Below is the unedited draft of the article that has been accepted for publication
(© Cognitive Neurodynamics, 2022, V. 16, P. 255-282.; https://doi.org/10.1007/s11571-021-09719-5)

Self, Me and I in the repertoire of spontaneously occurring altered states of Selfhood: eight neurophenomenological case study reports

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Abstract:

This study investigates eight case reports of spontaneously emerging, brief episodes of vivid altered states of Selfhood (ASoSs) that occurred during mental exercise in six long-term meditators by using a neurophenomenological electroencephalography (EEG) approach. In agreement with the neurophenomenological methodology, first-person reports were used to identify such spontaneous ASoSs and to guide the neural analysis, which involved the estimation of three operational modules (OMs) of the brain self-referential network (measured by EEG operational synchrony). The result of such analysis demonstrated that the documented ASoSs had unique neurophenomenological profiles, where several aspects or components of Selfhood (measured neurophysiologically and phenomenologically) are affected and expressed differently, but still in agreement with the neurophysiological three-dimensional construct model of the complex experiential Selfhood proposed in our earlier work (Fingelkurts et al., 2020).

Keywords:

Self-referential brain network (SRN); default-mode network (DMN); altered states of selfhood (ASoS); subjective sense of Self; first-person perspective; electroencephalogram (EEG); alpha rhythm; operational synchrony; functional connectivity; agency; ownership; mineness; embodiment; narration; autobiography; self-consciousness.

1. Introduction

Neurophenomenology was established as a novel research paradigm aiming to unify two different and apparently irreconcilable methodologies (Varela, 1996): the neuroscientific experimental approach (quantitative data) and the phenomenological approach (qualitative data) by integrating the lived, experiential data with neuroscientific data (Olivares et al., 2015), where first-person accounts and neurophysiological data mutually inform one another (Varela, 1996; Gallagher & Sørensen, 2006; Gallagher & Zahavi, 2008). In other words, neurophenomenology requires an integration of third-person data (e.g., functional Magnetic Resonance Imaging – fMRI, Electroencephalography – EEG, Magnetoencephalography – MEG, etc.) with first-person accounts (e.g., reports of the participant's lived experience) (Varela & Shear, 1999).

Since its introduction, neurophenomenology has been successfully applied in multiple research studies (Varela et al., 1991; Varela, 1997, 1999; Gallagher, 1997; Petitot et al., 1999; Lutz, 2002; Lutz & Thompson, 2003; Petitmengin et al., 2007; Stewart et al., 2010; Froese, & Di Paolo, 2011; Froese & Fuchs, 2012; Berkovich-Ohana et al., 2013, 2020; Berkovich-Ohana, 2017). Here, we were interested in applying the neurophenomenological approach to altered states of consciousness (ASC), and more specifically, to the *ASC of Selfhood*. Even though ASCs have been an integral part of recorded human history (Winkelman, 1997), the scientific status of ASCs is still far from uniform and tends to be defined in rather broad terms (Kokoszka, 1999; Cofré et al., 2020).

Traditionally, an ASC is defined as a state in which "extraordinary" content is experienced or in which the manner of experiencing is "unusual" (Kokoszka, 1999) and being qualitatively different from normal/baseline waking consciousness (Tart, 1972). However, such conceptualisation lacks precision and leaves many open questions (Revonsuo, 2006; Cofré et al., 2020). For example, "[t]he phenomenal contents of consciousness do not all by themselves directly reveal whether the state of consciousness is an altered state or not. An identical phenomenal content of consciousness (say the experience of seeing an elephant in front of you) may be produced during the baseline state of consciousness (if you are in the zoo) or during an altered state of consciousness (if you are at home and dreaming or under the influence of LSD). The phenomenal content of consciousness (the pattern of subjective experience) does not by itself determine whether the background mechanisms of consciousness function normally or are somehow altered" (Revonsuo, 2006; p. 58). Therefore, it has been suggested that the relevant *alteration* in the background mechanisms of consciousness[1] determines the relation between subjective experiences that are actually produced and those that would have been produced in the baseline state of normal wakefulness: the alteration in the background mechanisms of consciousness changes this relationship, leading to an ASC.

[1] By "the background mechanisms of consciousness" we consider, following Revonsuo (2006), the "immediately lower-level [in relation to consciousness] entities [at the level of brain organization] on which consciousness as a whole is ontologically dependent, meaning that consciousness could not exist without them to be present" (Fingelkurts et al., 2013; p. 14). However, phenomenologically only contents are experienced and not the content-formation process itself (background mechanisms of consciousness), – so called "phenomenal transparency" (Metzinger, 2003; 2014).

Keeping this in mind, one may thus define the normotonic waking consciousness (*baseline state of consciousness*) as the state where person is awake and perceives the self and environment more or less accurately (Revonsuo, 2006). Therefore, in the "baseline state the contents of consciousness are modulated by the physical environment and the physical body and therefore consciousness succeeds in accurately representing them" (Revonsuo, 2006; p. 57). Then, for the baseline state of consciousness to count as an ASC, it must be *temporally* somehow *altered* in relation to this baseline state of consciousness (for a similar conceptualisation, see Hobson, 2001; Boly et al., 2008; Winkelman, 2011). Thus, an ASC can be defined as the *transitory* and typically *reversible* state of the background mechanisms of subjective experience that process and represent available information (internal and external) inaccurately (or delusionally) so that the resulting subjective experience mismatch the reality in one respect or another (Revonsuo, 2006). When such a state manifests, the person is in an ASC regardless of the contents of consciousness and regardless of what circumstances brought about the alteration in the background mechanisms of the person's brain. Meditative states, aura states during epileptic seizures, dreaming, drug-induced hallucinations, sensory deprivation states and hypnotic suggestions, all are examples of ASCs[2].

Analysis of the available literature on these states, suggests that during ASCs a dramatic and profound alteration occurs in the *experiential Selfhood*. Indeed, alterations in self *dominate* the phenomenological reports during ASCs: this is the case for dreams when one does not have a body, but rather is present "as an abstract, undefined volume of indeterminate extension or even as an unextended point in space" (Windt, 2015; p. 15; see also Windt, 2010; Metzinger, 2013), as well as during dreamless sleep, when even a minimal form of phenomenal selfhood is lost (Thompson, 2015; Windt, 2015, Windt et al., 2016), or drug-induced self dissolution (Lebedev et al., 2015; Wittmann, 2015; Letheby & Gerrans, 2017; Millière, 2017; Nour & Carhart-Harris, 2017; Deane, 2020), or alterations of self features as well as selfless states during meditation (Mañjuśrīmitra et al., 1987; Travis & Pearson, 2000; Shear, 2007; Josipovic, 2010; Berkovich-Ohana et al., 2013; Ataria et al., 2015; Metzinger, 2020) and during sensory deprivation (Kjellgren et al., 2008, 2010; Glicksohn et al., 2019; Glicksohn & Ben-Soussan, 2020), in hypnotic states (Crawford & Gruzelier, 1992; Gruzelier, 2000; Kallio & Revonsuo, 2003), and during epileptic seizures (Johanson et al., 2008; Blumenfeld, 2012). Given this empirical evidence, it is reasonable to speak about the *altered states of Selfhood* (*ASoS*). Similar to ASCs, the ASoSs are transitory, reversible and nonpathological.

A broad variety of behavioural, instrumental and pharmacological means are known to induce alterations in self-consciousness, ranging from meditation, special breathing techniques, hypnotic suggestions, sensory deprivation, magnetic/electric brain stimulation, or consumption of psychoactive drugs (Schmidt & Berkemeyer, 2018). While mediation- and drug-induced ASoSs have been extensively studied

[2] For the sake of completeness, it should be noted that ordinary visual illusions do not count as evidence for an ASC, even though they also misrepresent reality, because they are not *temporary* or *reversible*: particular types of stimuli invariably elicit illusions (Revonsuo, 2006). Further, momentarily fleeting misperceptions due to *noisy* signal are obviously not an ASC either. The same goes for the neuropsychopathology: during such disorders, the alterations of self-consciousness have a *long-term* or *permanent* presence (Parnas et al., 2005; Beck, 2008) and therefore such disorders do not count as evidence of ASC (Revonsuo, 2006), even though they may share similar mechanisms (Dittrich, 1998). Therefore, pragmatically, ASCs are the *non*pathological states (Kokoszka, 1999).

and frequently reported (see for a comprehensive overview, Millière et al., 2018), brain stimulation ASoSs have been largely restricted to the clinical domain. For example, some ASoSs typical for the epileptic seizures, can be elicited by electrically stimulating certain parts of the brain (Penfield, 1938; Halgren et al., 1978; Vignal et al., 2007).

Of these, the only ASoSs which can be achieved in a *pure form* (non-chemically and without one's volitional effort, or exogenous stimulation) are those that occur *spontaneously* (for a similar view, see Zahavi & Parnas, 1998). In such spontaneously emerging ASoSs, the altered phenomenal contents of self-consciousness that the person experiences are a consequence of the pure altered state that is a result of the background mechanisms of self-consciousness *only* and not due to confounding factors such as (i) intentional mental effort with biases of particular practice exercise or conceptualisations of the respective traditions, (ii) drug-induced neurochemical alterations, or (iii) brain activity manipulation by magnetic or electrical stimulation. However, catching and measuring such ASoSs in laboratory controlled settings is challenging. At the same time, possessing the capacity to register and analyse ASoSs in the laboratory (especially in conjunction with neurophenomenological approach) would be very helpful to progress in revealing the *nonpathological/normative range* of Selfhood variation.

It is known that ASoSs occasionally arise in *spontaneous* and *involuntary* manner during meditation practice[3] in highly-experienced long-term meditators (Soler et al., 2014; Berkovich-Ohana, 2017; Millière et al, 2018; Vieten et al., 2018; Penberthy et al., 2020). In this context, the usage of highly experienced meditators is of special interest for the purpose of studying these spontaneous ASoSs. Another important factor to consider is that long-term contemplative practitioners are acutely aware of and sensitive to the variations in their subjective experience, are able to stay within a given experience without being lost in thought or distracted by mind-wandering, and to provide a detailed and reliable first-person reports of such experiences that are lived through (Lutz et al., 2007; Fox et al., 2012; Berkovich-Ohana et al. 2013; Dor-Ziderman et al. 2013; Mrazek et al., 2013; Ataria et al., 2015). This later capability is a fundamental element of the neurophenomenological approach[4] (Varela, 1996), where the first-person data (phenomenology) "provide additional, valid information about externally uncontrollable aspects of mental activity, and this information can be used to detect significant patterns of dynamic activity at the neural level" (Thompson et al., 2005; pp. 45-46).

As for the "neural" component of the neurophenomenological approach and also to capture the background mechanisms of subjective experience of Selfhood, we used the recently introduced

[3] It is important to keep in mind that meditation and related contemplative practices, by themselves, do not represent altered states of consciousness, but rather facilitate them (Newberg & Yaden, 2018).

[4] In the neurophenomenological research paradigm, the ability to become aware of lived experience is considered a special skill, that requires a certain way of reflection toward the one's own subjective experience, and that it can and should be trained and learned (Froese et al., 2011). This is why subjects in such studies are usually phenomenologically trained (Thompson et al., 2005). This training is rather effortful and time-consuming. At the same time, experienced, long-term meditation practitioners have been repeatedly proposed as subjects suitable for such inquiry, because due to their long-term practice they already acquired the needed skill ("pre-trained") that enables the systematic gathering of reliable phenomenological reports (Varela et al., 1991; Varela & Shear, 1999; Bitbol, 2019; Kordeš et al., 2019; Berkovich-Ohana et al., 2020).

neurophysiological three-dimensional construct model of the complex experiential Selfhood (Fingelkurts & Fingelkurts, 2011; Fingelkurts et al., 2016a,b; for a detailed description, see Fingelkurts et al., 2020), which is based on the EEG operational synchrony analysis (Fingelkurts & Fingelkurts, 2008, 2015). This triad model of Selfhood has been put forward to account for the phenomenological distinctions between three major aspects of Selfhood, namely first-person agency, embodiment, and reflection/narration, all of which are commensurate with one another (Gallagher, 2013; Gallagher & Daly, 2018) and thus reflect the multi-faceted nature of self-awareness (Snodgrass & Thompson, 1997; Klein & Gangi, 2010; Musholt, 2013; Millière et al., 2018). Together these three aspects form a unified sense of self (Fingelkurts & Fingelkurts, 2011; Fingelkurts et al., 2020).

1.1. The triad model of Selfhood.

The triad model of Selfhood (Fingelkurts et al., 2016a,b, 2020) is built on neurophysiological evidence that *three* major spatially separate yet functionally interacting brain subnets (or operational modules – OMs) constitute the brain self-referential network (SRN), also frequently referred to as the default mode network (Raichle et al., 2001; Gusnard, 2005; Northoff et al., 2006, 2011; Schilbach et al., 2008; Fingelkurts & Fingelkurts, 2011; Fingelkurts et al., 2012; Davey et al., 2016; Northoff, 2016). Each OM is a set of brain regions having tight "functional connectivity" among one another within every given OM (Fingelkurts & Fingelkurts, 2011; for a further discussion, see Uddin et al., 2009; Andrews-Hanna et al., 2010; Spreng & Grady, 2010; Leech et al., 2011). The set of these three OMs include the anterior OM and two symmetrical (left and right) occipito-parieto-temporal OMs (Fig. 1) which can be reliably estimated by means of operational synchrony analysis of the EEG signal (Fingelkurts & Fingelkurts, 2008, 2015).

