consciousness in general.

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