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Trait-Like Stability of Selfhood Triumvirate and its Constituent Aspects: A qEEG Intra-Individual Test-Retest Reliability Study

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Abstract

This study investigated the intraindividual stability and reliability of the three core aspects of the Selfhood triumvirate ('Self', 'Me', and 'I') as well as their mutual relationship (the Selfhood triumvirate configuration/pattern) by measuring the within-subjects reproducibility of functional integrity within three operational modules (OMs) of the brain's self-referential network (SRN), each associated with one of these aspects, upon repeat testing (test–retest reliability). Our findings revealed statistically robust, moderate-to-high intraindividual test–retest reliability for the individual aspects ('Self', 'Me', and 'I'), and exceptionally high reliability for their overall functional configuration (i.e., the relative proportion of expression among the three aspects). Importantly, the analyses did not provide evidence that the duration between assessments, participants' age, or the presence of somatic or psychopathological conditions moderated these reliability measures. Taken together, the results suggest that the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate, as well as their overall functional configuration, exhibit trait-like properties, albeit to varying degrees, measured as the stability of functional integrity within the corresponding SRN OMs across time, age, and normative versus pathological conditions. Limitations of the present study and directions for future research are discussed.

Keywords: Quantitative electroencephalogram (qEEG); Self-consciousness; Selfhood triumvirate; Self-Me-I; intraindividual test–retest reliability; Neurophenomenology.

1. Introduction

In recent years, researchers across diverse disciplines have devoted increasing attention to the *self -consciousness* (Gallagher, 2000; Friston, 2012; Sui et al., 2012; Seth, 2013; Northoff & Huang, 2017; Wolff et al., 2018; Qin et al., 2020; Davey & Harrison, 2022, to name just a few). This growing interest is not surprising, given that *experiential Selfhood* is the most fundamental, deeply personal aspect of our status as autonomous, free agent, that integrates bodily experience, emotions, executive control, attention, intelligence, intention, and other facets within the first-person, intra-subjective perspective. In this way, Selfhood becomes central to comprehending the moral[1] significance of what makes life worth living (Levy, 2009; Levy & Savulescu, 2009). Here "experiential Selfhood refers to a sense of

[1] According to Levy (Levy, 2009; Levy & Savulescu, 2009), full *moral status* necessitates an individual's interest in life, a conviction in their own continuity throughout time, and future-oriented desires that motivate them to continue living.

the undergoing experience in its implicit first-person mode of givenness that is immediately and tacitly given as mine [...] and it is accompanied by a functionally autonomous experience of subjective confidence or certitude [...], making it possible to be engaged in autobiographical thoughts involving semantic and episodic memory events related to self, as well as projecting the self into the future, thus enabling the sense of invariance of a narrative self over time [...]" (Fingelkurts & Fingelkurts, 2022, p. 182) (see also Fingelkurts et al., 2020, p. 23). Importance of Selfhood is further supported by clinical evidence, suggesting that self-consciousness appears to be generally more resilient to brain damage or neuropsychopathology than many specialized cognitive functions, and it plays a critical role in facilitating the recovery of cognitive functions following impairments (for the review, see Fingelkurts & Fingelkurts, 2025).

Recently, to capture the wide range of phenomenological manifestations of Selfhood observed both under healthy conditions as well as within and across various neuropsychopathologies, and to reflect the inherently multi-faceted nature of self-consciousness (Klein & Gangi, 2010), the *Selfhood Triumvirate Model* was proposed (Fingelkurts & Fingelkurts, 2011) and subsequently subjected to empirical validation (Fingelkurts et al., 2020, 2022, 2023) using a *neurophenomenological* approach. For a comparison of the Selfhood Triumvirate Model with other contemporary models of the self, see Supplement 1 (after list of references).

According to the Selfhood Triumvirate Model, three functionally integrated[2] sets of cortex areas from the *brain's resting-state networks (RSNs)* (Mantini et al., 2007; see also De Luca et al, 2006, Damoiseaux et al., 2006) that participate in self-referential processes, thus constituting the *brain's self-referential network (SRN)* (Northoff et al., 2006; Fingelkurts & Fingelkurts, 2011; Fingelkurts et al., 2020, 2022) (*neurophysiology*), correspond to distinct aspects/facets of Self-consciousness – phenomenal first-person agency, embodiment, and reflection/narration – that are commensurate with one another (Zahavi, 2002; Gallagher, 2013; Gallagher & Daly, 2018) (*phenomenology*). These three sets of functionally integrated cortex areas manifest as the most stable, task-independent spatiotemporal patterns – termed operational modulus (OMs), that exhibited exceptionally high levels of operational synchrony in neurotypical individuals (Fingelkurts & Fingelkurts, 2011). Importantly, the study by Fingelkurts et al. (2020) strengthens the case for a direct *causal* relationship between the three fundamental phenomenological aspects of Selfhood and the corresponding functional integrity within these three OMs: (a) the *anterior SRN module* is associated with *witnessing agency or 'Self'* (first-person experiential presence or agency), (b) the *right posterior SRN module* is associated with *bodily representational–emotional agency or 'Me'* (embodied, interoceptive, and emotional self), and (c) the *left posterior SRN module* is associated with *reflective/narrative agency or 'I'* (reflective and autobiographical self). Specifically, it was demonstrated (Fingelkurts et al., 2020) that whenever participants deliberately and in a controlled manner up-regulated the subjective sense of 'Self' (witnessing agency), 'Me' (bodily representational–emotional agency), or 'I' (reflective/narrative agency), the functional integrity of the corresponding SRN OMs – as indexed by EEG operational synchrony – showed a significant increase. Conversely, intentional down-regulation of the sense of 'Self,' 'Me,' or 'I' led to a marked decrease in the functional integrity of the respective SRN OMs. These modulations in SRN integrity were consistently accompanied by participants' self-reports of altered phenomenological experience during the up- or down-regulation of 'Self,' 'Me,' and 'I'. Moreover, functional integrity within these three SRN OMs showed significant correlations with corresponding phenomenological factors assessed by standardized questionnaires. Converging evidence further strengthens the argument that qEEG synchrony within these three SRN OMs is related to the phenomenal characteristics of the Selfhood triumvirate rather than to random oscillations of the resting state EEG: (a) altered states of Selfhood (ASoSs) demonstrated shifts in qEEG synchrony that corresponded to vivid changes in phenomenological dimensions of Selfhood (Fingelkurts et al., 2022), and (b) across various psychopathologies, synchrony within these three SRN OMs increased or decreased in accordance with alterations in the phenomenology related to 'Self,' 'Me,' and 'I' (for review, see Fingelkurts & Fingelkurts, 2025).

[2] In this context, *functional integration* refers to the non-random synchronization of operations of functional neuronal assemblies located in distant cortex areas in order to cooperate in a coordinated manner (Fingelkurts & Fingelkurts, 2004; Fingelkurts et al., 2005).

Together, 'Self', 'Me', and 'I' form a unified and dynamically integrated sense of experiential Selfhood (for details and visualization see Fingelkurts & Fingelkurts 2025). The facts that these three aspects of the Selfhood triumvirate are present since early childhood (Woźniak, 2024; for brief review see Fingelkurts & Fingelkurts, 2025), expressed along the entire continuum of functioning from health to pathology (Fingelkurts et al., 2023), and are transdiagnostic (Fingelkurts & Fingelkurts, 2025), meaning that alterations in these aspects are observed in multiple disorders across the spectrum of neuropsychopathology, collectively suggest that 'Self', 'Me', and 'I' represent fundamental, primary aspects of phenomenal experience.

Previously, it was shown that the magnitude of the expression of the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate can be assessed by quantitative electroencephalogram (qEEG)[3] operational synchrony (Fingelkurts et al., 2020). In that empirical study, a causal relationship was demonstrated between the phenomenological expression of 'Self,' 'Me', and 'I' aspects and the magnitude of functional integration within three brain SRN's OMs (as measured by qEEG operational synchrony). Accordingly, qEEG-based operational synchrony within three brain SRN's OMs can be regarded as a reliable proxy for the expression of the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate (for a review of experimental evidence, see Fingelkurts et al., 2023).

Empirical observations further demonstrated that, although the absolute magnitude of expression of the 'Self', 'Me', and 'I' aspects may vary across individuals and conditions, their mutual relationships remain invariant to these variability across normotypical and numerous pathological conditions (Fingelkurts & Fingelkurts, 2025). This suggests that the Selfhood triumvirate has a stable functional configuration/structure – the relative proportion of 'Self', 'Me', and 'I' aspects and the degree of their manifestations (Fingelkurts & Fingelkurts, 2025): 'Self' is the most prominent aspect, followed by 'Me' and then 'I', in terms of functional integration as measured by qEEG operational synchrony (Fingelkurts & Fingelkurts, 2008, 2015).

However, because the Selfhood triumvirate is a neurophenomenological construct, the proportions of the magnitude of functional integration within three brain SRN's OMs (associated with 'Self,' 'Me', and 'I') are expected to vary in accordance with changes in phenomenology (for evidence of a causal relationship between the magnitude of functional integration assessed by qEEG operational synchrony and phenomenological expression of 'Self,' 'Me', and 'I' aspects, see Fingelkurts et al., 2020). Importantly, such intraindividual fluctuations do not appear to be random; rather, they are likely personally specific and exhibit trait-like properties (Fingelkurts et al., 2016a; see also Hanley et al., 2018; Lindström et al., 2023). This supposition is indirectly supported by evidence of very high (up to 99%) within-subject stability and test–retest reliability of functional interrelations across cortical areas (Thatcher et al., 1986; Roberts et al., 2016), including those implicated in the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate (Fingelkurts & Fingelkurts 2011; Fingelkurts et al., 2020). Nevertheless, formal investigation of intraindividual variability and test–retest reliability of the Selfhood triumvirate and its aspects has not yet been conducted.

Establishing such test–retest reliability is of critical importance for the neurophenomenology of Selfhood. Without demonstrating temporal stability, it is impossible to distinguish whether observed variations in the 'Self', 'Me', and 'I' aspects reflect genuine neurophenomenological dynamics or merely random neural or measurement noise. Reliability studies provide the methodological foundation for interpreting these measures as trait-like markers of self-related experience, enabling meaningful comparisons across individuals, groups, and clinical conditions. Furthermore, robust test–retest evidence is essential for validating the Selfhood triumvirate as a stable neurophenomenological architecture, thereby ensuring that subsequent findings in both basic and clinical research can be attributed to enduring features of Selfhood rather than transient fluctuations.

Building on this rationale, the importance of establishing within-subject stability of the Selfhood triumvirate can be articulated across several dimensions: (a) to ensure that scores on the Selfhood triumvirate reflect enduring aspects of an individual's experiential Selfhood rather than random

[3] An electroencephalogram (EEG) is a summation of the electrical activities along the scalp generated by dendritic and postsynaptic currents of many cortical neurons firing in non-random partial synchrony. The aggregate of these electric voltage fields produces an electrical reading that can be detected and recorded by electrodes on the scalp. A quantitative EEG (qEEG) is a digitally recorded EEG that has been statistically and algorithmically processed to extract information that is not visible to "naked" eye inspections of the signal.

fluctuations or measurement error, thereby validating the structural integrity of the Selfhood triumvirate model; (b) to evaluate trait-like properties (longitudinal stability) of the Selfhood triumvirate configuration and its constituent aspects ('Self', 'Me', and 'I'); (c) to characterize the degree of individual variability of the Selfhood triumvirate and its aspects; (d) to ensure that the Selfhood triumvirate and its aspects' variability associated with neuropsychopathology is genuine, thus enabling clinical applications; (e) to identify markers of vulnerability to neuropsychopathology when stability is disrupted; and (f) to facilitate cross-group comparability and longitudinal research.