According to this triad model of Selfhood (Fingelkurts et al., 2016a,b), the *anterior module* of the SRN (Fig. 1) is associated with the *phenomenal* first-person perspective and the *phenomenal* sense of agency (Fingelkurts et al., 2020). We label it the "witnessing observer" or simply the "**Self**" in the narrowest sense (Fingelkurts et al., 2020) – as the phenomenal non-conceptual core in the act of knowing itself (Blanke & Metzinger, 2009), or in the words of Velmans (2014), a sensed "centre of gravity", where one having an experience of directly and immediately present as the centre (or a focus) of a phenomenal multimodal perceptual reality (Metzinger, 2004, 2008; Revonsuo, 2006; Trehub, 2007; Blanke & Metzinger, 2009). Here, agency is treated as the "sense of ownership" of thoughts, perceptions, and actions relevant to Selfhood (Metzinger, 2004, 2008; de Vignemont & Fourneret, 2004; Hohwy, 2007; Blanke & Metzinger, 2009) and the sense that it is "I" who is undergoing the experience in its implicit first-person mode of givenness (Gallagher, 2000; Zahavi, 2002; Metzinger, 2008). Research has shown that such a *Self* in the act of knowing (a "witnessing observer") can be enhanced as a symptom in pathological conditions like depression (Fingelkurts & Fingelkurts, 2017a), and post-traumatic stress disorder (Fingelkurts & Fingelkurts, 2018). It also can be diminished or even disappear completely, as for example, in patients with disorders of consciousness (Fingelkurts et al., 2012, 2016c; Fingelkurts & Fingelkurts, 2017b, Huang et al., 2014), and

also in non-pathological conditions like dreamless sleep (Thompson, 2015; Windt, 2015), in specific meditative states (Wahbeh et al., 2018; Josipovic, 2019), or under psychedelics like 5-MeO-DMT (Millière, 2017, 2020; Letheby & Gerrans, 2017; Deane, 2020). Further, it can also be voluntary manipulated by trained meditation practitioners (Lutz et al., 2008; Kerr et al., 2011; Fingelkurts et al., 2016a,b, 2020).

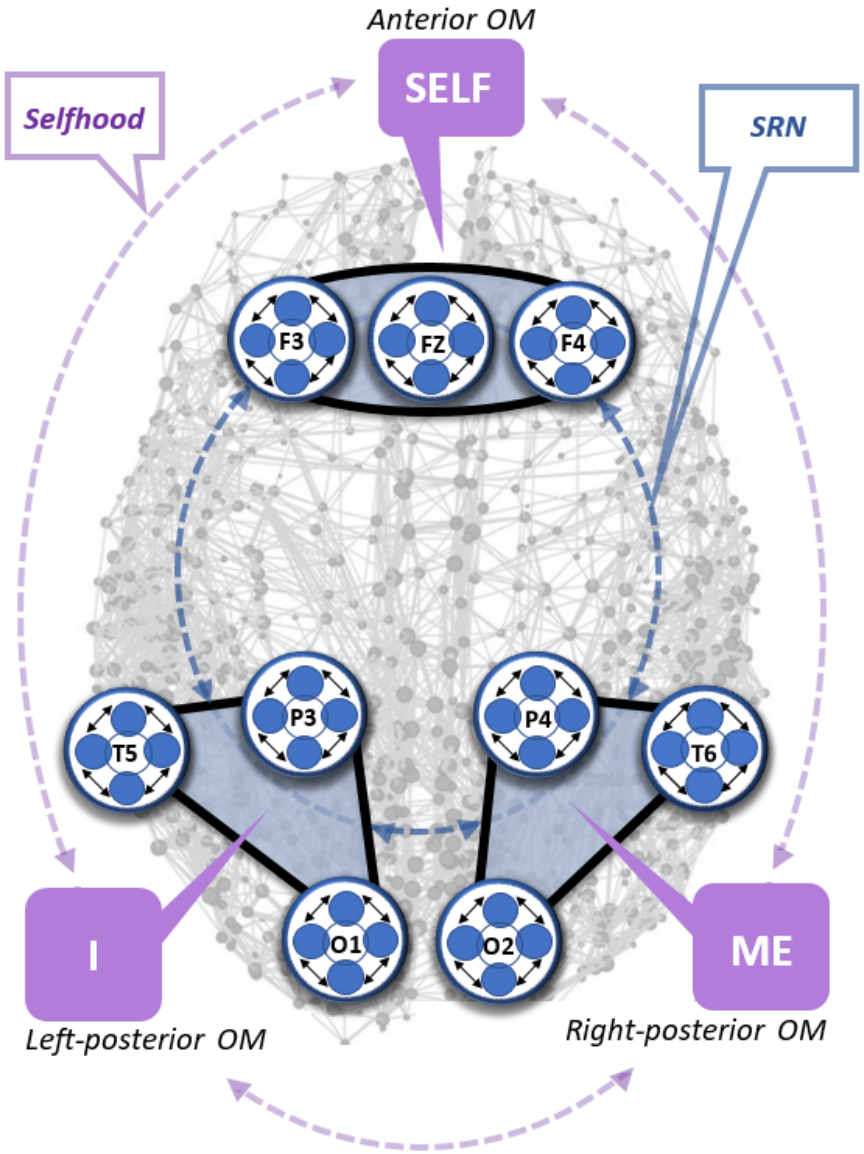

Figure 1. Operational modules (subnets) constituting the self-referential brain network and their relation to the three components of Selfhood. Operational modules (OMs) are indicated as blue-coloured areas that involve operational synchrony among three EEG locations (marked by white circles with EEG electrode IDs) per OM, that are mapped onto a schematic cortex map. A schematic cortex map presents the brain's functional connections with dark grey spheres marking network nodes and light grey lines representing their functional connections. The network nodes are shown in their respective anatomical coordinates, hence preserving the spatial embedding of the network. Every OM has a clear nested functional hierarchy, where higher levels are physically composed of lower levels (Feinberg, 2012). Indeed, every OM is a functional integration of several local brain fields (registered by the correspondent EEG electrodes), which in their turn are the integration of yet smaller local fields of transient functional neuronal assemblies (Fingelkurts & Fingelkurts, 2001, 2013; Fingelkurts et al., 2019; see also Freeman & Kozma, 2000; Kozma

& Freeman, 2009; Freeman et al., 2015). Together, three OMs, form a higher level of a functional nested architecture – the self-referential network (marked as a dashed, blue circle line that connects the three OMs). At the phenomenological level they represent three aspects of Selfhood, marked as "Self", "Me" and "I"; and their dynamic interaction forms the coherent experience of Selfhood (marked as a dashed purple circling line connecting "Self", "Me" and "I"). Abbreviations: EEG: electroencephalogram; OM: operational module; SRN: self-referential network; Double-pointed black arrows schematically indicate functional couplings of the local fields produced by neuronal assemblies under a given electrode; Electrode IDs/Positions: F3 – left frontal, Fz – frontal midline, F4 – right frontal, T5 – left temporal, P3 – left parietal, O1 – left occipital, T6 – right temporal, P4 – right parietal, O2 – right occipital. The Figure is modified from Fingelkurts et al., 2020.

The *right posterior module* of the SRN (Fig. 1) is linked with the experience of self as a normally localized (through interoceptive and exteroceptive sensory processing) within bodily boundaries entity, as well emotional states, and related autobiographical emotional memories (Fingelkurts et al., 2016a,b, 2020). We label this module "representational-emotional agency" or simply "**Me**"[5] (Fingelkurts et al., 2020). The defining feature of the Me-module is that, in contrast to a phenomenal first-person perspective, here only a purely *geometrical first-person perspective* is present that takes its origin from within the body representation, thus signifying an egocentric spatiotemporal self-model (Blanke & Metzinger, 2009). The body here is treated not as just one more object of the physical world, but as a "vehicle" that enables being a self in the world (Varela et al., 1991; Gallagher, 2005; Legrand, 2006; Hohwy, 2010, 2013; Seth et al., 2012; Limanowski & Blankenburg, 2013; Apps & Tsakiris, 2014). It has been documented that this sense of *Me* ("bodily self") can undergo significant alteration or become abnormal during various pathological conditions, as for instance in post-traumatic stress disorder (Fingelkurts & Fingelkurts, 2018), depression (Fingelkurts & Fingelkurts, 2017a), heautoscopic out-of-body experiences (Blanke & Mohr, 2005; Blanke et al., 2002; Ionta et al., 2011), in depersonalization syndrome, where the sense of body ownership is lost (Berlucchi & Aglioti, 1997), or in vegetative or minimally conscious states (Fingelkurts et al., 2012). Within a normative continuum, it can be intentionally manipulated by experienced long-term meditators, who are able to achieve a dramatic loss of bodily perceptions – so called "self-boundarylessness" or "bodylessness" (Newberg et al., 2001; Newberg & Iversen, 2003; Berkovich-Ohana et al., 2013; Ataria et al., 2015; Fingelkurts et al., 2016b, 2020).

The *left posterior module* of the SRN (Fig. 1) is involved in the experience of thinking about and reflecting upon oneself, including momentary narrative thoughts and inner speech, as well as reinterpretation of episodic and semantic memory events related to self – autobiographical story telling (Fingelkurts et al., 2016a,b, 2020). We label it "reflective agency" or simply "**I**"[6] (Fingelkurts et al., 2020). It has been proposed that such narrative self-reflection relies on the uniquely human capability for language (Damasio, 1994; Budwig, 2000; Gallagher, 2000; Craig, 2004) and provides the basis for the sense of invariance of Selfhood

[5] The other names found in literature are "minimal self" (Gallagher, 2000; Gallagher, 2005), "proto-self" (Panksepp, 2005; Panksepp & Northoff, 2009), or "bodily self" (Damasio, 1999; Legrand, 2006; Blanke, 2012).

[6] In the literature other terms have been used: "narrative self" (Gallagher, 2000), "conceptual self" (Neisser, 1988; Demiray & Bluck, 2011), "autonoetic self" (Gardiner, 2001; Klein, 2016), or "autobiographical self" (Damasio, 1999, 2010).

over time (James, 1890; Metzinger, 2003; Friston et al., 2017). Research has shown, that such sense of *I* ("reflective agency") can be altered, thus presenting either a clinical symptom in several pathologies, like schizophrenia, depression, post-traumatic stress disorder or brain injury (Frith, 1992; Gallagher, 2003a; Moseley et al., 2013; Fingelkurts & Fingelkurts, 2017a,b, 2018), or be a normative variation when voluntary modified through a meditation technique (Fingelkurts et al., 2016b, 2020).

The integration of dynamics of these three SRN OMs enables nonreductive intertwining of the triad of Selfhood aspects (witnessing observer, representational-emotional agency, and reflective agency), thus providing a coherent instantiation of the unique, complex phenomenal pattern – a Self (Fingelkurts & Fingelkurts, 2011; Fingelkurts et al., 2016a,b, 2020). Such a neurophysiological three-dimensional construct model of the complex experiential Selfhood treats phenomenological distinctions between different aspects of self not as opposites, but rather as commensurate and complementary with one another (see also Gallagher, 2013; Gallagher & Daly, 2018).

Recently, it has been documented experimentally that there is a causal link between the three phenomenological aspects of Selfhood and related to them the three OMs of brain SRN (Fingelkurts et al., 2020). In that study, the dynamics of functional integrity of the three SRN OMs were analysed while experienced meditators mentally manipulated (either increase/up-regulate or decrease/down-regulate) every component of the self triad (witnessing observer – "Self", representational-emotional agency – "Me", and reflective agency – "I") in a randomised, independent, and controlled manner. It was shown that *up-regulation* of the expression of Self, Me, or I resulted in a significant *increase* in the functional integrity (indexed by EEG operational synchrony) of the corresponding SRN OMs, while conversely, *down-regulation* of the Self/Me/I expression resulted in a significant *decrease* in the functional integrity of the respective SRN OMs (Fingelkurts et al., 2020). Further, the observed changes in the functional integrity of the SRN OMs were in keeping with participants' self-reports of alterations in the phenomenological experience during up- or down-regulation of Selfhood components, and also significantly correlated with phenomenological factors estimated by a set of standardised questionnaires (Fingelkurts et al., 2020).

However, in that study (Fingelkurts et al., 2020) a design-based group analysis was used; hence group averaging may have masked unique individual variation in the phenomenological expression of Selfhood components, that may not always be in synch with the intended target mental state. Further, participants were *requested* to mentally *induce* pre-defined states representing either increased or decreased sense of Self, Me, or I through several trials. Such design required a certain mental effort from the participants, which in itself is likely to result in unique phenomenological/neurophysiological manifestation of its own. The first-person reports indicated that nearly all participants experienced *spontaneously* emerged brief episodes of vivid and intense ASoSs that were *independent* of the target mental states (unpublished data of the Fingelkurts et al., 2020 study). The present study was built on the rich dataset and insights gained from that previous study; however, it is an original study, since the data used in the present study was not considered in the previous one – it was excluded from the analysis because it did not satisfy the inclusion criteria and was outside the study's scope (see for details Fingelkurts et al., 2020).

1.2. Aim of the study

In the present study, instead of intentionally achieved mental states, we were focusing on the relationship between rare, *spontaneously occurring*, brief episodes of vivid altered states of Selfhood (as phenomenologically experienced ASoSs) and related to them three OMs of the SRN (measured by EEG operational synchrony). Specifically, and in agreement with the neurophenomenological methodology (Varela, 1996; Varela & Shear, 1999; Gallagher & Sørensen, 2006), first-person reports were used to identify such spontaneous ASoSs and *guide* the neural analysis, as opposed to a design-based group analysis. We hypothesized that the nuanced phenomenological experiences of ASoSs would associate with expected changes (according to the triad model of Selfhood; Fingelkurts et al., 2016a,b, 2020) in the functional integrity within three OMs of the SRN. In other words, we were interested to see if subjective variability of ASoSs would be tied to specific neurophysiological fluctuations in an integrated and coherent way (see also, Gallagher, 2010).