Therefore, the aim of the present study was to explore the intraindividual stability of (a) the Selfhood triumvirate configuration (the relative proportion of 'Self', 'Me', and 'I' aspects) and (b) the magnitude of expression of its aspects ('Self,' 'Me,' and 'I') within various stable conditions. To achieve this aim, we assessed test–retest reliability of the Selfhood triumvirate and its aspects during the closed-eyes resting state, by measuring the qEEG operational synchrony within the brain SRN's OMs across repeated measurements.

2. Methods

2.1 Participants

For the purpose of this study, archived anonymized routine scalp EEGs, along with demographic and medical data, were extracted for retrospective analysis from the BM-Science electronic data-registry. Subjects included in this registry were either participants from previous studies, individuals who self-selected to receive well-being advice, or patients referred by physicians for neurophysiological evaluation.

To ensure real-world representativeness (general community) and assuming that experiential Selfhood, if trait-like, should remain intraindividually stable across both health and chronic stable disease for any sex and age (except the maturation phase), the target population of this study was comprised of both healthy subjects and subjects with various health conditions as long as these conditions are stable and chronic of any sex and age (≥ 20 years old). Subjects' data were eligible for inclusion in the current study if they met both inclusion and exclusion criteria.

The inclusion criteria were: (a) both sexes assigned at birth (male and female), (b) age ≥ 20 years old (to avoid maturational changes), (c) been healthy or have stable chronic[4] psychological or somatic condition lasting ≥ 3 months (to ensure a stable background and minimize the likelihood of spontaneous remission), (d) absence of active organic problems, (e) no history of brain stroke within the past 12 months, (f) no current medication, or if the medication is used, it should remain unchanged for at least 4 weeks prior to the first EEG (to ensure a stable medication background), (g) availability of two EEG recordings, with the second EEG registered at least 2 months after the first (this timeframe was selected because test-retest reliability over a longer period of time (> 1 month) implies temporal stability that is associated with trait-like characteristics; Chmielewski & Watson, 2009; McCrae et al., 2011).

The exclusion criteria included (a) age < 20 years old, (b) pregnancy, (c) alcoholism or drug addiction, (d) health problems with cyclic or dynamic manifestations (e.g., allergies, epilepsy), (e) acquisition of a new health condition or disease within the 3 months preceding the first EEG, (f) initiation or modification of medication within the 4 weeks prior to the first EEG, (g) significant changes between EEG sessions, such as (i) acquiring brain concussion(s) or new disease(s), (ii) major life changes such as relocation, change of occupation, or other drastic shifts in daily life, (iii) starting or changing medication, (iv) occurrence of significant life event(s) such as pregnancy, divorce, death of a close relative or friend, being a subject of abuse or violence, or in life-threatening situation(s).

A total of 85 subjects were identified in the registry who met both the inclusion and exclusion criteria. Their anonymized routine scalp EEGs, demographic and medical data were extracted for two sessions (1st and 2nd assessments), yielding 170 EEG recordings in total. The interval between the two EEG sessions ranged from 2.83 to 31.3 months (mean = 7.90, SD = 5.95).

[4] Since there are no unambiguous criteria for chronicity (Bernell & Howard, 2016), for the purpose of this study, we define chronicity as a three-month or longer period of persistent symptoms and experiences that consistently affect a person.

The entire study sample (*E*) had the following demographic characteristics: the mean age of the sample was 50.59 years (SD = 11.7; range: 28-76); it contained 65.9% females and 34.1% males; 94.1% were right-handed, 4.7% left-handed, and 1.2% ambidextrous; 61.2% were healthy (no diagnosis or medication was reported), 23.5% had chronic (≥ 3 years) stable somatic pathology (90% medicated, 10% unmedicated), and 15.3% had chronic (≥ 1 year) stable psychopathology (38.5% medicated, 61.5% unmedicated).

To evaluate the potential influence of pathology on the intra-subjects' stability of the Selfhood triumvirate and its constituent aspects, the entire sample was divided into three subgroups.

The *Healthy subgroup (H)*: included data from 52 healthy subjects (55.8% females, 44.2% males; mean age 47.76 ± 9.77 years, range: 28-75; 90.4% right-handed, 7.7% left-handed, and 1.9% ambidextrous). Subjects in this subgroup reported no any health complains or symptoms, traumatic events, history of neurological or psychiatric pathology, or medication use.

The *SomaticPathology subgroup (SP)*: included data from 20 subjects (75% females, 25% males; mean age 59.76 ± 12.41 years, range: 33-76; 100% right-handed). Subjects in this subgroup reported either one or two of the following conditions: hypertension, migraine, hypothyroidism, osteoarthritis, or low testosterone. 90% of participants reported taking medication, including antihypertensive, antithrombotic, blood thinners, statins, thyroxine, or testosterone, either alone or in combination.

The *PsychoPathology subgroup (PP)*: included data from 13 subjects (92.3% females, 7.7% males; mean age 50.15 ± 11.59, range: 39-75; 100% right-handed). The subjects in this subgroup reported one of the following conditions: anxiety, depression, burnout, fatigue, or ADHD. 38.5% of participants reported taking antidepressants, anxiolytics, or antipsychotics, either alone or in combination.

None of the participants using medication reported change in medication type or dosage between the 1st and 2nd assessments. However, one participant reported adding Vi-Siblin (a fiber supplement) and another added Somac (a selective proton pump inhibitor) to their diet during that interval. These additions are not expected to meaningfully influence the results. Additionally, one participant did not specify the exact medication or dosage and reported only 'antihypertensive' for both sessions. For details on the demographics and dataset, see Supplement 2 (after list of references).

The study was conducted in compliance with the World Medical Association's Code of Ethics (Declaration of Helsinki) and the criteria of the Review Board for the BM-Science – Brain and Mind Technologies Research Centre. Originally, all subjects signed an informed consent form prior to EEG registrations, including authorization for the use and re-use of their data in scientific research.

In line with the guidelines of the Finnish National Board on Research Integrity TENK (2019), an ethics committee statement was not required for this retrospective study, as all data were extracted from an archival registry, anonymized, and used with participants' prior consent for scientific purposes.

2.2 EEG Registration

EEG recordings were conducted late in the morning to minimize drowsiness. Sessions took place in a quiet, dimly illuminated room maintained at a comfortable ambient temperature to reduce sweating-related artifacts. Subjects were seated in a comfortable, semi-reclined armchair to promote relaxation and minimize movement. Prior to the EEG session, subjects were instructed to consume a moderate breakfast and to avoid psychoactive drugs (e.g., antidepressants and benzodiazepines) as well as other stimulants (e.g., coffee, tea, and alcohol) on the morning of the EEG session. Before the EEG recording, all participants confirmed that they had followed the preparatory instructions.

During the EEG recording, in order to achieve the wakeful resting condition, subjects were asked to relax and engage in no specific mental activity, minimize movements, avoid talking, and stay awake.

EEG Ag/AgCl electrodes were positioned on the head at 19 scalp locations (O1, O2, P3, P4, Pz, C3, C4, Cz, T3, T4, T5, T6, Fz, F3, F4, F7, F8, Fp1, Fp2) according to the International 10–20 System of the EEG electrode placement. EEG signals were acquired at a sampling rate of 256 Hz using an EEG data acquisition system (Mitsar, Ltd) with a monopolar montage and linked earlobes as a reference electrode, and the ground electrode was placed on the scalp, at a site equidistant between Fpz and Fz. The following recording parameters were additionally enforced: the EEG had 0.5–30 Hz bandpass; the 50 Hz notch filter was ON and the impedance was below 10 kΩ. An electrooculogram with a bandpass of 0.5–70 Hz and a simplified cardiogram were also recorded. The duration of the continuous EEG was 12 minutes: 6 minutes with the eyes closed and 6 minutes with the eyes open in resting (but awake)

settings. This timing of EEG recording is sufficient to obtain reliable and internally consistent data (Gasser et al., 1985; van Albada, et al., 2007) and is well tolerated by the subjects. Throughout the EEG recording, the researcher monitored the subject's state and on-going EEG traces to assist the subject in maintaining adequate level of vigilance (i.e., avoiding drowsiness and sleep onset).

All EEG recordings were performed by the same researcher, who has over 30 years of experience, in the same room, using identical equipment and standardized procedures across both the 1st and 2nd sessions. This consistency was maintained to minimize measurement variability.

The presence of an adequate EEG-signal was initially determined by visually inspecting the raw digital signal on the computer screen.

Only resting-state, closed-eyes qEEG data were included in this study, as this condition best represents the brain's intrinsic activity, free from the confounding influences of visual input, external tasks, events, or stimulation. Closed-eyes resting-state qEEG reflects a non-random intrinsic default activity that instantiates a trait-like self-organization that regulates multiple brain systems, adapting the brain and body to an ever-changing environment (Gasser et al., 1985; Dünki et al., 2000; Grandy et al., 2013; Tomescu et al., 2024). It depicts self-reflection, internal narrative, and the autobiographical self (Knyazev et al., 2011,2012,2015; Cannon & Baldwin, 2012; Wolff et al., 2019; Kolvoort et al., 2020; Kraus et al., 2021; Tarailis et al., 2024), allowing for the assessment of self-relevant baseline brain and mind activity.

2.3 Demographics and Clinical Data Collection

All participants completed two screening questionnaires. The first was administered before the 1st EEG session and collected demographic information along with self-reported psychological, neurological, physical, and medical history, including current medications. The second questionnaire was completed before the 2nd EEG session and gathered the same categories of information to determine whether any changes had occurred since the first assessment.

2.4 EEG Pre-Processing

Artefacts caused by eye movement, eyes opening, excessive 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 algorithmically corrected or eliminated from the continuous broadband EEG prior to further qEEG processing. This was accomplished using a spatial filtering technique (Independent Component Analysis – ICA [Extended Infomax version]) by zeroing the activation curves of individual independent components identified as artifact-related (WinEEG software, Mitsar, Ltd). The selection criteria for component elimination were based on the visual (a) inspection of component topographies associated with artefacts and (b) comparison of the raw (uncorrected) multi-channel EEG, the corrected EEG, and the waveforms of the excluded artifact components. The procedure was repeated iteratively until a 'clean' EEG signal was achieved that met visual-inspection standards, which remain the golden standard in electrophysiology. In most cases, 0–4 components were removed, although the precise number of eliminated components was not documented.

Additionally, epochs with excessive EEG amplitude (≥ 200 μV), fast (20-30 Hz, ≥ 50 μV), or slow (0.5-1 Hz, ≥ 50 μV) frequency activity were excluded.

After artefact rejection, the remaining EEG data accepted for further analysis ranged from 3 to 6 minutes. This duration falls within the recommended length for achieving highly reliable and internally consistent EEG measures, as reported in earlier studies (Gasser et al., 1985; Salinsky et al., 1991; van Albada et al., 2007).

For each registration, a complete artifact-free EEG stream was divided into consecutive 1-minute epochs. The rationale for using 1-minute epochs was the following: (a) although these epochs are not fully independent, treating them as repeated samples within individuals increases the effective degrees of freedom and thereby improves the precision of the resulting stability estimates, (b) because the segmentation was not time-locked to any specific event, and because artifact-free epochs occurred in a quasi-random manner across participants and sessions, the resulting set of epochs approximates a random sampling of the underlying signal, (c) prior studies demonstrated that synchronicity patterns

(relevant for this study) remain stable, statistically independent, and robust across segments longer than a few seconds (Fingelkurts, 1998; Fingelkurts et al., 2003), and (d) because subjects contributed different amounts of artifact-free EEG (3–6 minutes), dividing the data into consecutive 1-minute epochs standardizes the unit of analysis across subjects while allowing each individual to contribute as many valid epochs as available. Thus, dividing the continuous EEG into 1-minute epochs provides multiple observations per subjects and ensures a consistent analytical unit across subjects without altering the underlying synchronicity profile.

Further each 1-minute EEG epoch was bandpass-filtered (sixth order Butterworth filter) in the alpha frequency band (7–13 Hz). Phase shifts were eliminated by forward and backward filtering. The alpha frequency band was chosen because converging evidence suggests a relationship between alpha rhythm to conscious awareness and self-consciousness: (1) phylogenetically (evolutionarily) alpha entropy decreases and alpha coherence increases from invertebrates to humans, coinciding with the development of higher cognitive processes and self-reflection (Başar & Güntekin, 2009), and ontogenetically – from birth to about three years of age, when some signs of self-consciousness emerge (Rochat, 2003; Praetorius, 2009), (2) alpha rhythm is related to important aspects of self-consciousness such as global attentional readiness, internalized attention, processing of sensorimotor or semantic information (Klimesch et al., 1997, 1998, 2010; Cooper et al., 2003), perceptual feature integration and 'binding' (Bressler et al., 1993), 'semantic orientation' – the ability to be consciously oriented in time, space, and context with respect to the meaning of all entities surrounding the individual (Klimesch, 2012), affective regulation (Tomarken et al., 1992, Coan & Allen, 2004), personality (Knyazev et al., 2004), and subjective experience (Lehmann et al., 1981, 1995; Pütz et al., 2006; Vlisides et al., 2018), (3) alpha activity is associated/correlated with conscious awareness (Sokolov 1992; Babiloni et al., 2006a,b; Vaitl et al., 2005; Fingelkurts et al., 2012), self-awareness, and spontaneous self-referential mentation (Farrow & Hebert, 1982; Badawi et al., 1984; Travis & Wallace, 1999; Shaw, 2003; Travis et al., 2004; Arenander & Travis, 2004; Knyazev et al., 2011, 2012, 2015; Cannon & Baldwin, 2012; Carhart-Harris et al., 2014; Kraus et al., 2021), (4) alpha rhythm is causally related to conscious awareness (Babiloni et al., 2007) or self-consciousness (Fingelkurts et al., 2020), (5) alpha rhythm significantly positively correlates with the brain's self-referential network (Laufs et al. 2003; Mantini et al., 2007; Jann et al., 2009; Knyazev et al., 2011, 2012); and (6) it has been shown that exactly EEG alpha band operational connectivity within three modules of self-referential network correlates significantly with variation in self-consciousness during psychoneuropathology (Fingelkurts et al., 2023; Fingelkurts & Fingelkurts, 2025) and with Selfhood alterations during meditation (Fingelkurts et al., 2016a,b).

2.5 Estimation of SRN OMs and assessing their synchrony strength as a proxy for the 'Self', 'Me,' and 'I' aspects of the Selfhood triumvirate

The magnitude of qEEG-based operational synchrony within the three brain SRN's OMs was used to assess the expression of the 'Self,' 'Me,' and 'I' aspects of the Selfhood triumvirate (for a causal relationship between the magnitude of functional integration assessed by EEG operational synchrony within three brain SRN's OMs and the phenomenological expression of 'Self,' 'Me,' and 'I,' see Fingelkurts et al., 2020).

Estimation of operational synchrony within each operational module (OM) involved several hierarchical stages of qEEG data processing. In brief, local 1-minute qEEG signals were segmented into quasi-stationary segments, defined by rapid transitional periods (RTPs), which are thought to reflect transient operations of functional neuronal assemblies (Fingelkurts & Fingelkurts, 2001). Synchronization of these segments across different qEEG channels was then quantified as operational synchrony, indicating functional coupling (positive values) or decoupling (negative values) beyond chance levels. Groups of channels exhibiting consistent synchrony – synchrocomplexes (SCs) – were used to define OMs, with their strength of synchrony reflecting the functional integrity of each module. Full methodological details of this multistage procedure are provided elsewhere (Fingelkurts & Fingelkurts, 2008, 2015).

It is sometimes argued that EEG analysis at the sensor level is vulnerable to volume conduction, potentially complicating the interpretation of EEG data in terms of brain functional connectivity.

However, evidence indicates that the scalp EEG-electrode locations provide accurate voltage recordings of the corresponding underlying anatomical structures (Thatcher et al., 1986, 2012). Additional studies have further established robust correlations between EEG activity at specific electrode sites and their corresponding cortical areas (for the review see page 30 at Fingelkurts et al., 2016b). These results have been verified through an EEG-MRI sensor system and an automated projection algorithm (Koessler et al., 2009). Furthermore, simulation studies demonstrated that the operational synchrony measure used here reflects underlying cortical morpho-functional organization rather than being confounded by volume conduction, EEG power fluctuations, or reference electrode choices (Fingelkurts & Fingelkurts, 2008, 2015). Together these observations support the validity of sensor-level EEG analyses for examining brain functional connectivity.

2.6 Statistical analysis

To assess intraindividual stability and reliability of the Selfhood triumvirate aspects ('Self', 'Me', and 'I') and their mutual relationship (Selfhood triumvirate configuration), the within-subjects reproducibility of functional integrity within the brain's SRN OMs associated with 'Self', 'Me', and 'I' (Fingelkurts et al., 2020) was calculated upon repeat testing (test–retest reliability).

2.6.1 Calculation of the intraindividual test-retest reliability of the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate

To assess intraindividual test-retest reliability of the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate (variable-level reliability), the *Pearson Correlation Coefficient* (R) between 1st and 2nd measurements of functional integrity within the brain's SRN OMs associated with 'Self', 'Me', and 'I' was calculated for the Entire sample (*E;* $n = 85$) and three subgroups: Healthy subgroup (*H;* $n = 52$), SomaticPathology subgroup (*SP;* $n = 20$), and PsychoPathology subgroup (*PP;* $n = 13$).

The results are presented as R(degrees of freedom) = the R statistic, p = the p value, where degrees of freedom for R is n–2.

In order to evaluate the correlation between measurements, it is important to know the 'magnitude' or 'strength' of the correlation in addition to its statistical significance. To determine the strength of the relationship, the correlation coefficients were squared, resulting in the values (R^2, the *coefficient of determination*) that represent the proportion of common variation in the two measurements. Multiplied by 100, this proportion of variance indicates the percentage of variance that is explained by the regression function.

Because Pearson's R reflects association rather than agreement between two measurements of the same variable, *Bland–Altman analysis* (Bland & Altman, 1986) was used to complement the correlation analysis. Bland–Altman analysis evaluates (a) how far paired scores deviate from perfect agreement, (b) whether deviations are systematic (bias), and (c) whether deviations change with the magnitude of the measurement (heteroscedasticity). The following Bland–Altman agreement parameters were calculated: (a) the mean difference (bias), defined as the 2nd assessment minus the 1st, (b) the standard deviation of the differences (SD_{diff}), which reflects the spread of disagreement, and (c) the upper and lower limits of agreement (LoA), computed as $bias \pm 1.96 \times SD_{diff}$. Good agreement between two measurements of the same variable is indicated when the bias is close to zero, most points fall within the LoA, and the differences remain approximately constant across the range of measurement means.

To supplement the Bland–Altman analysis, the *Intraclass Correlation Coefficient (ICC)* was calculated because Bland–Altman analysis, while informative about agreement, does not provide a single reliability coefficient and cannot quantify relative reliability (rank-order consistency) (Berchtold, 2016). ICC is specifically suited for test–retest reliability, assessing the extent to which repeated measurements within individuals are more similar than measurements between individuals. Depending on the model, ICC can evaluate absolute agreement or consistency and incorporates both between-subject and within-subject variability. For the test-retest design used in this study – where the same variables are measured twice from the same participants using the same instrument, protocol, and conditions, and where the two measurement occasions are considered fixed – the recommended model is ICC(3,1), a two-way mixed-effects model with absolute agreement (Shrout & Fleiss, 1979; McGraw & Wong, 1996; Koo & Li, 2016). Reliability was interpreted according to Koo & Li (2016): values <

0.05 (poor reliability), 0.50–0.75 (moderate reliability), > 0.75 (good reliability), and > 0.90 (excellent reliability).

To compare the magnitude of the reliability coefficients for the 'Self'-OM, 'Me'-OM, and 'I'-OM, the Steiger's *Z*-test for dependent, non-overlapping correlations was used. This test is appropriate when correlations are obtained from the same sample but involve different variables (Steiger, 1980). To adjust for multiple comparisons, the Holm correction was applied. Holm's method controls the family-wise error rate, is suitable for confirmatory reliability comparisons, is less conservative and more powerful than the Bonferroni correction, does not require independence among tests (unlike Hochberg's method), and avoids the higher false-positive tolerance associated with the Benjamini–Hochberg procedure, which is not ideal for reliability assessment.

To examine whether test–retest reliability between the 1st and 2nd assessments depended on the interval between them ('Duration') and the subjects' age ('Age'), a multiple linear regression analysis was conducted with the 2nd assessment as the dependent variable and the 1st assessment, 'Duration', 'Age', and their interaction terms as predictors. Significant interaction terms would imply that the strength of the association between the two assessments varied as a function of 'Duration' or 'Age'. A regression analysis was performed separately for 'Self'-OM, 'Me'-OM, and 'I'-OM for the Entire sample (*E*) (n = 85).

2.6.2 Calculation of the intraindividual test-retest reliability of the Selfhood triumvirate configuration (pattern)

To assess the intraindividual test-retest reliability of the Selfhood triumvirate configuration (the composite pattern reliability), *Pearson Correlation Coefficient* (*R*) between the 3-variable vector ['Self'-OM_1, 'Me'-OM_1, 'I'-OM_1] at the 1st measurement and 3-variable vector ['Self'-OM_2, 'Me'-OM_2, 'I'-OM_2] at the 2nd measurement was calculated for each subject within the Entire sample (*E;* n = 85) and three subgroups: Healthy subgroup (*H;* n = 52), SomaticPathology subgroup (*SP;* n = 20), and PsychoPathology subgroup (*PP;* n = 13) using the following steps:

- For each subject, the Pearson correlation between their vectors at Time 1 (['Self'-OM_1, 'Me'-OM_1, 'I'-OM_1]) and Time 2 (['Self'-OM_2, 'Me'-OM_2, 'I'-OM_2]) was calculated. This provides a *subject-specific pattern stability score*.
- Then, the *overall pattern reliability estimate* was calculated by averaging the pattern stability scores across all subjects within the entire sample and subgroups. For averaging the correlation coefficients across the subjects, the correlation coefficients were converted into so-called Fisher *Z* values. This is required since an average of correlation coefficients across subjects does not represent an 'average correlation' in all those subjects (because the correlation coefficient value is not a linear function of the magnitude of the relationship between the variables). Thus, before averaging, correlation coefficients were converted into Fisher *Z* values (which are additive measures) using the formula:
  $Z = ½ * \log[(1+R)/(1-R)]$, where *R* is correlation coefficient.
  Then, the Mean *Z* was calculated by averaging the *Z* values across all subjects within each group. In addition, standard deviation (SD *Z*), standard error (SE *Z*), and 95% confidence intervals (CI) (lower *Z* and upper *Z*) were calculated.
  Next, Mean *Z* and CI values were back-transformed to *R* scale using the back-transform function:
  $R = (EXP(2*Z)-1)/(EXP(2*Z)+1)$.