Since the focus of the present study was the rare and spontaneously emerging brief episodes of ASoSs, which are the single time-points during different trials and occurring in different participants, every ASoS was analysed individually, therefore signifying a *case study approach*[7] which is free from group averaging (Shallice, 1979; Barabasz and Barabasz, 1992).

The results of this study could prove useful not only for the future development of the classification (taxonomies) of altered states affecting Selfhood, but also for a better understanding of the mere nature (the essence) of self-consciousness and its normative boundaries. Further, this line of research could be helpful in interpreting clinical data, since many ASoSs characteristics are also present in different neuropsychopathologies in the form of long-lasting or permanent symptoms (Dittrich, 1998; Martin et al., 2014; Fingelkurts & Fingelkurts, 2017a,b, 2018).

2. Materials and methods

2.1. Subjects

Six (4 females / 2 males; mean age = 54.3, SD = 16.9) long-term meditators with an average of 22 (SD = 7.9) cumulative years of meditation practice, and an average of 3397 (SD = 1895) total hours of meditation practice are reported in the present study. The participants were part of a bigger group that was recruited to investigate the causal link between voluntary manipulated three aspects of Selfhood and functional integrity of the three SRN OMs (Fingelkurts et al., 2020). For the present study the only *inclusion criterium* was the

[7] Case studies have been crucially important in shaping the psychophysiology science since its initiation (Zhou et al., 2016; Pöppel et al., 2013). Further, a case study approach is frequently utilized to investigate meditation-induced alterations in the subjective experience (see, for example, Lehmann et al., 2001; Engström & Söderfeldt, 2010; Hagerty et al., 2013; Ataria, 2015; Modestino, 2016; Berkovich-Ohana, 2017).

presence of the spontaneously occurring *involuntary*[8], brief episodes of vivid and intense ASoSs which did not overlap with the original study's pre-defined mental states (which was the focus of a previous study, Fingelkurts et al., 2020). In this respect the present study is original and is using the data that was not part of the previous study. All participants of the present study were right-handed and had more than 15 years of education. *Exclusion criteria* included ASoSs which contents overlapped with the original pre-defined mental states (Fingelkurts et al., 2020), any history of neurologic and/or psychiatric disorder, brain trauma/concussion, epilepsy, serious somatic disorder in the past year, stressful events (e.g. job loss, divorce, bereavement, etc.) in the past 6 months, pregnancy (for the females), or use of medication that may affect brain activity.

The study was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) and standards established by the BM-Science – Brain and Mind Technologies Research Centre Review Board. Prior to participating in the study and EEG scanning, the experimental procedures were explained and participants signed an informed consent form. The use of the data for scientific studies was authorized by written informed consent of subjects and approval by the Review Board of BM-Science – Brain and Mind Technologies Research Centre. To ensure confidentiality of the participants' information, all data were anonymized and arbitrary ID-codes were assigned for each individual data set.

2.2. Study design

During the experiment, each EEG session began with a 5-min resting-state baseline period with eyes closed, followed by an introspective self-report and a battery of standardised questionnaires (see below). An EEG was then registered again during an eyes-closed 10-min mental exercise session run aimed to achieve a pre-defined target mental state (Fingelkurts et al., 2020). After that, the introspective self-reports were obtained and a battery of standardised questionnaires was administered again[9]. In such design the mental state conditions (*experimental condition*) and rest (*control condition*) were closely matched to each other, because participants kept their eyes closed during both conditions (rest and experimental task); further, no stimuli were presented in either condition, and no motor responses were required.

2.3. Self-reports and questionnaires

The current study used a neurophenomenological design (Varela, 1996; Gallagher, 2003b; Lutz & Thompson, 2003; Berkovich-Ohana et al., 2020), incorporating both EEG recordings and first-person descriptions from the same subjects, that was enhanced by using the replies of participants to a set of

[8] Subjects felt as if the experience 'comes to them'. They did not purposely make the experience happen.
[9] This sequence was repeated 3 times for 3 target mental states ("Self", "Me" and "I") with 2 variant each (Up- and Down-regulation), thus resulting in 108 trials for 6 participants.

standardised questionnaires using Likert scales[10], as was proposed by Gallagher and colleagues (2015). The rest condition with eyes closed and without executing any task served as the start point for participants to produce their *baseline* subjective reports and answer questionnaires about this baseline condition. The following reports and questionnaire replies were collected immediately[11] after every period of 10-min EEG recording while achieving a particular target mental state (Fingelkurts et al., 2020).

In the *introspective Self-Report*, participants were asked to describe in their own words their subjective experience during the target mental state, focusing on internal process and specific aspects of body awareness and sensations, vigilance, internal speech and narration, and the sense of witnessing. No constraints were specified on the type of reporting; any comments were welcomed. In doing so and in accordance with the recommendations of Gallagher and Sørensen (2006), participants were asked to suspend their own beliefs, metaphysical interpretations and theoretical background assumptions while describing their subjective experiences. Participants were encouraged to report any *spontaneously occurring* brief episodes of vivid ASoSs, even if they did not coincide with the intended pre-defined target mental states[12]. Whenever such ASoS episodes were reported, participants were requested to indicate the time-period during the 10-min EEG recording when such episodes have occurred[13].

Additionally, participants filled in a set of *standardised questionnaires* using Likert-scale type of responses (Norman, 2010). For the present study replies on the following questionnaires were also used: (1) *Sense of Agency Rating Scale* – SOARS (Polito et al., 2013); with "Involuntariness" and "Effortlessness" factors used. (2) *Rumination-Reflection Questionnaire* – RRQ (Trapnell & Campbell, 1999); with "Rumination" and "Reflection" factors used. (3) *Five Facet Mindfulness Questionnaire* – FFMQ (Baer et al., 2006); with "Observing" factor used. (4) *Embodiment Questionnaire* – EQ (Aymerich-Franch et al., 2015); with "Ownership", "Self-Location" and "Agency" factors used. (5) *The Sense of Body* – SB (an in-house questionnaire, following Pope & Singer, 1978; Winget & Kramer, 1979); with "Body Image", "Body Perception" and "Body Orientation" factors used. (6) *The Sense of Time* (ST) *and Thought Speed* (TS)

[10] The questionnaires were used to facilitate (confirm or correct) the interpretations across the different types of data (see also Gallagher et al. 2015).

[11] This strategy guarantees a sufficient trustworthiness of reports (Windt, 2013) and also minimizes reliance on episodic recall inference, misremembering or confabulation (Jack & Roepstorff, 2002; Windt, 2013).

[12] The exact meditation technique routinely used by these participants was not important, because during an experiment the participants were instructed to voluntary reach particular pre-defined mental states (see Fingelkurts et al., 2020) instead of practicing a specific meditation. So, they did not meditate in the traditional sense of the practice (Nash & Newberg, 2013).

[13] We used a mixed visual analogue scale (VAS; Costa et al., 2016) with discrete scale, where VAS was complimented with temporal markers in seconds and minutes to help the participants to locate time-period of ASoS. One may argue that such post-hoc ASoS timing may be imprecise. While this is certainly a possibility, it is an established fact that the ability to accurately detect the temporal order of events is a stable human trait (Grabot & van Wassenhove, 2017). Further, the temporal accuracy is higher for new, unusual or remarkable events that appear within a given time period (James, 1890; Block and Zakay, 1997), which was exactly the case in the present study. Taking these observations together, one can have trust in the reliability of the temporal stamps for the ASoSs. Moreover, the fact that participants of the present study were experienced mediators adds additional assurance that the ASoSs timing was assessed reliably, since long-term experienced meditators are known for having enhanced skill to provide detailed and accurate first-person descriptions of their experiences (Lutz et al., 2007; Fox et al., 2012; Berkovich-Ohana et al., 2013; Dor-Ziderman et al., 2013; Ataria et al., 2015). It is also important to note that meditation and related practices, by themselves, do not represent ASCs, but rather facilitate them (Newberg & Yaden, 2018).

(another in-house questionnaire, following Pope & Singer, 1978; Winget & Kramer, 1979); with "Here and Now", "Future", "Past", "Concatenation of Thoughts", "Continuity of Thoughts" and "Speed of Thoughts" factors used.

In accordance with the aim of this study, only the results pertaining to rare and brief episodes of spontaneously occurring ASoSs are reported and discussed here.

2.4. EEG registration and pre-processing

EEG was recorded during eyes-closed waking state ("rest" or "achieving a target state") using a 21-channel EEG data acquisition system (Mitsar, St. Petersburg, Russian Federation) from 19 electrodes positioned on the head according to the International 10–20 system (i.e. O1, O2, P3, P4, Pz, C3, C4, Cz, T3, T4, T5, T6, Fz, F3, F4, F7, F8, Fp1, Fp2). The following recording parameters were used: linked earlobes as a reference electrode; 0.5–30 Hz bandpass; 50 Hz notch filter ON; 250 Hz sampling rate; electrooculogram (0.5–70 Hz bandpass); impedance below 10 kΩ.

During the EEG recordings participants were asked to either (i) relax and engage in no specific mental activity with eyes closed (resting state), or (ii) engage in achieving a target mental state according to the instructions (Fingelkurts et al., 2020) with eyes closed (experimental state). The presence of an adequate EEG-signal was first determined by visual inspection of the raw signal. Artefacts due to eyes opening, eye movement, significant muscle activity, and movements on EEG channels, as well as drowsy episodes (indexed by slowing of background frequencies by ≥1 Hz, vertex sharp waves and slow eye movements) were corrected or eliminated by (a) using spatial filtration technique based on zeroing the activation curves of individual Independent Component Analysis (ICA) components that correspond to these artefacts (Vigário, 1997), and (b) excluding epochs with excessive amplitude of EEG (≥ 70 μV) as well as excessive fast (20-30 Hz, ≥ 35 μV) and slow (0.5-1 Hz, ≥ 50 μV) frequency activities.

For every session, artifact-free EEG streams were fragmented into consecutive 1-minute epochs, which were bandpass-filtered (Butterworth filter of sixth order) in the alpha (7–13 Hz) frequency band. Forward and backward filtering were used to eliminate phase shifts. The reasons for the alpha frequency choice are described in detail in Fingelkurts et al. (2020).

2.5. Deriving SRN OMs and estimating their strength

In the current study (similar to our previous studies on the triad model; Fingelkurts et al., 2012, 2016a,b,c, 2020; Fingelkurts & Fingelkurts, 2017a,b, 2018), a set of brain areas that have been previously established belong to SRN (Fingelkurts & Fingelkurts, 2011) was used. Such areas were not chosen arbitrary to be part of the SRN. Nine areas (included in the triad model, see Fig. 1) naturally emerged as members of three most stable task-independent EEG spatiotemporal patterns (OMs) with extremely high strength of operational synchrony. This finding has been replicated in two independent studies with participation of

subjects from two different nationalities and two different sensory modalities (for detail, see Fingelkurts & Fingelkurts, 2011). These nine operationally synchronized cortical areas were used to estimate the operational synchrony strength within the three SRN OMs: *anterior OM* – formed by F3-Fz-F4 EEG locations; *left posterior OM* – formed by T5-P3-O1 EEG locations; and *right posterior OM* – formed by T6-P4-O2 EEG locations (Fig. 1).

Several hierarchical stages of data processing were required in order to estimate operational synchrony strength within every OM. The details of this multistage procedure can be found elsewhere (Fingelkurts & Fingelkurts, 2008, 2015). Here only a brief overview of the main steps is provided. During the first step, each local EEG signal was reduced to a *naturally existing* temporal sequence of nearly stationary (quasi-stationary) segments of varying duration. To uncover these quasi-stationary segments from the complex nonstationary structure of local EEG signals, an adaptive segmentation procedure was used (Fingelkurts & Fingelkurts, 2008, 2015). The aim of such segmentation is to divide each local EEG signal into naturally existing quasi-stationary segments by estimating the intrinsic boundaries among segments – *rapid transitional periods* (RTPs). RTP is defined as an abrupt change in the analytical amplitude of the EEG signal above a particular threshold derived from modelling studies and statistical analysis (Fingelkurts & Fingelkurts, 2008, 2015). It has been proposed that each stationary (homogeneous) segment in the local EEG signal corresponds to a temporary stable local microstate – an operation executed by a neuronal assembly (Fingelkurts & Fingelkurts, 2001; Fingelkurts et al., 2010, 2013). The temporal coupling (synchronization) of such segments among several local EEG recordings then, reflects synchronization of operations (i.e. *operational synchrony*) produced by different neuronal assemblies (located in different cortical regions) into the integrated and unified patterns responsible for complex mental operations Fingelkurts & Fingelkurts, 2001; Fingelkurts et al., 2010, 2013; see also Freeman & Kozma, 2000; Kozma & Freeman, 2009; Freeman et al., 2015).

The second step of the analysis constituted estimation of operational synchrony[14] within every OM. Operational synchrony estimates the statistical level of RTP temporal coupling between two or more local EEG recordings (Fingelkurts & Fingelkurts, 2008, 2015). This measure tends toward zero if there is no synchronization between EEG segments derived from every pair of EEG channels, and has positive or negative values where such synchronization exists. Positive values (above upper stochastic threshold) indicate an "active" process of coupling of EEG segments (synchronization of EEG segments is observed significantly more often than expected by chance as a result of random shuffling of segments during a computer simulation), whereas negative values (below lower stochastic threshold) mark an "active" process of decoupling of segments (synchronization of EEG segments is observed significantly less than expected by

[14] A brief note has to be made here: it is sometimes claimed that EEG analysis performed at the sensor level is prone to volume conduction and it may present an obstacle in interpreting EEG data in terms of brain functional connectivity. The operational synchrony measure used in the current study has been specifically tested through previous modelling experiments to address this issue. These tests show that operational synchrony values are sensitive to morpho-functional organization of the cortex as opposed to volume conduction, EEG signal power, and/or choice of the reference electrode (for further details, we refer the reader to Fingelkurts & Fingelkurts, 2008, 2015).

chance as a result of random shuffling of segments during a computer simulation) (Fingelkurts & Fingelkurts, 2008, 2015). The *strength* of EEG operational synchrony is proportional to the actual (absolute) value of the measure: the higher this value, the greater the strength of functional connection and correspondently the functional integrity of the OM.