To test whether Mean *Z* differed from 0 (where '0' means that patterns do not persist over time), a one-sample *t*-test was used.

To examine *R* variability among subjects within groups, descriptive statistics for the distribution of individual *R* values were calculated. It included the mean, median, standard deviation (SD), first quartile (Q1) - the 25th percentile, third quartile (Q3) - the 75th percentile, interquartile range (IQR) - the difference between Q3 and Q1, minimal value (Min), and maximal value (Max).

To examine whether the composite pattern reliability of individual correlations between the 1st and 2nd measurements (expressed as Fisher *Z*-transformed Pearson correlations) was influenced by the interval between assessments and subjects' age, a multiple linear regression analysis was conducted. Fisher *Z* values were used because the Fisher *Z* transformation makes the distribution approximately normal, which is preferable for regression. The Fisher *Z* values served as the dependent variable.

'Duration' (in months between the two assessments) and 'Age' (in years) were entered as independent variables concurrently. This approach allowed us to test whether either predictor, or their combined contribution, accounted for systematic variation in reliability throughout the Entire sample (*E; n* = 85).

3. Results

To assess intraindividual stability and reliability of the Selfhood triumvirate aspects ('Self', 'Me', and 'I') and their mutual relationship (Selfhood triumvirate configuration), the within-subjects reproducibility of functional integrity within the brain's SRN OMs associated with 'Self', 'Me', and 'I' was calculated upon repeat testing (test–retest reliability).

3.1 The intraindividual test-retest reliability of the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate

Test–retest reliability between the 1st and 2nd measurements of functional integrity within the three brain's SRN OMs associated with the 'Self', 'Me', and 'I' aspects was assessed for the Entire sample (*E; n* = 85) using Pearson correlations, Bland–Altman analysis, and intraclass correlation coefficients (ICCs).

The Pearson correlation analysis demonstrated highly statistically significant ($p < 0.00001$) *moderate-to-strong* positive correlation between the measurements (see Fig. 1A), ranging from $R = 0.64$, 95% CI [0.494, 0.750] for the 'Me'-OM, to $R = 0.7$, 95% CI [0.603, 0.775] for 'I'-OM, and $R = 0.82$, 95% CI [0.735, 0.880] for 'Self'-OM. These correspond to coefficients of determination (R^2 x 100) of approximately 41% (for 'Me'-OM), 49% (for 'I'-OM) and 67% (for 'Self'-OM), indicating that a substantial proportion of retest variability is explained by the initial measurement. The effect is considered large for all aspects of the Selfhood triumvirate by conventional benchmarks.

These results indicate moderate (for 'Me'- and 'I'- OMs) and high (for 'Self'-OM) test–retest correlations. The fact that all points on the scatter plots form an elongated cloud along the diagonal (Fig. 1A) suggests relatively high specificity (reliable capture of the differences between individuals). The confidence interval widths of 0.26 (for 'Me'-OM), 0.17 (for 'I'-OM), and 0.15 (for 'Self'-OM) suggest moderate to high precision considering the sample sizes.

A *strong positive association* between the measurements (Pearson *R*, Fig. 1A) for the 'Self'-OM was supported by the Bland–Altman analysis, that showed a mean difference of −0.17 units (retest minus test), indicating negligible systematic bias (Fig. 1A). The standard deviation of the differences was 3.30, yielding 95% limits of agreement (LoA) from −6.64 to +6.31, consistent with *excellent absolute agreement*. The intraclass correlation coefficient, ICC(3,1), was 0.84, with a relatively narrow 95% CI [0.74, 0.88] (Fig. 1A), further confirming *good relative reliability*. Taken together, these results indicate that functional integrity within the 'Self'-OM demonstrates *strong test-retest reliability*, characterized by both high relative stability and excellent absolute agreement across testing occasions.

A *moderate-to-strong association* between the measurements (Pearson *R*, Fig. 1A) for the 'I'-OM was supported by the ICC(3,1) value of 0.71 (95% CI: 0.58–0.81) (Fig. 1A), reflecting *moderate-to-good reliability*. Bland–Altman analysis showed a mean difference of +1.46 units (Fig. 1A), indicating a small systematic increase on retest. The standard deviation of the differences was 8.29, producing 95% LoA from −14.79 to +17.72 and indicating substantial individual variability and *limited absolute agreement*. Thus, although Pearson *R* and ICC indicated acceptable test-retest relative stability for the 'I'-OM, the wide Bland–Altman limits indicate limited absolute agreement, making the measure appropriate for group-level analyses or ranking individuals but less reliable for detecting subtle individual changes over time.

A *moderate positive association* between the measurements (Pearson *R*, Figure 1A) for the 'Me'-OM was confirmed by the ICC(3,1) value of 0.66 (95% CI: 0.52–0.77) (Figure 1A), indicating *moderate reliability*. Bland–Altman analysis revealed a mean difference of +1.82 units (Figure 1A), suggesting a small systematic increase on retest, similar to the pattern observed for the 'I'-OM. The standard deviation of the differences was 8.46, yielding wide 95% LoA from −14.76 to +18.41 and indicating substantial individual variability and *limited absolute agreement*. As with the 'I' aspect, although

Pearson *R* and ICC demonstrated acceptable test-retest relative stability for the 'Me'-OM, the wide Bland–Altman limits indicate limited absolute agreement, meaning the measure is suitable for group-level comparisons or ranking individuals but less reliable for detecting small within-person changes.

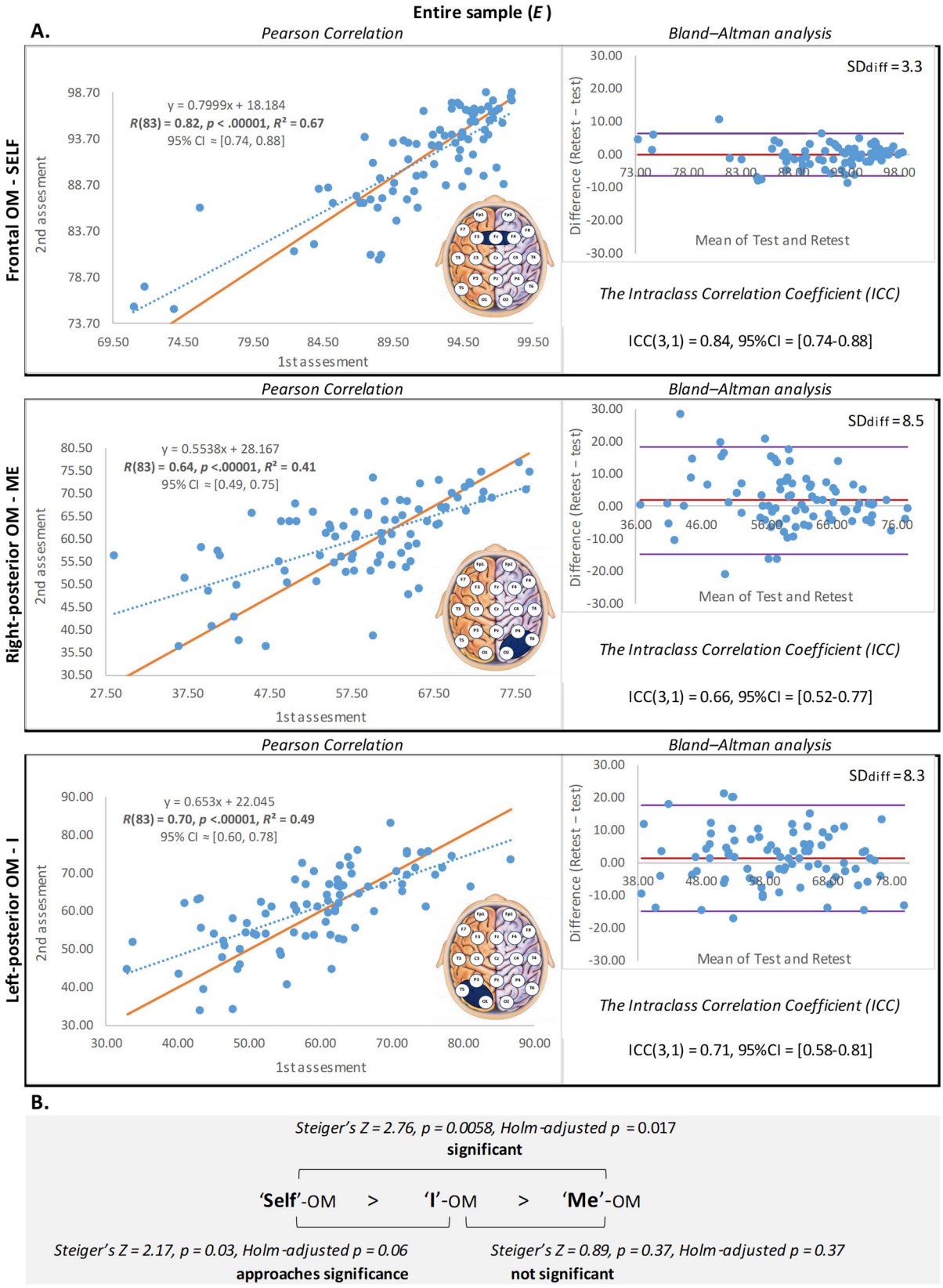

Fig 1. Panel A: Pearson correlation scatter plots showing within-subject reproducibility of functional integrity within three brain's SRN operational modules (OMs) associated with the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate for the Entire sample ($n = 85$) during the closed-eyes resting condition. The schematic cortex maps (on the right) depict the spatial locations of the three OMs (dark blue regions) corresponding to the three phenomenological aspects of the Selfhood triumvirate: 'Self' (witnessing agency), 'Me' (bodily representational–emotional agency), and 'I' (reflective-narrative agency) (Fingelkurts et al., 2020, 2022). White circles with letters and numbers indicate EEG electrode positions. Bland–Altman difference plots display the difference between the two measurements (2nd minus 1st) on the *y*-axis against their mean on the *x*-axis, illustrating agreement between repeated assessments. Each plot shows the mean difference (bias), the 95% limits of agreement (LoA), and the standard deviation of the differences (SD_{diff}). The Intraclass Correlation Coefficient (ICC) values correspond to ICC(3,1), a two-way mixed-effects model with absolute agreement, reported with 95% confidence intervals.

Panel B: Comparison of the magnitude of the reliability coefficients for the 'Self'-OM, 'Me'-OM, and 'I'-OM, evaluated using the Steiger's *Z*-test for dependent, non-overlapping correlations. Multiple comparisons were controlled using the Holm correction.

Figure annotations: For Pearson's correlation scatter plots: blue dotted line = regression line, solid orange line = identity line (y=x), *R* = Pearson correlation coefficient; R^2 = coefficient of determination; *CI* = confidence interval; 'Self', 'Me' and 'I' = aspects of the Selfhood triumvirate; *p* = statistical significance. For Bland–Altman difference plots: red horizontal line = bias (mean difference); purple horizontal lines = upper and lower limits of agreement (LoA); SD_{Diff} = standard deviation of the differences.

The test–retest reliabilities of the three Selfhood aspects followed a descending numerical order: 'Self'-OM > 'I'-OM > 'Me'-OM (for statistical significance see Fig. 1B).

Since the duration interval between the 1st and 2nd measurements varied between about 3 and 30 months, and the participants' age ranged from 28 and 76 years old in the Entire sample, it was important to assess whether the duration interval and participants' age were associated with the test-retest reliability between the 1st and 2nd measurements.

To examine whether test–retest reliability between the 1st and 2nd assessments depended on the interval between them ('Duration') and the subjects' age ('Age'), a multiple linear regression analysis was performed with the 2nd assessment as the dependent variable and the 1st assessment, 'Duration', 'Age', and their interaction terms as predictors.