Using the described pair-wise analysis, operational synchrony was identified in several (more than two) channels – synchrocomplexes (SC); these define *operational modules* – OMs. The criterion for defining an OM is a sequence of the same synchrocomplexes (SC) during every 1-min epoch, whereas a SC is a set of EEG locations in which each location forms a paired combination with valid values of synchrony with all other EEG locations within the same SC; meaning that all pairs of EEG locations in an SC have to have statistically significant synchrony linking them together (Fingelkurts & Fingelkurts, 2008, 2015).

2.6. Statistics

The participant's first-person reports were used to guide the EEG operational synchrony analyses. An EEG epoch of 1-min duration was selected around the time-points indicated by the participants for every experienced ASoSs. The strength of functional connectivity within individual OMs was assessed for these 1-min epochs using EEG operational synchrony measure outlined in the previous section. Every individual ASoS-epoch was analysed as a separate event without averaging[15], due to being a unique representative of subjective descriptions given by the participants about ASoS[16]. The difference in the strength of operational synchrony from the resting baseline condition to every given ASoSs was presented as a *percent change*. Likewise, the differences between psychometric tests' factors were also presented as a *percent change* from baseline state to a correspondent ASoS.

Since we were testing every ASoS-epoch individually as a unique event, statistical significance estimation was not possible and thus the results of this study should be considered as *descriptive* (Guetterman, 2019).

3. Results and discussion

All six participants indicated at least one spontaneously and involuntary occurring vivid ASoS during meditation sessions. A total of 8 unique ASoSs were recorded among 108 trials, that is a sum of 3 target mental states ("Self", "Me" and "I") with 2 variant each (Up- and Down-regulation) repeated 3 times for 6 participants. This result indicates that spontaneously occurring ASoSs are indeed rather rare, supporting

[15] The usefulness and advantage of such an approach was illustrated in the seminal work of Lutz (2002) and Lutz et al. (2002), which received much attention (Gallagher, 2003b; Bayne, 2004; Overgaard, 2004).

[16] Within each of these phenomenological ASoSs there were patterns of subjective *variability* that uniquely characterize and distinguish *distinct types* of ASoSs.

previous findings in highly experienced, long-term meditators (Soler et al., 2014; Berkovich-Ohana, 2017; Millière et al, 2018; Vieten et al., 2018; Penberthy et al., 2020).

A summary of the involuntary occurring ASoSs is presented in the Table 1. As it is clear from the table, vast majority (75%) of the registered ASoSs were related to embodiment domain and 25% – to a domain of autobiographic history and narration (the difference is statistically significant: Chi-Square, $p = 0.00001$). The prevalence of changes in the embodiment phenomenology among other phenomenal features during altered states of Selfhood is consistent with previous reports (Grof, 1976; Lindahl et al., 2017; Girn & Christoff, 2018; Millière et al., 2018) and could be explained by the fact that it is the most basic and primordial form of self-consciousness that is directly and immediately present to a subject[17] (Damasio, 1999; Bermúdez, 2011; De Vignemont, 2011; Seth, 2013; Tsakiris, 2017). Further, it is also evident that while all ASoSs from the embodiment domain were characterised by some level of disembodiment (see Table 1), there are noticeable nuances in the phenomenological experiences, which points to a conclusion that these ASoSs were essentially different despite the common phenomenological denominator of disembodiment (see also Millière et al., 2018). A similar picture emerged in the autobiographic/narration domain (Table 1).

Table 1. Spontaneously and involuntary occurring altered states of Selfhood.

1	I observed my body from outside
2	Bodilessness with no location or time
3	Different parts of my body disappeared completely
4	My boundaries expanded into a whole room and street
5	I was both in my body and outside it
6	I raised and felt the space around
7	The experience of my life history disappeared
8	My thoughts stopped

In light of mentioned in the introduction section findings on the causal link between the three phenomenally distinct aspects of Selfhood (Self, Me and I) and correspondent to them three distinct OMs of brain SRN (Fingelkurts et al., 2020), we expected to see the predictable reflection of the nuanced phenomenology (captured by self-reports and factors derived from the standardised questionnaires) in the variability of neuronal dynamics (represented by OMs functional integrity) accompanying the observed

[17] Indeed, it has been argued, that in normal conditions, bodily proprioceptive and interoceptive processing, due to their constant presence, ground a basic sense of self, anchoring it in a body-centered spatial frame of reference (Metzinger 2004, 2008), thus making a tight link between self and one's own body (Damasio, 1999; Craig, 2002; Seth, 2013; Tsakiris, 2017). It is also thought, that such dependence likely evolved evolutionary to help organisms maintain homeostasis (Herbert & Pollatos, 2012; Craig, 2013; Damasio & Carvalho, 2013), thus intimately connected to self-regulation and eventually self-awareness (Seth 2013; Farb et al., 2015). Interpedently, the interoceptive dysregulation was systematically reported in relation to many "self-involved" disorders, including dissociative disorders (Michal et al., 2014; Sedeño et al., 2014), post-traumatic stress disorder (Wald & Taylor, 2008; Fingelkurts & Fingelkurts, 2018), affective disorders and depression (Paulus & Stein, 2010; Fingelkurts & Fingelkurts, 2017a), somatoform disorders (Schaefer et al., 2012), and addiction (Naqvi & Bechara, 2010).

ASoSs. The neurophenomenological profiles (incorporating both EEG OMs and first-person descriptions) for every reported ASoS are presented individually and discussed in detail below.

3.1. "I observed my body from the outside"

Figure 2 presents the neurophenomenological profile of the ASoS: "I observed my body from the outside". The participant described this state as: "*The boundaries (of the body) however vanished and it felt like I looked/observed my body from the outside. Bodily sensations were decreased and they were not felt in a personal manner*"[18]. Neurophysiologically, this ASoS was found to be constituted by a slightly enhanced functional integrity of the Self-module of the brain SRN and a pronounced decrease in the functional integrity of both Me- and I- modules of the brain SRN (Fig. 2). According to the triad model of Selfhood and in agreement with a previous study that examined causal link between three aspects of Selfhood and three SRN modules (Fingelkurts et al., 2020), an upregulated Self-module is responsible for the feeling of being a *phenomenal* spatio-temporal (and often extensionless[19]) point, that observes and witnesses itself and the world (Revonsuo, 2006; Trehub, 2007; Damasio, 2010; Velmans, 2014; Metzinger, 2020). It provides the experience of *being a witnessing agent* (self in the act of knowing) – an epistemic agent that expands its knowledge by directing its own attention at oneself and the world in the present moment (Metzinger, 2013; Velmans, 2014; see also Gallagher, 2000; Revonsuo, 2006; Zahavi, 2006; Damasio, 2010). The fact that the participant has reported to observe her body from the outside clearly pointed to preservation of the phenomenal spatio-temporal centre, despite loss of her body awareness[20]. Strong down-regulation of the Me- and I- modules (Fig. 2), that are responsible for embodiment and thoughts/narration respectively (Fingelkurts et al., 2020), is compatible with the subjective feeling of *disembodiment* and *diminished self-reflection*.

The questionnaires data, that were used to facilitate (confirm or correct) interpretations, provided a more nuanced picture of how this ASoS was subjectively perceived. From Figure 2 it could be seen that the expression of all measured phenomenal aspects diminished except for the aspect "Involuntariness" and "Observing" whose expression increased. In totality, these observations point to the fact that in this ASoS the participant did not experience oneself as a full-fledged embodied entity: the automatic and immediate sense of physical agency decreased, along with a decrease in the first-order experiential sense of ownership (that it is me who owns the body; Gallagher, 2000; Tsakiris, 2010), body self-location, body orientation, body image and body schema (Gallagher, 1986). These changes were corroborated by (i) an increased sense of

[18] This and further reports of the ASoSs of the current study are admittedly concrete and without fine-grained and often esoteric or mystic phenomenological descriptions typical for the Advaita and Tibetan Buddhist traditions (Rgyal-ba-g′yung-drung et al., 2017; Rinpoche & Namgyal, 2011). This is so because participants were encouraged to suspend their own beliefs, metaphysical interpretations and theoretical background assumptions while describing their experiences during ASoSs, thus avoiding the so-called "theory contamination" (see also Nash & Newberg, 2013).

[19] The feeling as an extensionless point in space was often reported during various bodiless states (Kjellgren et al., 2008; Berkovich-Ohana et al., 2013; Ataria et al., 2015; Windt, 2010; Wittmann, 2015).

[20] This is in line with the observations done by Blanke and Metzinger (2009) and also Fingelkurts et al (2020) that bodily agency while a causally enabling, is not a constitutive condition, for phenomenal self.

involuntariness that marks the lack of deliberate control, feeling that body sensations and thoughts are not caused by oneself (Gallagher, 2000, 2005) and (ii) a sense of increased observing via up-regulation of the witnessing state (Fingelkurts et al., 2020).

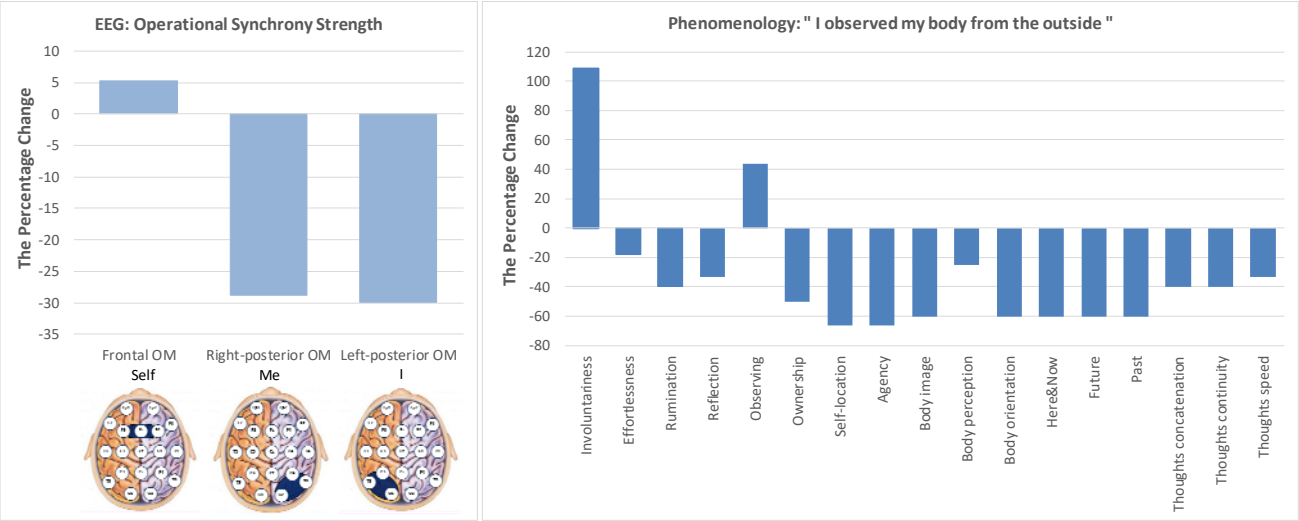

Figure 2. Neurophenomenological profile of the altered state of Selfhood (ASoS) "I observed my body from the outside". The *Y*-axis presents percent change from the baseline condition for both neurophysiological/EEG (left part of the Figure) and phenomenological (right part of the Figure) aspects of the profile. The *X*-axis represents (a) in the left part of the Figure: the functional integrity (indexed by operational synchrony strength) of three SRN OMs corresponding to three phenomenological features of Selfhood: "Self" (witnessing agency), "Me" (body-representational agency) and "I" (reflective/narrative agency). The schematic cortex maps below the graphs indicate the positions of OMs (dark blue shapes) across the cortex; (b) in the right part of the Figure: the expression of the 17 phenomenological aspects measured by the standardised questionnaires ("Involuntariness" and "Effortlessness" [Sense of Agency Rating Scale – SOARS; Polito et al., 2013]; "Rumination" and "Reflection" [Rumination-Reflection Questionnaire – RRQ; Trapnell & Campbell, 1999]; "Observing" [Five Facet Mindfulness Questionnaire – FFMQ; Baer et al., 2006]; "Ownership", "Self-Location", and "Agency" [Embodiment Questionnaire – EQ; Aymerich-Franch et al., 2015]; "Body image", "Body perception", and "Body orientation" [The Sense of Body – SB; in-house produced questionnaire, following Pope & Singer, 1978; Winget & Kramer, 1979]; "Here & now", "The future", "The past", "Concatenation of thoughts", "Thoughts continuity", and "Speed of thoughts" [The Sense of Time (ST) and Thought Speed (TS); in-house produced questionnaire, following Pope & Singer, 1978; Winget & Kramer, 1979]). Abbreviations: ASoS: altered state of Selfhood; EEG: electroencephalogram; OM: operational module; SRN: self-referential network.