A multiple regression analyses revealed that:

(a) the 1st assessment of functional integrity within the brain's SRN OM associated with 'Self' significantly predicted the 2nd assessment ($B = 0.78$, $t(79) = 12.15$, $p < 0.001$) (Table 1). Neither interval duration ($B = 0.07$, $t(79) = 0.84$, $p = 0.41$), or participants' age ($B = –0.02$, $t(79) = –0.9$, $p = 0.37$), nor their interactions with the 1st assessment were significant predictors (all $p > 0.29$) (Table 1), indicating that test–retest reliability for 'Self'-OM did not vary as a function of interval length or participants' age.

(b) the 1st assessment of functional integrity within the brain's SRN OM associated with 'Me' significantly predicted the 2nd assessment ($B = 0.55$, $t(79) = 7.55$, $p < 0.001$) (Table 2). Neither interval duration ($B = –0.1$, $t(79) = –0.69$, $p = 0.49$), or participants' age ($B = 0.01$, $t(79) = 0.55$, $p = 0.58$), nor their interactions with the 1st assessment were significant predictors (all $p > 0.16$) (Table 2), indicating that test–retest reliability for 'Me'-OM did not vary as a function of interval length or participants' age.

(c) the 1st assessment of functional integrity within the brain's SRN OM associated with 'I' significantly predicted the 2nd assessment ($B = 0.67$, $t(79) = 9.19$, $p < 0.001$) (Table 3). 'Duration' and 'Age' were not significant predictors ($p = 0.9$ and $p = 0.13$, respectively). The negative interaction between 1st assessment and duration approached significance ($B = –0.14$, $t(79) = -1.97$, $p = 0.052$) (Table 3), suggesting a possible weakening of the test–retest relationship at longer intervals. Similarly, the interaction between 1st assessment and the participants' age showed a trend toward significance ($B = 0.013$, $t(79) = 1.89$, $p = 0.063$) (Table 3), indicating a potential strengthening of the relationship with increasing age. However, neither interaction reached statistically significance level.

Table 1. Multiple regression predicting the functional integrity within the brain's SRN OM associated with the 'Self' aspect of the Selfhood triumvirate at the 2nd assessment from the 1st assessment, duration (assessments interval), age, and their interactions for the Entire sample (*E*).

Predictor	*B*	SE *B*	*t*	*p*	Significance
Intercept	91.6	0.35	261.96	<.001	significant
1st-assessment	0.78	0.06	12.15	<.001	significant
Duration	0.07	0.08	0.84	0.405	not significant
1st-assessment × Duration	–0.03	0.03	–1.06	0.293	not significant
Age	–0.02	0.02	–0.90	0.372	not significant
1st-assessment × Age	–0.00	0	–0.26	0.799	not significant

Model summary: Multiple $R = 0.83$, $R^2 = 0.68$, Adjusted $R^2 = 0.66$, $F(5, 79) = 34.03$, $p < 0.001$.
Note: $n = 85$. Dependent variable = 2nd assessment. Predictors were mean-centered prior to creating interaction terms. *B* = unstandardized regression coefficient, SE(*B*) = the standard error of the coefficient, *F* = ANOVA significance, *t* = t-test, Multiple *R* = the correlation coefficient between the observed values and the predicted values from the regression model, R^2 = the coefficient of determination, Adjusted R^2 = a corrected version of R^2 that accounts for the number of predictors in the model.

Table 2. Multiple regression predicting the functional integrity within the brain's SRN OM associated with the 'Me' aspect of the Selfhood triumvirate at the 2nd assessment from the 1st assessment, duration (assessments interval), age, and their interactions for the Entire sample (*E*).

Predictor	*B*	SE *B*	*t*	*p*	Significance
Intercept	60.88	0.78	78.43	<.001	significant
1st assessment	0.55	0.07	7.55	<.001	significant
Duration	–0.10	0.14	–0.69	0.492	not significant
1st-assessment × Duration	–0.10	0.07	–1.42	0.161	not significant
Age	0.01	0.01	0.55	0.583	not significant
1st-assessment × Age	0.01	0.01	1.17	0.246	not significant

Model summary: Multiple $R = 0.66$, $R^2 = 0.44$, Adjusted $R^2 = 0.41$, $F(5, 79) = 12.43$, $p < 0.001$.
For the Note see Table 1.

Table 3. Multiple regression predicting the functional integrity within the brain's SRN OM associated with the 'I' aspect of the Selfhood triumvirate at the 2nd assessment from the 1st assessment, duration (assessments interval), age, and their interactions for the Entire sample (*E*).

Predictor	*B*	SE *B*	*t*	*p*	Significance
Intercept	60.57	0.79	76.64	<.001	significant
1st assessment	0.67	0.07	9.19	<.001	significant
Duration	0.02	0.14	0.12	0.903	not significant
1st-assessment × Duration	–0.14	0.07	–1.97	0.052	not significant
Age	0.02	0.01	1.52	0.132	not significant
1st-assessment × Age	0.01	0.01	1.89	0.063	not significant

Model summary: Multiple $R = 0.73$, $R^2 = 0.53$, Adjusted $R^2 = 0.51$, $F(5, 79) = 18.16$, $p < 0.001$.
For the Note see Table 1.

To evaluate the potential influence of pathology on intra-subjects' stability of functional integrity within the three brain's SRN OMs associated with the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate, the Pearson correlations, Bland–Altman analysis, and intraclass correlation coefficients (ICCs) between the 1st and 2nd measurements were calculated for the three subgroups: Healthy (*H; n* = 52), SomaticPathology (*SP; n* = 20), and PsychoPathology (*PP; n* = 13).

The analysis demonstrated highly statistically significant ($p < 0.01$–0.00001) *moderate-to-strong positive correlations* between measurements (see Fig. 2A, 3), thereby confirming the results obtained for the Entire sample (*E*) (Fig. 1A).

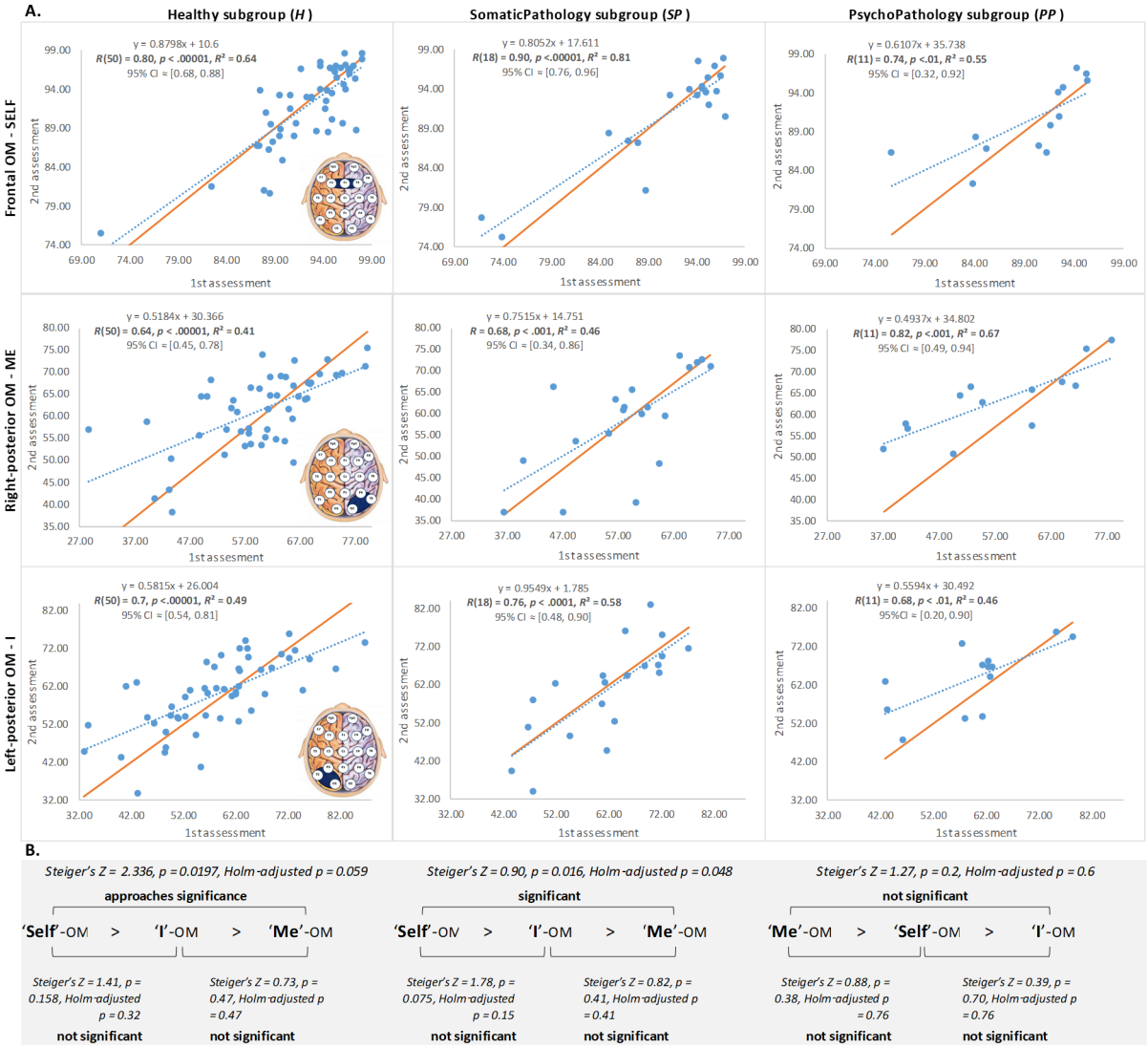

Fig. 2. Panel A: Pearson correlation scatter plots showing within-subject reproducibility of functional integrity within three brain's SRN operational modules (OMs) associated with the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate during the closed-eyes resting condition. For the schematic cortex maps, see the description in Fig. 1. Results are shown separately for the Healthy subgroup (*H; n* = 52), SomaticPathology subgroup (*SP; n* = 20), and PsychoPathology subgroup (*PP; n* = 13) during closed-eyes resting condition.

Panel B: Comparison of the magnitude of the reliability coefficients for the 'Self'-OM, 'Me'-OM, and 'I'-OM, evaluated using the Steiger's *Z*-test for dependent, non-overlapping correlations. Multiple comparisons were controlled using the Holm correction. See Fig. 1 for additional explanations and abbreviations.

These results indicate *moderate-to-high positive test–retest associations* of functional integrity within the three brain's SRN OMs associated with the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate across all subgroups.

Similar to the Entire sample (see Fig. 1B), the test–retest reliability of the 'Self'-OM was greater than that of the 'I'-OM, which in turn was greater than that of the 'Me'-OM in both the Healthy (*H*) and SomaticPathology (*SP*) subgroups: 'Self'-OM > 'I'-OM > 'Me'-OM (Fig. 2B). In the Healthy subgroup (*H*), the 'Self'-OM demonstrated *strong stability* ($R = 0.80$, ICC = 0.83, 95% CI: 0.73–0.90) with minimal bias (−0.52) and relatively narrow limits of agreement (LoA: −6.77 to +6.74). The 'I'-OM showed *moderate-to-strong reliability* ($R = 0.70$, ICC = 0.72, 95% CI: 0.56–0.83), with wider LoA (−14.61 to +17.91) and a bias of 1.65, while the 'Me'-OM showed *moderate stability* ($R = 0.64$, ICC = 0.66, 95% CI: 0.47–0.79; bias of 1.64; LoA: −14.17 to +17.44) (Fig. 2B, 3). In the SomaticPathology subgroup (*SP*), the 'Self'-OM again showed *excellent reliability* ($R = 0.90$, ICC = 0.91, 95% CI: 0.82–0.96) with negligible bias (−0.14) and narrow LoA (−6.23 to +5.95). Both the 'I'-OM ($R = 0.76$, ICC =

0.71, 95% CI: 0.46–0.87) and the 'Me'-OM (R = 0.68, ICC = 0.72, 95% CI: 0.47–0.87) showed *good relative stability*, with minimal bias ('I': -0.99; 'Me': 0.16), but wide LoA ('I': −17.20 to +15.21; 'Me': −17.39 to +17.71), indicating *limited absolute agreement* (Fig. 2B, 3).