Curiously, the participant's sense of time was transiently suspended in this ASoS (Fig. 2) indicated by a diminished feeling of all three dimensions of time ("Past", "Present" and "Future")[21] – some kind of "timelessness". A profound alteration in time perception (feeling of timelessness) was systematically reported during various altered states of consciousness (Glicksohn, 2001; Shanon, 2001; Wackermann et al., 2008; Studerus et al., 2010; Berkovich-Ohana et al., 2013; Ataria et al., 2015; Wittmann, 2015). One may speculate that such a loss of the sense of time that goes hand in hand with a feeling of bodilessness is due to a

[21] Interestingly, functional disintegration of the posterior parts of the SRN was previously reported to be associated with decreased mental time travel (Speth et al., 2016), while strong SRN functional connectivity at rest was related to increased tendency for mental time travel (Godwin et al., 2017; Karapanagiotidis et al., 2017).

tight connection between the two (Wittmann, 2013; Craig, 2015). Indeed, it has been proposed that subjective time emerges through the bodily self as an enduring embodied entity across time[22] (Wittmann, 2013; Berkovich-Ohana & Wittmann, 2017).

Further, this ASoS was also accompanied by diminished "Thoughts speed", "Thoughts concatenation" and "Continuity", as well as decreased narration ("Reflection" and "Rumination") and autobiographical reflection (Fig. 2). These findings are in line with previously reported phenomenological records of altered states of self-consciousness, where embodiment distortions were accompanied by the distortions in thought process (Blakemore et al., 2000; Parnas & Handest, 2003; Millière, 2017, 2020; Ataria et al., 2015; Pollan, 2018) and autobiographical/narrative self (Cohen, 1964; Grof, 1976; Lebedev et al., 2015; Girn & Christoff, 2018). Interestingly, as psychedelic observations have shown (Grof, 1976; Girn & Christoff, 2018), attenuation of the autobiographical self and personal narrative seems to occur following initial changes in bodily self and is associated with changes in perception of time (Schacter et al., 2007; Wang et al., 2017).

3.2. "Bodilessness with no location or time"

Figure 3 presents the neurophenomenological profile of the ASoS: "Bodilessness with no location or time". This state was described as: "*Bodily feeling broadened out of the body into bodilessness without location or time… Not many thoughts appeared – very few*". Neurophysiologically, this ASoS was constituted by a similar to an above discussed ASoS changes in the triad of SRN OMs (Fig. 3): a very slightly enhanced functional integrity of the Self-module accompanied by strong decreases in the functional integrity of both Me- and I- modules (with Me-module exhibiting a stronger decrease; which is in contrast to a previously discussed ASoS, in which it was the I-module that showed the largest decrease, see Fig. 2). This particular nuanced quantitative difference between the two ASoSs was probably responsible for the experienced distinguishing qualitative flavour expressed in the phenomenological descriptions of these two ASoSs.

Despite the fact that the participant reported an absence of "Location" and "Time", the slight increase in the functional integrity of the Self-module signifies that some *phenomenological* self-location was still present in this ASoS (as it follows from the previous study, Fingelkurts et al., 2020). This is not particularly strange, as for example, reports of out-of-body experiences (OBEs)[23], while describing the experience of disembodiment[24], sometimes mention some "thin/nonexplicit" experience of being an extensionless point not

[22] Such a proposition is compatible with the notion of "temporal thickness" (Friston, 2018; Limanowski & Friston, 2018), according to which a brain continuously predicts future states by embodying the tonic alertness within a certain temporal span with simultaneous creation of counterfactual depth – representation of possible future states of knowledge (Friston, 2018).

[23] One potentially interesting direction for future research is to use hypnosis as an instrumental means to produce – in controlled manner – an OBE- (or near-death-experience [NDE]) like phenomenology while monitoring the EEG. For some examples of such studies, see Palmieri et al., 2014; Facco et al., 2019; Martial et al., 2019.

[24] Disembodiment is normally characterized by a loss of the *geometrical* self-location, which is the experience of oneself as located within one's body that serves as a spatial (embodied) frame of reference (Metzinger, 2013; see also Fingelkurts et al., 2020).

anchored to the body (Alvarado, 2000; Lopez & Elzière, 2018). Similar experiences were also reported for some "bodiless" dreams when persons do not experience themselves as embodied within the dream (Cicogna & Bosinelli, 2001) but rather "as a disembodied point or freely moving center of awareness" (Windt, 2010; p. 201). This is also in line with an observation of Dor-Ziderman and colleagues that "even when the [sense of boundaries] disappears, a minimal level of dynamic proprioception continues to exist" (Dor-Ziderman et al., 2016; p. 3). According to Metzinger (2013, 2020), this minimal sensation is sufficient for creating a phenomenological centre of gravity (Velmans, 2014) and self-identification that is tied to an individual phenomenological first-personal givenness (Zahavi, 2006).

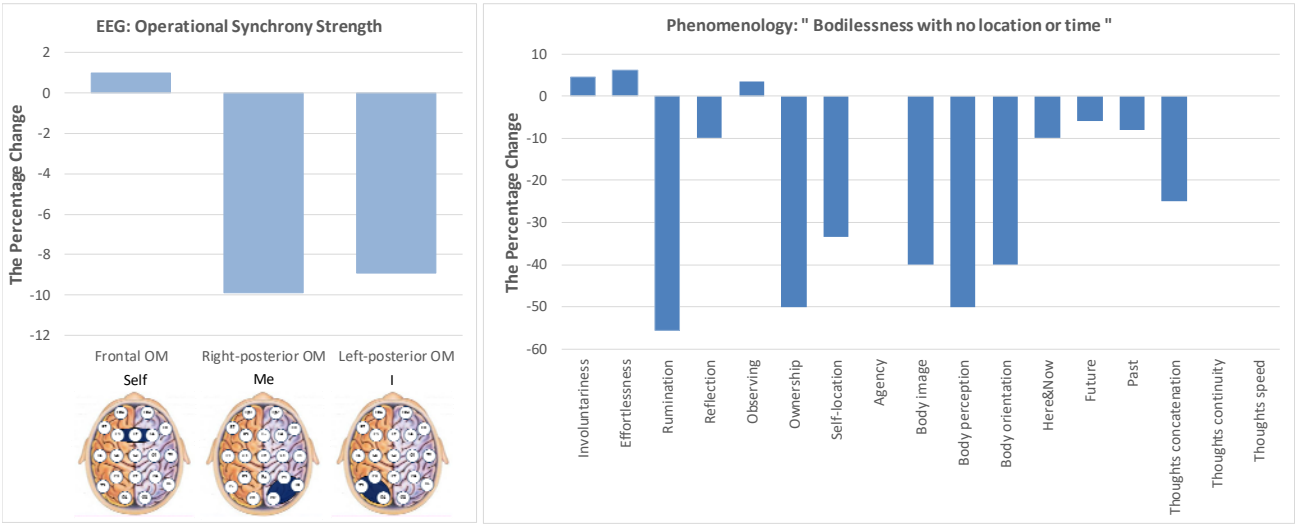

Figure 3. Neurophenomenological profile of the altered state of Selfhood (ASoS) "Bodilessness with no location or time". The legend of this figure is the same as that of the Fig. 2.

The replies on the questionnaires supported the neurophysiological findings for this ASoS (Fig. 3). For example, the expression of phenomenal aspects of "Observing", "Effortlessness" and "Involuntariness" increased, thus indicating an enhanced sense of involuntary witnessing that occurs without effort (passively) and may signify some level of "distance" between experience and experiencer[25] (Lane, 2020). This conclusion is corroborated by decreased sense of "Ownership" and all other aspects of embodiment, including geometrical "Self-location" and perception of temporality (Fig. 3). At the same time, the phenomenal sense of physical "Agency" did not change in relation to the restful baseline, as also was a case for "Thoughts continuity" and "Thoughts speed". Despite this, "Thoughts concatenation" and "Reflection" together with "Rumination" decreased markedly supporting the participant's statement that there were very few thoughts in this ASoS and implying that such overall experience was not the result of active introspection or thought wandering. It also confirms previous observations that one's temporally embedded identity facilitates the construction of a personal narrative (Wittmann, 2013; Berkovich-Ohana & Wittmann,

[25] This experience is quite similar to the episodes of clear, effortless mindfulness with distant perception of the physical body and the environment with an entirely quiet mind (as for example in Vedic, Buddhist and Chinese traditions; Travis & Shear, 2010; Ataria et al., 2015; Finnigan, 2018).

2017; Fingelkurts et al., 2020), and if one is diminished the other follows (Lebedev et al., 2015; Nour & Carhart-Harris, 2017).

3.3. "Different parts of my body disappeared completely"

Figure 4 presents the neurophenomenological profile of the ASoS: "Different parts of my body disappeared completely". The participant described this state as: "*Different parts of the body disappeared completely and just some entirety that was breathing or rather that was being breathed in remained. Breathing was a wave and that was all there is. Thoughts were circulating in my head*". Neurophysiologically, this ASoS was constituted by a very slight decrease in the functional integrity of the Self-module and strong decrease of Me-module with an increase in the functional integrity of I-module of the brain SRN (Fig. 4). In accordance with previous results (Fingelkurts et al., 2020), such changes in the functional integrity of the OMs triad implies a strong decrease in the embodiment as pre-reflective, non-conceptual, pre-linguistic, and immediate sense with a geometrical first-person perspective (Gallagher, 2000, 2005; Legrand, 2006; Lenggenhager et al., 2007; Metzinger, 2008) causing the correspondent decrease in the phenomenal point of view (phenomenal first-person perspective; Metzinger, 2004, 2008; Revonsuo, 2006; Trehub, 2007; Blanke & Metzinger, 2009). The phenomenal point of view is, in this conceptualisation, a phenomenal non-conceptual core in the act of knowing itself (Blanke & Metzinger, 2009; Velmans, 2014), that is experienced as a directly and immediately present centre that witnesses a phenomenal multimodal perceptual reality and itself (witnessing agency, Fingelkurts et al., 2020). Such decreases, however were compensated in this ASoS by an increase in explicit self-reflection flavoured by conceptual and linguistic aspects, thus providing a strong epistemic input (Metzinger, 2020), that tried to make sense of the reflected experience (Gallagher & Daly, 2018).

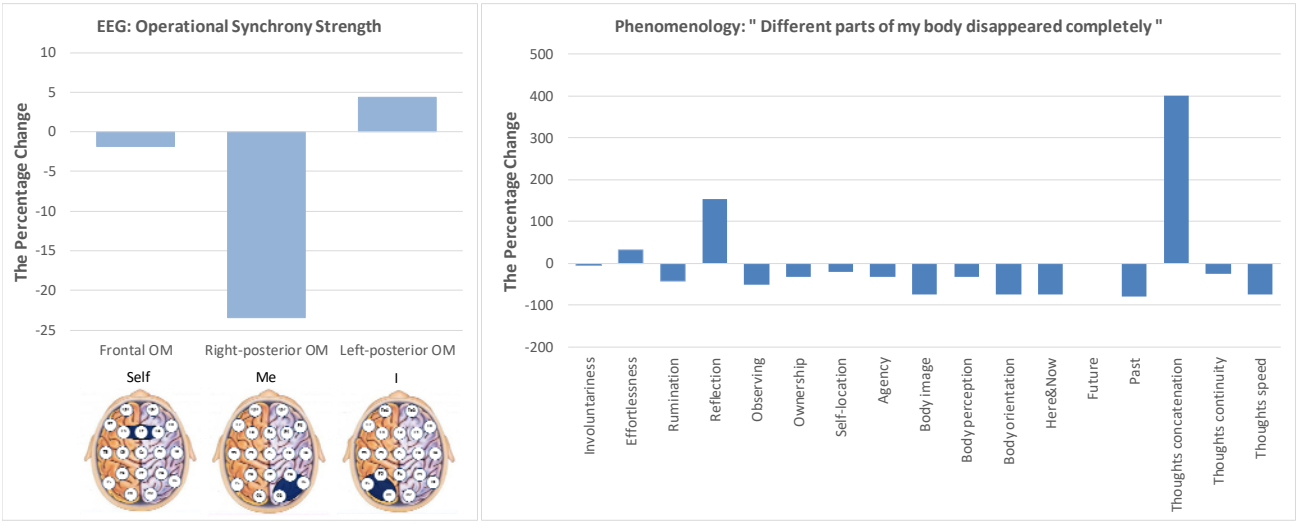

Figure 4. Neurophenomenological profile of the altered state of Selfhood (ASoS) "Different parts of my body disappeared completely". The legend of this figure is the same as that of the Fig. 2.

The questionnaires data (used to facilitate the phenomenological reports) were in line with neurophysiological findings (Fig. 4). It is noteworthy that expression of such phenomenological aspects as "Thoughts concatenation" and "Reflection" increased markedly, while at the same time "Thoughts speed" and "Thoughts continuity" decreased. Curiously, such an increase in self-reflection was not accompanied by an increase in time perception, the sense of which transiently decreased in this ASooS (Fig. 4), thus indicating that self-reflection was not accompanied by an autobiographical narrative (see Damasio, 1999, 2010), but instead was more about making rational sense of the altered ongoing experience. Such a unique dissociation between cognitive thought and witnessing self, alongside a remarkable disembodiment (indexed by a decrease in all embodiment phenomenological aspects, see Fig. 4), is reminiscent of the subjective report of deafblind person taking a relaxing bath, as she appeared to retain an ability to think about what is happening to her (that indicates the ability to form *de se* thoughts[26]) despite being in an ASoS of radical disembodiment and self-disintegration (for a detailed discussion, see Millière, 2019). These observations are important because they provide evidence that even when one's sense of body, location and time have faded away, the ability to think about oneself need not necessarily be disrupted also, especially if effortless self-reflections in the form of mind-wandering potentiates the suppression of bodily awareness and self-location, which was apparently the case in this particular ASoS (Fig. 4).