In contrast, the hierarchical ordering of temporal stabilities among the three aspects of Selfhood was reordered in the PsychoPathology subgroup (*PP*), with the 'Me'-OM being the most reliable over time, followed by the 'Self'-OM, and then the 'I'-OM: 'Me'-OM > 'Self'-OM > 'I'-OM (Fig. 2B, 3). Indeed, the 'Me'-OM demonstrated *strong relative stability* (R = 0.82, ICC = 0.84, 95% CI: 0.57–0.95), although accompanied by a noticeable positive bias (+5.71) and wide LoA (−10.43 to +21.85). The 'Self-'OM showed *moderate-to-strong reliability* (R = 0.74, ICC = 0.76, 95% CI: 0.42–0.92), with minimal bias (+0.84) and relatively narrow LoA (−6.82 to +8.50). The 'I'-OM exhibited *moderate reliability* (R = 0.68, ICC = 0.70, 95% CI: 0.33–0.89), with a positive bias (+4.22) and wide LoA (−11.33 to +19.76) (Fig. 2B, 3). Across this subgroup, the wide confidence intervals reflect reduced precision due to the small sample size.

Although numerically test–retest reliabilities differed between the Selfhood aspects, most of these differences did not reach statistical significance, according to Steiger's Z-tests for dependent, non-overlapping correlations, most likely due to the relatively small subgroup sample sizes (Fig. 2B).

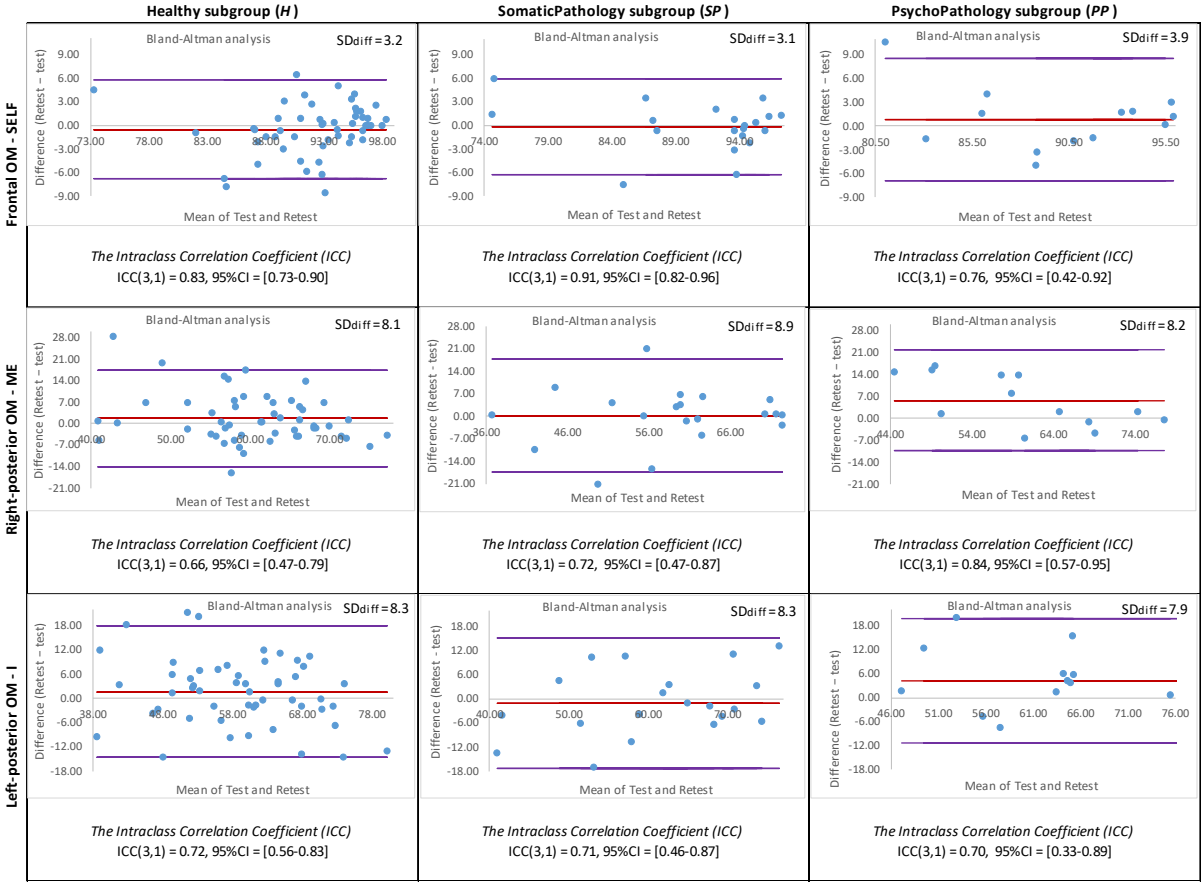

Fig. 3. Bland–Altman difference plots display the difference between the two measurements (2nd minus 1st) on the y-axis against their mean on the x-axis, illustrating agreement between repeated assessments. Each plot shows the mean difference (bias – red horizontal line), the 95% limits of agreement (LoA – purple horizontal lines), and the standard deviation of the differences (SD_{diff}). The Intraclass Correlation Coefficient (ICC) values correspond to ICC(3,1), a two-way mixed-effects model with absolute agreement, reported with 95% confidence intervals (CI). Results are shown separately for the Healthy subgroup (*H*, n = 52), SomaticPathology subgroup (*SP*, n = 20), and PsychoPathology subgroup (*PP*, n = 13) during closed-eyes resting condition. 'Self', 'Me', and 'I' = aspects of the Selfhood triumvirate.

3.2 The intraindividual test-retest reliability of the Selfhood triumvirate configuration (pattern)

To assess the intraindividual test-retest reliability of the Selfhood triumvirate configuration (the composite pattern reliability), the Pearson Correlation Coefficient (*R*) between the 3-variable vector ['Self'-OM_1, 'Me'-OM_1, 'I'-OM_1] at the 1st measurement and 3-variable vector ['Self'-OM_2, 'Me'-OM_2, 'I'-OM_2] at the 2nd measurement was calculated for each subject within the Entire sample (*E; n* = 85) and three subgroups: Healthy subgroup (*H; n* = 52), SomaticPathology subgroup (*SP; n* = 20), and PsychoPathology subgroup (*PP; n* = 13). Next, Pearson Correlations were Fisher *Z*-transformed, averaged, and then back-transformed to determine the group mean correlation.

The analysis demonstrated that the intraindividual test-retest reliability of the Selfhood triumvirate configuration (i.e., pattern of relative magnitudes across the three aspects) is *very high* for the Entire sample (*E*) (Table 4). The average Fisher *Z* is 2.724 (SD = 1.043), yielding a mean pattern correlation *R* mean = 0.991 with a 95% CI [0.987, 0.995], indicating *near-perfect retention* of the three-variable pattern between measurements. The one-sample test on Fisher *Z* gives $t = 24.08$, $df = 84$, and $p \approx 1.8\times10^{-39}$, indicating that the mean Fisher *Z* is highly significantly greater than zero and suggesting that the observed pattern similarity is not attributable to chance. The narrow CI and extremely small *p*-value reflect both very large effect size and adequate sample precision (Table 4A, *E*).

Table 4. Pattern reliability statistics (A) and descriptive statistics for the distribution of individual *R* values (B) for the Entire sample (*E*), the Healthy subgroup (*H*), the SomaticPathology subgroup (*SP*), and the PsychoPathology subgroup (*PP*).

Statistic	Entire sample (*E*)	*H* subgroup	*SP* subgroup	*PP* subgroup
(A) Pattern reliability statistics				
Mean *Z*	2.724	2.826	2.606	2.6
SD *Z*	1.043	1.114	0.828	1.047
SE *Z*	0.113	0.154	0.185	0.29
95% CI (*Z* scale)	[2.502, 2.946]	[2.523, 3.129]	[2.243, 2.969]	[2.031, 3.169]
Mean *R* (back-transformed)	0.991	0.993	0.989	0.989
95% CI (*R* scale)	[0.987, 0.995]	[0.987, 0.996]	[0.978, 0.995]	[0.966, 0.996]
t	24.08	18.292	14.07	8.957
p (two-tailed)	1.836E-39	4.698E-24	1.687E-11	6.35E-07
(B) Descriptive statistics for the distribution of individual *R* values				
N	85	52	20	13
Mean	0.973	0.978	0.962	0.971
Median	0.987	0.987	0.993	0.986
SD	0.044	0.033	0.066	0.037
Q1	0.97	0.973	0.967	0.96
Q3	0.996	0.995	0.997	0.988
IQR	0.026	0.022	0.03	0.027
Minimum	0.768	0.785	0.768	0.862
Maximum	1	1	0.999	1

Note: *R* values are back-transformed from Fisher's *Z*. *Z* = Fisher's *Z* values, SD = standard deviation, SE = standard error, *R* = Pearson correlation, CI = confidence interval, *t* = one-sample *t*-test, *p* = *p*-value (two-tailed), Q1 = first quartile (the 25th percentile), Q3 = third quartile (the 75th percentile), IQR = interquartile range (the difference between Q3 and Q1).

Overall, there is *very high similarity* in the distribution of individual within-subject pattern correlations. The mean *R* = 0.973 and median *R* = 0.987 indicate strong central tendency near 1. The IQR is narrow (0.026; Q1 = 0.970, Q3 = 0.996), and SD is small (0.044), indicating that most subjects cluster tightly around high correlations (Table 4B, *E*).

The analysis of the intra-subjects' stability of the Selfhood triumvirate configuration (pattern) for the Healthy (*H*), SomaticPathology (*SP*), and PsychoPathology (*PP*) subgroups revealed that in all subgroups, the average within-subject pattern's *test-retest reliability was extremely high* and statistically significant, with the narrow 95% confidence intervals (Table 4A, *H*, *SP*, *PP*), suggesting

high measurement precision. Most individuals had *very strong positive correlations* between repeated measurements (Table 4B, *H*, *SP*, *PP*). It should be noted, however, that in the *PP* subgroup, the standard error and CI were wider than in other subgroups, reflecting greater uncertainty due to the modest sample size (n = 13). The wider SD (1.047 on *Z*) relative to other subgroups indicates more between-case variability in *Z*. Nevertheless, after back-transformation, most *R* still cluster near 1 (Table 4A, *PP*). With n = 13, the estimate is reasonably precise, but less so than with larger samples.

To examine whether the Selfhood triumvirate pattern's reliability of individual correlations between the 1st and 2nd measurements (expressed as Fisher *Z*-transformed Pearson correlations) was influenced by the interval between assessments (duration) and subjects' age, a multiple linear regression analysis was conducted for the Entire sample (*E*).

The analysis demonstrated that the overall model was not significant, $F(2, 82) = 0.55$, $p = 0.58$, and explained only 1.3% of the variance in Fisher's *Z* ($R^2 = 0.01$, Adjusted $R^2 = –0.01$). Neither 'Duration' ($B = –0.01$, SE = 0.02, $p = 0.78$) nor 'Age' ($B = –0.01$, SE = 0.01, $p = 0.3$) were significant predictors (Table 5). These results suggest that the Selfhood triumvirate pattern's test–retest reliability did not vary systematically with interval length or participants' age.

Table 5. Multiple regression predicting Fisher's *Z* (pattern test–retest reliability) from 'Duration' and 'Age' for the Entire sample (*E*).

Predictor	*B*	SE *B*	*t*	*p*	Significance
Intercept	3.29	0.56	5.83	<.001	significant
Duration	–0.01	0.02	–0.28	0.777	not significant
Age	–0.01	0.01	–1.04	0.302	not significant

Model summary: Multiple $R = 0.11$, $R^2 = 0.01$, Adjusted $R^2 = –0.01$, $F(2, 82) = 0.55$, $p = 0.581$.
Note: n = 85. Dependent variable = Fisher's *Z* correlation between 1st and 2nd measurements. *B* = unstandardized regression coefficient, SE(*B*) = the standard error of the coefficient, *F* = ANOVA significance, *t* = t-test, Multiple *R* = the correlation coefficient between the observed values and the predicted values from the regression model, R^2 = the coefficient of determination, Adjusted R^2 = a corrected version of R^2 that accounts for the number of predictors in the model.

4. Discussion

Overall, the results of this study demonstrated highly statistically significant *moderate-to-high intraindividual test-retest reliability* (as indicated by Pearson correlations and ICCs) of the 'Self', 'Me, and 'I' aspects of the Selfhood triumvirate, as well as a *very high intraindividual test-retest reliability* (as reflected by Pearson correlations) for its overall functional configuration/pattern (defined as the relative proportion of expression of the 'Self', 'Me', and 'I' aspects) measured as functional integrity within the three brain's SRN OMs associated with the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate[5].

However, when taking together, the results of all reliability analyses performed (Pearson *R*, Bland–Altman, and ICC) reveal a *differentiation* in reliabilities among the three Selfhood-related OMs. Functional integrity within the 'Self'-OM – associated with witnessing agency – showed *strong test–retest reliability*, reflected in *high relative stability* (Pearson *R*, ICC) and *excellent absolute agreement*

[5] For evidence of a causal relationship between functional integrity (measured by qEEG operational synchrony) within the three brain's SRN OMs and the phenomenological expression of the three aspects of the Selfhood triumvirate, see Fingelkurts et al. (2020). Such causality is not unexpected, given converging evidence from several lines of research: (a) the structure of the brain's electromagnetic field, as measured through qEEG operational architectonics, is functionally isomorphic to the mind's phenomenological architecture, together forming complementary aspects of the same unified metastable continuum (Fingelkurts et al., 2009), (b) the space of EEG oscillatory parameters is systematically associated with the space of subjective characteristics of mental processes (Roik et al., 2014; Portnova, 2019), (c) mental states can be reliably identified from EEG oscillatory patterns (Ivanitsky, 1997, Ivanitsky et al., 2007), and (d) rhythmic brain stimulation has well-documented behavioral and cognitive consequences (Klimesch et al., 2003; Babiloni et al., 2007).

(Bland–Altman). This robustness suggests that the functional integrity of the 'Self'-OM reflects a highly stable and trait-like aspect of Selfhood, aligning with the theoretical view that witnessing agency represents the most stable and foundational aspect of the Selfhood triumvirate (Fingelkurts & Fingelkurts, 2025).

In contrast, both the 'I'-OM (reflective–narrative agency) and the 'Me'-OM (bodily representational–emotional agency) demonstrated acceptable relative stability (*moderate-to-strong* for 'I' and *moderate* for 'Me', as indicated by Pearson *R*, ICC) but showed wide Bland–Altman limits, indicating *limited absolute agreement*. These findings suggest that the more dynamic and context-dependent aspects of Selfhood – the reflective–narrative 'I' and the emotionally embodied 'Me'– exhibit greater intrasubject temporal variability.

Overall, these results collectively support a hierarchical organization of Selfhood, with the witnessing 'Self' showing the greatest intrasubject temporal stability, and the 'I' and 'Me' aspects reflecting progressively more variable, experience-dependent components of Selfhood.

Given the relatively long retest interval (approximately 3–30 months), these results suggest that the 'Self', 'Me, and 'I' aspects of the Selfhood triumvirate and their functional configuration/pattern are highly stable over time within individual, most likely reflecting *trait-like* properties (Fingelkurts et al., 2016a; see also Hanley et al., 2018; Lindström et al., 2023) to varying degrees. The 'Self' aspect shows a *strong trait-like profile*, demonstrated by high relative stability (Pearson *R* and ICC) and excellent absolute agreement (narrow Bland–Altman limits). In contrast, the 'I' and 'Me' aspects show *trait-like tendencies*, reflected in acceptable relative stability (Pearson *R* and ICC) and limited absolute agreement (wide Bland–Altman limits).

This suggests that the functional integrity within the three brain's SRN OMs reflects enduring (though to varying degrees) experiential dimensions of Selfhood, rather than random fluctuations in brain activity, and that it is personally specific.

Furthermore, the analyses did not find evidence that either the duration between assessments or participants' age moderated the intraindividual test–retest reliabilities of the 'Self', 'Me', and 'I' aspects or their configuration.

Moreover, the lack of evidence that test–retest reliabilities were affected by the presence of somatic or psychopathology indicates that the Selfhood triumvirate pattern and its constituent aspects remain individually stable over time across neuropsychophysiological conditions along the norm–pathology continuum. This implies that even when experiential Selfhood is altered in the context of neuropsychopathology (Fingelkurts & Fingelkurts, 2025), such alterations are themselves stable within individuals over time.

The robust intraindividual stability of the Selfhood triumvirate and its aspects (measured as functional integrity within the three SRN OMs) across age, time, and norm-pathology conditions raises the possibility that heritability may play a role in functional brain connectivity associated with the 'Self', 'Me, and 'I' aspects of the Selfhood triumvirate. Indeed, previous studies have reported that functional brain connectivity (measured as EEG coherence) is up to 81% heritable (Stassen et al., 1988; van Beijsterveldt and Boomsma, 1994; van Baal et al., 1998; van Beijsterveldt et al., 1998). However, it is important to note that test-retest reliability and heritability measures complementary but distant phenomena: in the context of this study, reliability reflects the stability of an individual's neurophenomenological features of the Selfhood triumvirate over time, whereas heritability reflects the proportion of variance across individuals explained by genetics.

4.1 Hierarchy of the intraindividual test-retest reliabilities of the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate

The ordering of the intraindividual test–retest reliabilities of the functional integrity within the 'Self'-OM, 'Me'-OM, and 'I'-OM provides insight into which aspect of the Selfhood triumvirate is the most/least stable in the entire sample and within each subgroup.

Indeed, despite the relatively high intraindividual stability of the functional integrity of all three 'Self'-OM, 'Me'-OM, and 'I'-OM, there were numerical differences between them (though these were not always statistically significant given the relatively small subgroup sample sizes). For the Entire sample (*E*), as well as the Healthy (*H*) and SomaticPathology (*SP*) subgroups, the ordering was 'Self'-

OM > 'I'-OM > 'Me'-OM. In contrast, in the PsychoPathology (*PP*) subgroup, the order shifted to 'Me'-OM > 'Self'-OM > 'I'-OM.

Although most differences in intraindividual test–retest reliabilities among the 'Self'-OM, 'Me'-OM, and 'I'-OM were not statistically significant, a cautious, tentative theory-driven interpretation of their numerical variation is still warranted, as observed orderings remain potentially informative. First, a non-significant result simply indicates insufficient evidence to reject the null hypothesis; it does not imply that the reliabilities are truly identical. Second, even when confidence intervals overlap, the point estimates still offer insight into the most plausible ordering of reliabilities. Third, small differences in reliability may still have practical implications for interpretation, prediction, or classification. Fourth, the ordering of reliabilities is consistent across multiple subgroups, increasing confidence that the pattern is not random. Fifth, ICCs and Bland–Altman generally align with the reliabilities ordering suggested by Pearson *R*, providing converging evidence across complementary reliability metrics. Therefore, considering numerical differences – while explicitly acknowledging their uncertainty – helps avoid prematurely concluding that all OMs function equivalently and supports more nuanced, theoretically grounded measurement interpretation.

It seems that in healthy conditions, the 'Self' (witnessing agency) aspect of the Selfhood triumvirate exhibits the strongest intraindividual temporal stability, suggesting a trait-like capacity to witness experience from a first-person perspective without being completely immersed in it (Josipovic, 2019; Metzinger, 2020). This witnessing capacity is always present and thus relatively context independent, that may explain its highest test–retest reliability. The 'I' (reflective/narrative agency) aspect of the Selfhood triumvirate has the next strong intraindividual temporal stability, indicating trait-like capacity to reflect, construct and maintain a coherent life story (autobiographical narrative) (Gallagher, 2023). This capacity is stable, but more vulnerable to reinterpretation and situational influences, rendering it somewhat less stable than the 'Self' aspect. The 'Me' (bodily representational–emotional agency) aspect of the Selfhood triumvirate, on the other hand, shows a moderate intraindividual temporal stability (the smallest of the three aspects), likely due to its dependence on fluctuating bodily and affective states (Damasio, 1999; Tsakiris, 2010).

Somatic pathology does not alter the ordering of the intraindividual test–retest reliabilities of the functional integrity within 'Self'-OM, 'Me'-OM, and 'I'-OM. This may be explained by the types of the somatic pathologies represented in the SomaticPathology subgroup (e.g., hypertension, migraine, hypothyroidism, rheumatoid arthritis, and low testosterone), which, especially when pharmacologically compensated, are largely subjectively 'invisible' and thus leaving the ordering of intraindividual test–retest reliabilities unaffected.

However, in the Psychopathology subgroup, this order changes: 'Me' > Self' > 'I', suggesting that in this population, bodily–emotional self-representations are more stable over time in comparison to witnessing or reflective aspects of Selfhood. In other words, in psychopathology, bodily representational–emotional agency ('Me') becomes temporally the most stable – often rigidly so – reflecting repetitive maladaptive bodily/emotional patterns with heightened somatic focus and affective dysregulation (van der Kolk, 1994; Craig, 2004; Paulus and Stein, 2010). The witnessing agency ('Self'), though always present, appears less consistent temporally in psychopathology (e.g., reduced metacognitive distance, difficulty maintaining perspective; Ouwersloot et al., 2020; Ciaunica et al., 2021). Therefore, it is relatively less stable than the bodily–emotional self. In contrast, the reflective/narrative agency ('I') is often incoherent or fragmented in psychopathology (e.g., identity diffusion, disrupted autobiographical memory; Gallagher and Cole, 2011; Jensen et al., 2020; Lysaker et al., 2022), making it temporally the least stable of the three aspects of Selfhood.

Taken together, the results support a hierarchical organization of Selfhood triumvirate. Importantly, the presence of acceptable reliability across all three OMs – even in clinical populations – indicates that the functional architecture of Selfhood remains measurable and meaningfully structured despite somatic or psychological pathology. Overall, these observations reinforce the view that Selfhood is not unitary construct but a multicomponent system with distinct temporal properties: a highly stable witnessing core, accompanied by more flexible narrative and embodied aspects that adapt to internal and external conditions. This differentiation has important implications for both theoretical models of self-consciousness and the use of these OMs in longitudinal or clinical research (for a comparison of the Selfhood Triumvirate Model with other contemporary models of the Self, see Supplement 1).