3.4. "My boundaries expanded into the whole room and street"

Figure 5 presents the neurophenomenological profile for the ASoS: "My boundaries expanded into the whole room and street". It has been described by the participant as: "*My body boundaries expanded into the whole room and street, then thoughts and images began to pop into my mind*". Neurophysiologically, this ASoS was constituted by a very slight decrease in the functional integrity of Self-module and a rather strong decrease in the functional integrity of the Me- and especially I- modules of the brain SRN (Fig. 5). These changes in the functional integrity of the OMs triad imply that in this particular ASoS, the participant experienced (as it follows from previous findings, Fingelkurts et al., 2020): (i) dramatic disembodiment characterised by body boundaries dissolution, guided by an abrupt detachment from the interoceptive and exteroceptive sense perceptions; (ii) dissolution of the normal narrative and self-reflection; and (iii) nonsignificant attenuation of witnessing agency. In general, this altered state resembles the so-called transcendental states that are incidents of clear, rational thought-free consciousness, characterized by a self boundaries dissolution, when the knower, the known and the process of knowing become unified in a state of *Am*-ness (Hebert et al., 2005; see also Travis & Shear, 2010). Another similar phenomenon is known as

[26] In philosophy of mind, *de se* thoughts are referred to thoughts that involve the first-person concept and are naturally expressed using the first-person pronoun (García-Carpintero, 2015). There is a spectrum of *de se* thoughts. For example, one may explicitly reflect on one's personality traits or one's life trajectory (so called narrative selfhood) or just has thoughts that include more mundane instances of mind-wandering about the current ongoing experience that is happening to oneself.

drug-induced ego dissolution (DIED)[27], that is a loss of one's sense of self and self-world boundaries, accompanied by a feeling of "oneness", typically experienced under the influence of psychedelics (Letheby & Gerrans, 2017; Nour & Carhart-Harris, 2017).

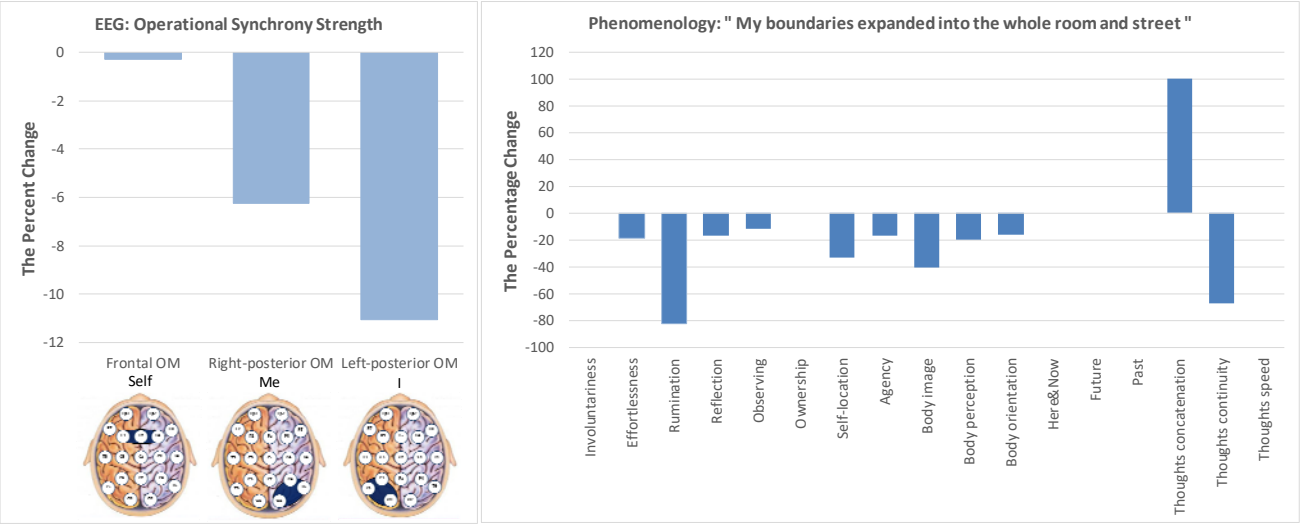

Figure 5. Neurophenomenological profile of the altered state of Selfhood (ASoS) "My boundaries expanded into the whole room and street". The legend of this figure is the same as that of the Fig. 2.

The questionnaires data largely supported the neurophysiological observations; however, providing additional nuances of how this ASoS was subjectively perceived. From Figure 5 it could be seen that the expression of all measured phenomenal aspects related to embodiment (that include "Self-location", "Physical agency", "Body image", "Body perception" and "Body orientation") diminished, thus indicating that alterations in bodily self-experience, guided by disruption in the multimodal integration of sensory signals, resulted in the experience of an altered body image and perception (Giummarra et al., 2008; Blanke & Metzinger, 2009; Blanke, 2012; Seth, 2013). These was accompanied by decreased expression of self- "Reflection", "Rumination" and "Thoughts continuity"; while "Thoughts concatenation" on the contrary increased (Fig. 5), implying that even though there were groups of thoughts occurring together ("concatenation"), they were semantically discontinuous, and generally were rear, thus resulting in diminished self-reflection and narration. It is possible to further speculate that during this ASoS the subjective experience involves a reduced tendency to be engaged (personally and emotionally) in one's own thoughts and feelings, such that "the contents of consciousness [were] less filtered through considerations of self-relevance than is usual" (Letheby & Gerrans, 2017; p. 7).

Interestingly, neither time perception, nor the feeling of ownership were affected in this ASoS (Fig. 5). Since the autobiographical narrative relies heavily on temporality – either episodic memory of the past or

[27] Curiously, and in agreement with the current results, the main neurophysiological correlate of the DIED is a decreased functional integrity of the SRN (Carhart-Harris et al., 2016), which is also reflected in the increased entropic brain activity (Lebedev et al., 2016) as well as increase in the neurophysiological signal diversity (Schartner et al., 2017).

imagined/planned future (Damasio, 1999, 2010; Gardiner, 2001) – one may speculate that the autobiographical component of the personal narrative remained not altered during this ASoS, while other aspects of the narrative were (as discussed above). This observation pointed to the fact that different components of narrative may have different dynamics[28] under certain circumstances. Furthermore, considering the abovementioned strong disembodiment that accompanied this ASoS, and keeping in mind that quite often during the alterations in the sense of Selfhood changes in bodily self and autobiographical self co-occur (Fingelkurts et al., 2020), the present findings indicate that under certain conditions they may have independent dynamics and may in fact de-couple (for a similar conclusion see Sebastián, 2020; for further relevant discussion, see Millière et al., 2018). The fact that the Self-module of brain SRN was almost not altered may explain why the subjective sense of "Ownership" was not affected (Fig. 5). Indeed, normally, the Self-module constitutes the sense of a "centre of gravity", where one is having an experience of directly and immediately present as the centre (or a focus) of a phenomenal multimodal perceptual reality (Metzinger, 2004, 2008; Revonsuo, 2006; Trehub, 2007; Blanke & Metzinger, 2009), with the sense of ownership of thoughts, perceptions, and actions relevant to Selfhood (Metzinger, 2004, 2008; de Vignemont & Fourneret, 2004; Hohwy, 2007; Blanke & Metzinger, 2009). Keeping this in mind, one may suppose that such only minor alteration in the functional integrity of the Self-module was still sufficient for the presence of these subjective feelings.

3.5. "I was both in my body and outside it"

Figure 6 presents the neurophenomenological profile for the ASoS: "I was both in my body and outside it". The participant described this state as: "*Profound experience – I was both in my body and outside it, in this room, and via all the floors (I sensed the rooms below and above me) connected to the air outside*". Neurophysiologically, this ASoS was constituted by a very slight decrease in the functional integrity of the Self-module, a stronger decrease in the functional integrity of the I-module, and a yet stronger increase in the functional integrity of the Me-module of the brain SRN (Fig. 6). Such changes in the functional integrity of the OMs triad, when approached from the findings of the previous study on the causal links between the functional integrity of the three SRN OMs and correspondent to them the three phenomenological aspects of Selfhood (Fingelkurts et al., 2020), could indicate that in this ASoS the participant experienced enhanced embodiment coupled with decreased self-reflection and narration, and only insignificantly altered witnessing agency. At first glance it may look as a contradiction, because the participant described this ASoS as being in the body and outside at the same time, so implying some kind of out-of-body experience (OBE). However,

[28] Such a possibility is discussed in detail by Millière et al. (2018; p. 6-7): "There are at least two ways in which narrative self-consciousness may be disrupted. First, the rate of occurrence of self-referential thought and mental time travel may be dramatically reduced, or altogether suppressed, during a certain time interval. […] While the temporary cessation of self-referential thoughts is one way in which narrative self-consciousness may be altered, it may also be disrupted by a total loss of access to autobiographical memories and self-related beliefs. […] However, the experience of losing access to these memories and beliefs might differ from the mere cessation of *de se* thought from a phenomenological point of view."

some types of OBE are exactly of this phenomenal nature: "parasomatic" OBE is characterised by the experience of being embodied in a spatial volume, which at the same time share many features of the physical body and simultaneously represented as an indeterminate form of volume (Green, 1968; Irwin, 1985). Therefore, one may expect to have an enhancement of the sense of embodiment, observed in this particular ASoS (Fig. 6). Indeed, in a recent study of the OBE-specific group, it was documented that some types of OBE display hyper-embodiment (Braithwaite et al., 2017; for a discussion, see Kessler & Braithwaite, 2016).

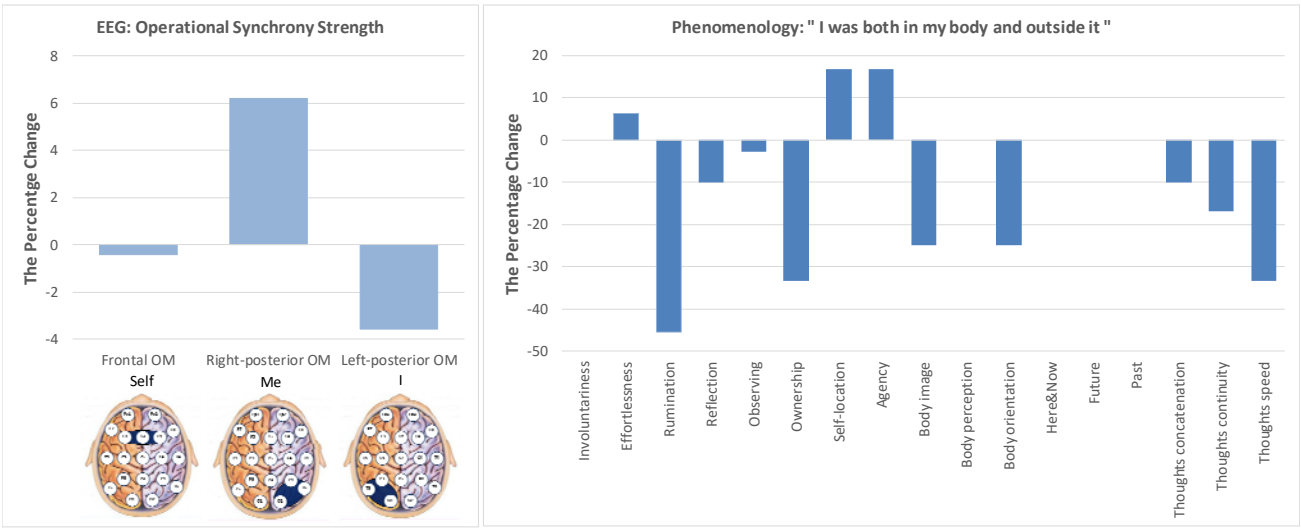

Figure 6. Neurophenomenological profile of the altered state of Selfhood (ASoS) "I was both in my body and outside it". The legend of this figure is the same as that of the Fig. 2.

The questionnaires revealed complementary details that enriched the understanding of this ASoS (Fig. 6). First, it was found that explicit body representation (indexed by the phenomenological aspect "Body image") is not necessary for having some level of self-identification during this ASoS, because voluminous experience of simultaneously being in the body and outside of it is sufficient to produce self-identification (as defined in Metzinger, 2013). This is why the sense of "Body perception" did not change. Second, bodily "Ownership" is not a necessary condition either[29], because during this ASoS the enhanced experiences of mental "Self-location" and physical "Agency" were sufficient for creating a *geometrical* first-person perspective (Fig. 6). At the same time, such experiences were not enough to form a strong, stable and veridical sense of *phenomenal* first-person givenness (Fingelkurts et al., 2020), as indicated by an insignificantly diminished "Observing" aspect.

This ASoS was further characterised by a marked decrease in the "Self-reflection", "Rumination" and "Thought"-processes (Fig. 6), confirming a decrease in the functional integrity of the I-module of the brain SRN, which is responsible for self-reflection and narration (Fingelkurts et al., 2020). Curiously, such disruption in thought process and self-reflection did not affect multiple aspects of the experience of time,

[29] Lack of body ownership causing the moments of OBE was also reported before during meditation practice (Ataria, 2015).

which remained unaltered in this ASoS (Fig. 6). Considering the conceptualisation of Wittmann (2013, 2015) that continuous visceral and proprioceptive input from the body is the functional anchor of time perception, one may speculate, that while increased body "Agency" and "Self-location" should enhance the experience of time, the decreased sense of body "Ownership" and "Body image" as well as "Body orientation", on the contrary, should decrease temporal perception, thus resulting in the counterbalance of the opposite tendencies in the temporal experience, leading to the overall experience of unaltered sense of time.

3.6. "I raised and felt the space around"

Figure 7 presents the neurophenomenological profile of the ASoS: "I raised and felt the space around". This state was described by the participant as: "*I raised up with my body and felt the space around. I looked at the building from a very high place, as if from an aeroplane. I myself however was in my body. Autobiographical memories and thoughts were present*". Neurophysiologically, this ASoS was constituted by a very slight increase in the functional integrity of the Self-module, medium increase in the functional integrity of the I-module, and a strong increase in the functional integrity of the Me-module of the brain SRN (Fig. 7). Together, these changes in the functional integrity of the OMs triad, may be interpreted (Fingelkurts et al., 2020) as that during this ASoS the participant was experiencing the so-called "somatic" OBE, which is characterised by a changed sense of self-location in comparison to the ordinary, everyday baseline state (Green, 1968; Irwin, 1985) without losing the sense of body, which was in fact reinforced by a constant self-reflection and analysis, and further accompanied by a slightly enhanced witnessing and self-observation.

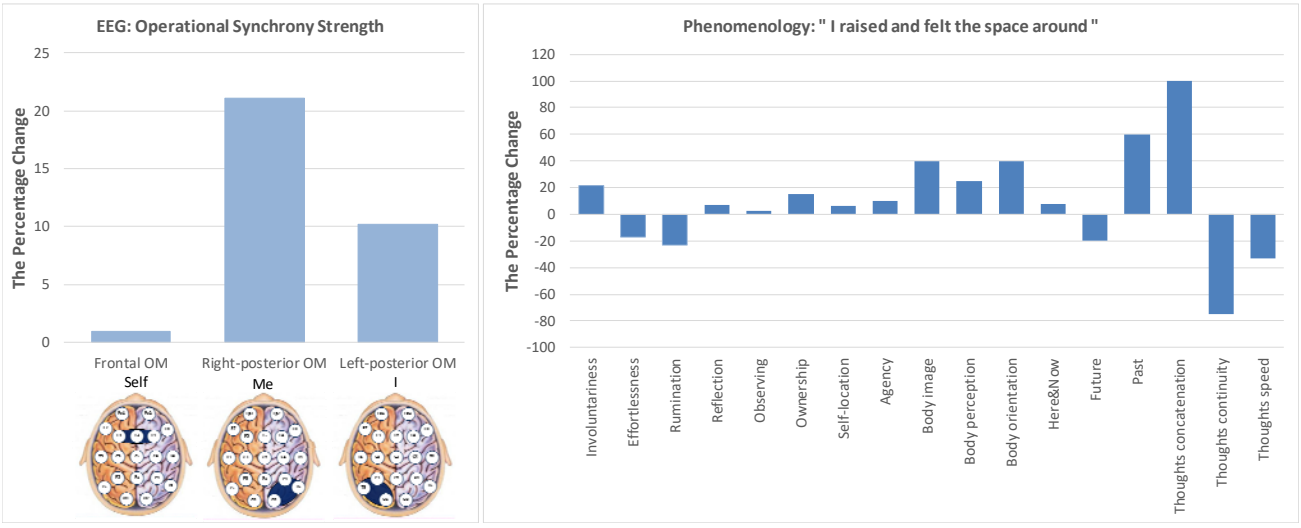

Figure 7. Neurophenomenological profile of the altered state of Selfhood (ASoS) "I raised and felt the space around". The legend of this figure is the same as that of the Fig. 2.

The questionnaires data largely confirmed the neurophysiological findings by providing additional nuances of how this ASoS was subjectively perceived (Fig. 7). It is noteworthy, that during this ASoS all embodiment aspects (that, in combination, create a sense of owning and inhabiting a physical body which is

the locus of one's experience; Blanke & Metzinger, 2009; Blanke, 2012; Seth, 2013) increased, paralleled by an increase in the sense of "Involuntariness", "Here and Now", and further the sense of "Past", "Thoughts concatenation", "Reflection", and "Observing". Thus, overall, while being in this ASoS, the participant experienced an involuntary increased sense of self and agency, dominated by hyperembodiment and to a lesser extent self-reflection (Fig. 7). Additionally, the participant had an enhanced experience of the present moment and spontaneously emerging past memories, accompanied by slowing of time (indicated by decreased "Thoughts speed"), similar to particular mindful experiences during meditation practices (Berkovich-Ohana et al., 2013; Wittmann, 2013; Berkovich-Ohana & Wittmann, 2017).

One last note in relation to this ASoS should be in place: given the established potential link between mind-wandering and unhappiness (Killingsworth & Gilbert, 2010), it is intriguing that "Rumination", in fact, decreased during this ASoS (Fig. 7). Ruminative self-processing was previously associated with higher social anxiety, psychological distress, and depression (Trapnell & Campbell, 1999; Ben-Artzi & Hamburger, 2001; Takano & Tanno, 2009), and its lack in this ASoS may seem contradictory given that self-related mind-wandering and sense of the past increased (see Fig 7). However, this apparent contradiction could be resolved by the fact that mind-wandering, besides self-rumination, also includes self-reflection which is associated with more accurate and extensive self-knowledge and lower psychological distress and increased feeling of well-being (Watson et al., 1996; Trapnell & Campbell, 1999). Such self-reflection was increased in this particular ASoS (Fig. 7).

3.7. "The experience of my life history disappeared"

Figure 8 presents the neurophenomenological profile of the ASoS: "The experience of my life history disappeared". The participant described this unusual state as: "*In this experience my life history disappeared. I realized it never existed; just a vanishing hint about something that actually did not exist. The experience changed me rather fundamentally*". Neurophysiologically, this ASoS was constituted by a very slight decrease in the functional integrity of the Self-module, strong decrease in the functional integrity of the Me-module and moderate increase in the I-module of the brain SRN (Fig. 8). Based on the previous study (Fingelkurts et al, 2020), such alterations in the SRN OMs may imply that in this ASoS the participant experienced a very slight decrease in witnessing agency, accompanied by a rather pronounced disembodiment, coupled with increased self-reflection.

The questionnaires data were largely in line with the neurophysiological observations; however, providing interesting nuances. From Figure 8 it could be seen that the expression of many measured phenomenal aspects related to embodiment (that include "Body image", "Body perception", "Body orientation" and "Self-location") diminished, thus indicating an alteration in bodily self-experience (Giummarra et al., 2008; Blanke & Metzinger, 2009; Blanke, 2012; Seth, 2013), though these were surprisingly not affecting "Ownership", and "Agency". It seems that the increased sense of effort (indexed

by a decreased "Effortlessness") maybe was sufficient to produce some sense of self-identification[30] (Metzinger, 2013, 2020; see also Yufik, 2019), thus counterbalancing the effect of body dissolution on the experience of ownership and agency (see Fig. 8).

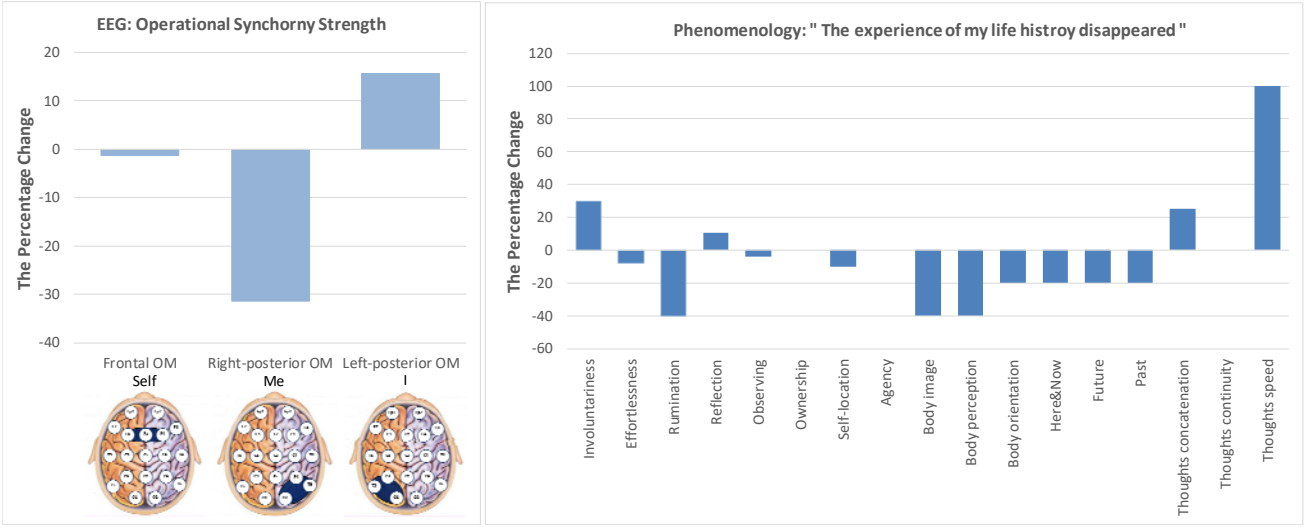

Figure 8. Neurophenomenological profile of the altered state of Selfhood (ASoS) "The experience of my life history disappeared". The legend of this figure is the same as that of the Fig. 2.

Further, this ASoS was accompanied by a transient disruption in the subjective experience of time, whereas all aspects of time perception diminished (Fig. 8), thus probably resulting in a feeling of disappearance of the "life history". In fact, the "autobiographical" self (Damasio, 1999, 2010) relies very much on self extended in time, where it is predicated on the retrieval and experience of memories and facts about one's life (Araujo et al., 2013). Hence, it is only logical to speculate that the disruption in time experience resulted in the disruption of the autobiographical identity and dissolution of life history, as they were temporary not integrated into a personal-level narrative. A similar loss of access to autobiographical memories is often reported during psychedelic drug induced altered states (Millière et al., 2018), with some reporting the disruption of even such fundamental self-knowledge that one is a human being (Johnstad, 2019). At the same time, the participant's phenomenological description clearly pointed that she has had rational thoughts about herself during this ASoS, indicated by her using the phrases like "I realized" or "vanishing hint about" (see above). This is also confirmed by an increase in such phenomenological aspects as "Reflection" and "Thoughts concatenation", as well as "Thoughts speed" that together were supported by increased functional integrity of the I-module of the brain SRN (Fig. 8). All-in-all, these observations point to the fact that alterations in autobiographical identity and self-referential thoughts may have some degree of independence and may take even opposite directions (although, their dynamics usually co-occur; Andrews-Hanna et al., 2014).

[30] Indeed, the subjective sense of effort presupposes some level of intentionality (Posner & Rothbart, 1998) and is sufficient to form at least a minimal sense of ownership and agency (Millière & Metzinger, 2020; Metzinger, 2020; see also Ataria et al., 2015).

3.8. "My thoughts stopped"

Figure 9 presents the neurophenomenological profile of the ASoS: "My thoughts stopped". This state was described as: "*The thoughts stopped. A pleasant openness remained. The body was no more. Nothing to observe*". Neurophysiologically, this ASoS was constituted by a some decrease in the functional integrity of the Self-module, stronger decrease in the functional integrity of the Me-module and even stronger decrease in the I-module of the brain SRN (Fig. 9). Considering the previous study on the relations between the triad SRN OMs and three aspects of Selfhood (Fingelkurts et al, 2020), the observed alterations in the SRN OMs triad may signify that in this ASoS the participant had approached[31] an experience sometimes described as a "pure awareness" (Stace, 1960; Fingelkurts & Fingelkurts, 2019), which is a phenomenological state of selfless, objectless and timeless presence (Metzinger, 2020), also reminiscent of subjective episodes during dreamless sleep (Thompson, 2015; Windt, 2015). Generally, such experience, is characterised by an "emptying out" of all phenomenological contents, including thoughts, and a lack of individual first-person perspective.

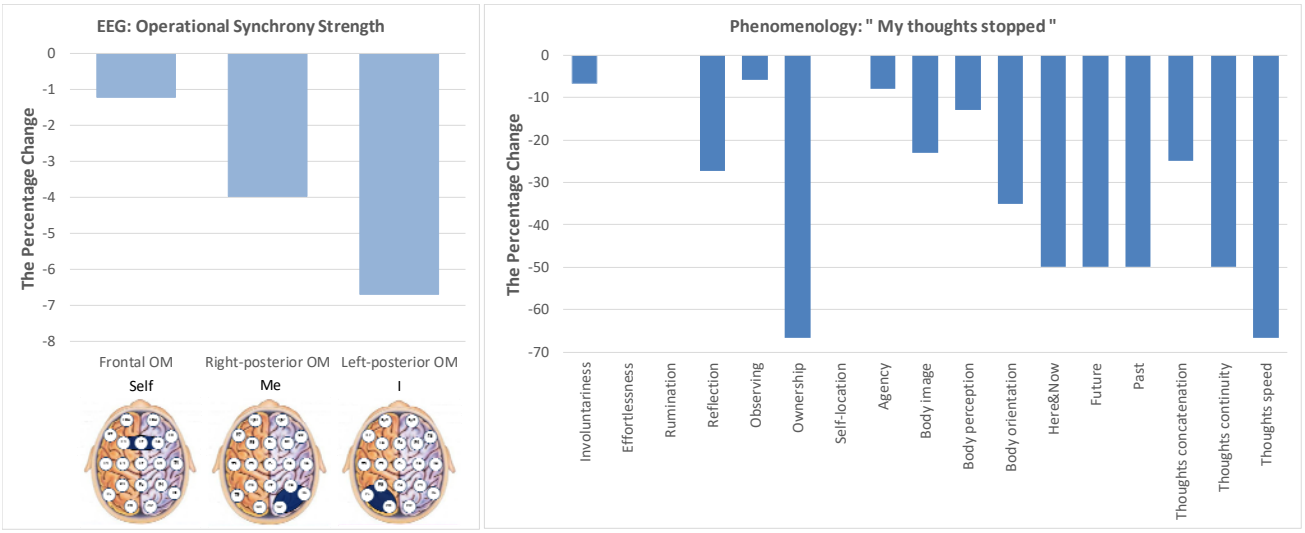

Figure 9. Neurophenomenological profile of the altered state of Selfhood (ASoS) "My thoughts stopped". The legend of this figure is the same as that of the Fig. 2.

The questionnaires data were remarkedly aligned with the neurophysiological observations; however, providing additional interesting nuances. From Figure 9 it could be seen that the expression of all phenomenological aspects related to discursive thought decreased notably (with "Thought speed" the most). Such alterations may contribute to a participant's phenomenological experience of decreased self-reflection

[31] The use of the word "approached" here is done on purpose. It stresses the point that the participant did not in fact reach this state of "pure awareness". If that state were to occur, then the complete absence of all phenomenological content would render the participant incapable of reporting such an episode. This is because during these episodes the self-referential mechanisms of forming an event in the subject's inner life narrative would be suspended (Metzinger, 2020). Therefore, the subjective experience during the full-fledged "pure awareness" ASoS could not be reported, only the process of entering into it or of emerging out of it can.

and thoughts halting[32], with "empty" content (recall the participant's description that there were "nothing to observe"). As expected, the related aspects of time experience (indexed by "Here&Now", "Future", and "Past") decreased strongly too (Fig. 9), thus indicating that, while in this ASoS, the participant had an experience of being outside of time (Shanon, 2001), hence not being located in a temporal frame of reference (Metzinger, 2020). Even the sense of "nowness" decreased strongly (see Fig. 9).

Further, during this unique ASoS, the expression of phenomenological aspects contributing to a sense of embodiment ("Body image", "Body perception", and "Body orientation") decreased markedly as well (Fig. 9), pointing to a rather high degree of phenomenological disconnection from the physical body's sensory and motor systems (Fingelkurts et al., 2020) and leading to a feeling of body dissolution. These changes in the embodiment cause a strong decrease in an immediate sense of a geometrical first-person perspective (Gallagher, 2000, 2005; Legrand, 2006; Metzinger, 2008) resulting in a diminished sense of "Agency", body "Ownership" and "Here&Now" (see Fig. 9). The alteration in a geometrical first-person perspective is related to a phenomenal point of view (phenomenal first-person perspective; Metzinger, 2004, 2008; Revonsuo, 2006; Trehub, 2007; Blanke & Metzinger, 2009). Therefore, one would expect a decrease in the sense of witnessing agency which is conceptualised as a phenomenal non-conceptual core in the act of knowing itself (Blanke & Metzinger, 2009; Velmans, 2014), that is experienced as a directly and immediately present centre that witnesses/observes a phenomenal multimodal perceptual reality and itself (Fingelkurts et al., 2020).

Indeed, the aspect of "Observing" decreased, though only slightly, in this ASoS (Fig. 9). This observation, together with a finding of a slightly decreased functional integrity of the Self-module of the brain SRN (that is responsible for the witnessing agency) (Fig. 9), may explain why the participant was still able to report this state at all. It seems, that such slight decreases were still sufficient to sustain a some very minimal sense of "self in the act of knowing" (Blanke & Metzinger, 2009; Velmans, 2014), and thus creating a minimal form of an internal, self-directed first-person perspectivalness; however, already not accompanied with executive control and extended self-reflection thought and autobiographical narrative all temporarily "offline" (Fingelkurts et al., 2020).

4. Summary, conclusions and limitations

The present study reports on eight unique ASoSs, that spontaneously occurred during mediation in six experienced long-term meditators. Since these ASoSs were the single time-points during different trials, they could be considered as phenomenological snapshots at given moments in time. Following the guidelines of the neurophenomenological framework (Varela, 1996; Gallagher & Sørensen, 2006; Gallagher & Zahavi, 2008; Berkovich-Ohana et al., 2020), the estimation of the OMs triad of the brain SRN, that was done using

[32] This, could be conceptualized as a longer time production (indexed by a slower rate of functioning of the internal timer), subjectively experienced as if the time seems to be moving slower or stopped (Glicksohn, 2001; Wittmann, 2013; Berkovich-Ohana & Wittmann, 2017).

EEG measurement, was guided by the participants' subjective reports. The result of such analysis demonstrated that documented 8 ASoSs had rather unique neurophenomenological profiles (Fig. 2-9), despite that all of them may be broadly divided in only two clusters: (i) changes in *embodiment* and (ii) changes in *self-reflection and narration* (see Table 1; ASoSs 1-6 and 7-8 respectively). In other words, grossly similar phenomenological experiences had very different subtle nuances that were captured by the neurophenomenological profiles that reveal transient perturbation of different components of Selfhood during any given ASoS. Therefore, one may conclude that experiences such as "disembodiment"/"OBE", loss of "autobiographic identity" and "self-reflection", or slight alterations of "witnessing observer", each is far from being the unequivocal phenomenon and all can take different forms where various aspects or components of Selfhood are affected and expressed differently (for a similar deduction, see Gallagher & Daly, 2018; Millière et al., 2018; Fingelkurts et al., 2020).

Figure 10 presents the dynamics of all three Selfhood components (Self, Me, and I) during eight ASoSs side by side. This representation allows to have an overview of all ASoSs at once and get new insights while comparing various ASoSs using range of common thresholds. It is straightforward that all ASoSs had a rather unique expression of Self-Me-I components. At the same time, and surprisingly, there were two different phenomenological states which shared an identical Self-Me-I phenotype – the two ASoSs in question were: (i) "My boundaries expanded into a whole room and street" and (ii) "My thoughts stopped" (Fig. 10). Thus, one may conclude that similar neurophysiological changes in the OMs triad were associated with both states. A closer look at these states (see analyses above: Section 3.4 and Section 3.8) reveals, that while participants in their subjective reports have focused on rather different phenomenological features (embodiment vs autobiographical narrative) of their experience, a detailed evaluation of the questionnaire replies revealed that the key features in the phenomenology had similar changes (diminished "Reflection", "Observing", "Physical agency", "Body image", "Body perception", "Body orientation", "Thoughts continuity"), thus supporting the similarity between the SRN OMs triads. These results highlight the importance and the utility of combining phenomenological descriptions and questionnaires with EEG neuroimaging measurement within the same experimental design when characterizing complex experiential Selfhood. Based on this analysis one may further suggest that a concrete altered state of Selfhood is determined not only by the *direction* of functional change in Selfhood components, but also by the *magnitude* of this change and a *mutual relation* between these components.

Analysis of Figure 10 data reinforces the view that self-consciousness is not a simple fixed unidimensional construct, but rather a fluid complex multidimensional pattern emerging from the dynamic interaction of differentially expressed characteristic aspects/features/qualities/components that jointly constitute Selfhood (Gallagher, 2013; see also Metzinger, 2014; Zahavi, 2014; Musholt, 2015; Millière et al., 2018; Fingelkurts et al., 2020). Furthermore, every aspect of Selfhood is not a simple unidimensional feature either, but instead a higher-order emergent complex multidimensional construct in its own right. Such a proposition has been made in our previous work (Fingelkurts et al., 2020) and is clearly confirmed in the present study. Indeed, every studied component of Selfhood comprises several low-level components. For

example, the *Me-component* subsumes body image, body perception, body orientation, ownership, geometrical first-person perspective and physical agency; the *I-component* includes reflection, rumination, narrative, autobiography, thoughts' structure and speed; the *Self-component* comprises phenomenal centre, phenomenal first-person perspective, epistemic certitude, witnessing observer. While, usually, the sub-components belonging to the same characteristic component behave in a similar manner (Fingelkurts et al., 2020), under certain conditions like during ASoSs, some of them may have different (even opposite) dynamics, as was observed in the present study (see the previous sections).

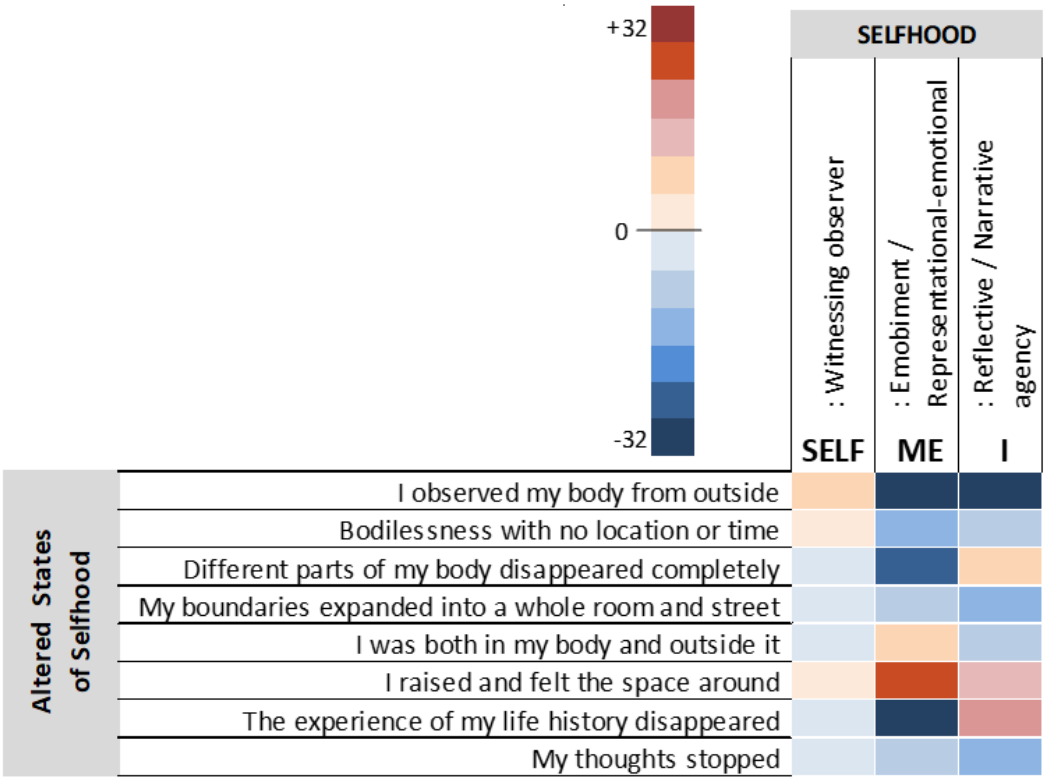

Figure 10. Dynamics of the three components of Selfhood (measured by the EEG functional integrity of OMs triad) during eight spontaneous altered states of Selfhood (ASoSs). The colour code is proportional to the percent change from the baseline condition in every component during a particular ASoS. Cold colour shades indicate decrease, while the warm colour shades indicate increase. Abbreviations: ASoS: altered state of Selfhood; EEG: electroencephalogram; OM: operational module.

By the same token, taken together, the analysis of 8 ASoS profiles indicates that changes in the triad of SRN OMs are largely in line with our previous study that established a causal link between three phenomenological aspects of Selfhood and brain OMs triad (Fingelkurts et al., 2020). Thus, the findings of the present study contribute to new converging evidence for a more comprehensive understanding of the ASoSs complexity.

4.1. Limitations

Since this study analyzed a subset of the data from a previous larger study (Fingelkurts et al., 2020), its limitations apply to the present one. These limitations are: (i) a small sample size as it was restricted to participants with a history of long-term meditation practice, (ii) uncertainty in regards to generalizability of results to a meditation naïve general population, (iii) analysis restricted to EEG alpha range only. Additionally, and specifically to the present study, no statistical evaluation was possible since the focus of this study was on brief spontaneously occurring, unique episodes of ASoSs that represent single snapshots of the phenomenological experience, hence making this a descriptive study. At the same time, such studies are crucially important because they often lead to unexpected hypotheses (Zhou et al., 2016) and provide a unique opportunity to address previously unasked questions (Pöppel et al., 2013). Another potential limitation of the present study was the way the ASoS time-stamps were indicated: they were not reported on the spot, but re-called after completing the 10-min experimental condition. Therefore, there is some possibility that the timings of ASoSs were assessed imprecisely. We have discussed this possibility in the footnote 13 and conclude that this is unlikely due to several reasons (see footnote 13). Thus, we are confident that the self-reported ASoS time stamps were indeed reliable.

Despite these limitations, the strength of this study is that it used a kind of enhanced neurophenomenological study (adding questionnaires and Likert scales to the usual pairing of EEG and phenomenology), following the proposal by Gallagher et al. 2015). Further, the findings from this study increase our knowledge on the normal variation of self-consciousness as could be observed in the spectrum of various ASoSs. Additionally, the results presented here provide a rich framework for new studies, specifically in the field of neuropsychopathology, where mechanisms similar to those that bring about the expression of a particular ASoS may be present as a given symptom or dysfunction contributing to a particular pathology.

CRediT authorship contribution statement

Andrew A. Fingelkurts: Conceptualization, Methodology, Investigation, Resources, Data curation, Formal analysis, Writing – Original Draft, Visualization, Project administration. **Alexander A. Fingelkurts:** Conceptualization, Methodology, Investigation, Resources, Formal analysis, Writing – Review & Editing, Visualization. **Tarja Kallio-Tamminen:** Conceptualization, Methodology, Writing – Review & Editing, Funding acquisition.

Declaration of Competing Interests

None of the authors have potential conflicts of interest with respect to the research, authorship, and/or publication of this article to be disclosed.

Funding

The authors received no funding for the research; however, some limited financial support was provided by private donations. These private persons had no role in the study design, data collection and analysis, decision to publish or preparation of the manuscript.

Acknowledgements

The authors thank the participants of this study for dedicating their time and unique contemplative expertise, and for their contribution in advancing the scientific understanding of experiential Selfhood. The authors would like further to thank C. Neves (Computer Science specialist) for programming, technical, and IT support and D. Skarin for English editing.

Data availability

The data are not publicly available, due to privacy or ethical restrictions.

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