However, these interpretations remain speculative and should be treated with caution, as most of the observed differences in reliabilities among the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate were not statistically significant, likely due to the relatively small subgroup sample sizes. Future studies with larger subgroup sample sizes are needed to evaluate this interpretation more rigorously.

4.2 The intraindividual test-retest reliability of the Selfhood triumvirate configuration (pattern)

The very high intraindividual test-retest reliability of the functional configuration/pattern of the Selfhood triumvirate (measured as the relative proportion of the functional integrity within the three brain's SRN OMs associated with the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate) indicates that this neurophenomenological pattern of self-experience is temporally stable within individuals and not randomly organized. Accordingly, it can be regarded as a stable trait of Selfhood neurophenomenology.

Previously, it was demonstrated that the functional configuration/pattern of the Selfhood triumvirate is also remarkably consistent across individuals and most examined healthy and pathological conditions (Fingelkurts and Fingelkurts 2025).

Taken together, these observations suggest that the Selfhood triumvirate pattern represents a species-specific functional architecture through which the human brain organizes Selfhood.

5. Summary and concluding remarks

The reported relatively high intraindividual temporal stability of the 'Self', 'Me, and 'I' aspects of the Selfhood triumvirate, as well as of its functional configuration/pattern (measured as functional integrity within the three brain's SRN OMs associated with the 'Self', 'Me', and 'I' aspects of the Selfhood triumvirate) ensures that these aspects and the Selfhood triumvirate configuration/pattern represent enduring trait-like properties (though to varying degrees). This strengthens the theoretical premise that Selfhood is organized into distinct but interrelated phenomenological aspect (agencies), each contributing uniquely to the continuity of subjective experience. One may suggest that in healthy and somatic conditions, the 'Self'-OM reflects the most enduring, trait-like aspect of Selfhood, whereas the 'I'-OM captures a somewhat more situational aspect of Selfhood, and the 'Me'-OM emphasizes context-dependent bodily-emotional self-representations, which are naturally less stable over time. In psychopathology, however, bodily–emotional self-representations may become more rigid and maladaptive, making them more stable over time than witnessing or reflective aspects of Selfhood.

The results of this study provide an important advance for the neurophenomenology of Selfhood by empirically demonstrating that the experiential dimensions of 'Self', 'Me', and 'I' – and their integrated configuration – are not fleeting states but stable, trait-like features of individual neurocognitive architecture. The observation that this stability persists across time, age, and health–pathology conditions reinforces the view for treating Selfhood as a fundamental organizing principle of brain–mind dynamics. Linking reproducible EEG-based operational modules to enduring phenomenological features connects subjective experience with objective neural measures, strengthening the methodological foundation of neurophenomenology and opening up new avenues for research into how stable self-related traits shape consciousness, identity, and psychopathology. The idea that psychopathology may reorganize the hierarchy of reliabilities emphasizes the relevance of the neurophenomenological approach in understanding how subjective experience is anchored in brain dynamics. By revealing which aspects of Selfhood are most stable or vulnerable across conditions, this work advances the field toward a more nuanced account of how the lived experience of Selfhood is instantiated, maintained, and disrupted in the human brain.

The observed intraindividual temporal stability also provides a solid basis for meaningful cross-group comparisons, allowing differences between healthy, somatic, and psychopathological populations to be interpreted as genuine variations in the aspects or organization of the Selfhood triumvirate. Additionally, these reliabilities enable confident tracking of changes in the Selfhood triumvirate's aspects or its configuration over time – whether arising from therapeutic intervention,

meditative practice, or illness progression. Moreover, deviations from the established stability range may serve as markers of altered states of Selfhood (ASoS; Fingelkurts et al., 2022), vulnerability, or neuropsychopathology (Fingelkurts & Fingelkurts, 2025).

Taken together, the results indicate that while all three OMs ('Self', 'Me', and 'I') are appropriate for group-level comparisons or for ranking individuals, only the 'Self'-OM provides sufficient precision to detect subtle within-person changes. This finding aligns with earlier observations that the 'Self' (the witnessing observer) aspect holds a special importance within the Selfhood triumvirate (Fingelkurts & Fingelkurts, 2025): empirical evidence shows that even marked reductions (or complete loss) of embodiment and geometrical perspectivalness ('Me' aspect) or narrative and conceptual self-reflection ('I' aspect) do not eliminate the most fundamental phenomenal sense of being someone: the witnessing observer ('Self' aspect). In contrast, a substantially diminished or absent witnessing capacity is associated with a collapse of intentional content, phenomenal spatiotemporal self-location, and phenomenal first-person perspective (Fingelkurts & Fingelkurts, 2025). Thus, proper functional integrity and temporal stability of the 'Self' aspect appear to be the necessary and sufficient conditions for sustaining the basic experiential feature of Selfhood – namely, experiencing oneself as a distinct epistemic center within the phenomenal world one witnesses and observes (Fingelkurts et al., 2020).

Finally, the relatively high within-subject test-retest reliabilities of the 'Self', 'Me, and 'I' aspects of the Selfhood triumvirate, as well as its functional configuration/pattern, across a wide range of ages, both sexes, and health-pathology conditions, suggest their generalizability.

6. Limitations and future research

While this study provides novel data on the within-subject test–retest reliabilities of the Selfhood triumvirate, several limitations should be acknowledged and addressed in future research.

First, the relatively small subgroup sample sizes may have an impact on Bland–Altman limits of agreement (LoA) (Bland & Altman, 1986, Bland, 1999; Giavarina, 2015) and on statistical significance assessments (Steiger's *Z*-test). Therefore, future study with larger sample sizes is encouraged to strengthen the robustness of these findings.

Second, subjects in the somatic and psychopathology subgroups self-reported their symptoms or diagnoses, and no formal assessment of symptoms or diagnoses was performed. Future research should incorporate standardized diagnostic evaluations to ensure greater accuracy and reliability of subgroup classification.

Third, medication type and dosage were documented based on responses to an extensive questionnaire administered before each session. Because differences in medication across sessions may confound test–retest stability, future studies should consider alternative methods to improve the accuracy of this information, such as inspecting current medication packages or obtaining a pharmacy printout at each study visit.

Fourth, since the reliability of a trait sets an upper limit to its heritability (Falconer, 1981), the reliabilities reported here can be considered as an estimate of upper limit to their heritability. However, the current study design (restricted to genetically unrelated individuals) did not allow assessment of the lower limit of the test-retest reliability. Indeed, monozygotic-twins (MZ) correlations can be regarded as an indication of the lower bound of the test-retest reliability, because the MZ correlation cannot exceed the correlation of the same subject measured on two occasions (van Beijsterveldt and van Baal, 2002). Therefore, future study employing both monozygotic and dizygotic twins would be valuable for determining the lower limit of the test-retest reliability and disentangling the genetic and environmental contributions to the stability of Selfhood triumvirate pattern and its aspects.

Fifth, although generalizability of the results was suggested, the present study cannot establish their universality, as the sample was drawn exclusively from a single culture (Finnish). Future research should extend these investigations to diverse cultural populations to determine the cross-cultural validity of the stability of the Selfhood triumvirate pattern and its aspects.

CRediT authorship contribution statement

Alexander A. Fingelkurts: Conceptualization, Methodology, Investigation, Resources, Data collection, Data curation, Formal analysis, Writing – Original Draft, Visualization. **Andrew A. Fingelkurts**: Conceptualization, Methodology, Investigation, Resources, Formal analysis, Writing – Review & Editing, Visualization.

Declaration of competing interest

An.A.F. and Al.A.F. are scientific co-founders of BM-Science Centre that focuses on fundamental and applied neuroscience research, the development of qEEG-based brain analysis methods, and the creation of well-being applications. Both, An.A.F. and Al.A.F. hold senior researcher positions at BM-Science.

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Data availability

Data used to generate the findings of this study are not available (subject to participant consent).

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Supplement 1

Comparison of the Selfhood Triumvirate Model with other contemporary models of Self

The Selfhood Triumvirate (ST) Model (Fingelkurts et al., 2020, 2023)

The Selfhood Triumvirate (ST) model (Fingelkurts et al., 2020, 2023) provides a neurophysiologically explicit and phenomenologically grounded account of self-consciousness. In this model, Selfhood is constituted by three sets of functionally integrated cortical areas, each forming a stable, task-independent spatiotemporal pattern known as an operational module (OM). These OMs are defined by exceptionally high levels of qEEG operational synchrony, reflecting robust and recurrent patterns of large-scale neuronal cooperation. Importantly, a causal relationship between the functional integrity within these three OMs and the expression of corresponding phenomenological aspects of Selfhood has been demonstrated (Fingelkurts et al, 2020). According to this, each of three OMs corresponds to a distinct aspect of self-consciousness: the *anterior SRN module* is associated with '*Self*' – the witnessing

or observational agency that enables the capacity to experience oneself as the center of the phenomenal world; the *right posterior SRN module* is associated with '*Me*' – the bodily representational–emotional agency grounding the lived body, affective states, and embodied self-presence; and the *left posterior SRN module* is associated with '*I*' – the reflective/narrative agency supporting autobiographical continuity, self-reflection, and temporally extended identity. Importantly, this tripartite structure is not merely conceptual but is explicitly linked to stable neurodynamic configurations, making ST model one of the few models that directly maps phenomenological distinctions onto spatiotemporal patterns of brain activity.

ST and Minimal-Narrative Self (Gallagher, 2000; Davey & Harrison, 2022)

The minimal–narrative distinction offers a valuable phenomenological and cognitive two-factor framework rather than a neurodynamic triadic model. At the phenomenological level, it overlaps with ST only partially. Gallagher's "minimal self" aligns reasonably well with the 'Me'-OM in the ST model, particularly regarding bodily ownership and affective grounding. His "narrative self" corresponds closely to the 'I'-OM in the ST model, which encompasses autobiographical and reflective aspects. However, the 'Self'-OM in the ST framework (representing the witnessing, observational, or perspectival stance) has no clear counterpart in Gallagher's two-factor model. Although the minimal self includes pre-reflective first-person givenness, it does not explicitly differentiate between embodied mineness and a distinct witnessing perspective. Both witnessing agency and embodiment are folded into the Gallagher's "minimal self," even though these dimensions can dissociate in certain pathologies or altered states (Fingelkurts et al., 2022, 2023). The ST model adds conceptual clarity by introducing this witnessing dimension (which is not explicitly theorized within the minimal–narrative account) as a separate operational module, allowing finer differentiation among experiential components and their neurodynamic correlates. In this sense, Gallagher's model remains phenomenologically foundational but somewhat under-differentiated: it misses the value of separating witnessing from embodiment and also linking all 'selves' to brain's self-referential network (SRN) subnets, as well state dynamics.

ST and Three-Layer Topography of Self (Northoff group: Qin et al., 2020)

Qin et al. (2020), along with the broader work of Northoff's group, propose a three-level model of self-processing that progresses from interoceptive to exteroceptive to mental self-related activity. This framework shares some common ground with the ST model but aligns with it only partially. In the ST, both the interoceptive/bodily and exteroceptive layers described by Qin et al. fall within the broader 'Me'-OM, which integrates bodily, affective, and representational dimensions of embodied Selfhood. The mental/reflective layer in Qin et al.'s model corresponds well to the 'I'-OM in the ST model, which captures autobiographical, conceptual, and reflective aspects of self-experience. However, similar to Gallagher's minimal–narrative model, Qin et al.'s model does not include an explicit counterpart to the 'Self'-OM, the witnessing or observational stance, that plays a central role in the ST model. In this sense, Qin et al.'s model remains somewhat phenomenologically coarse compared to the triadic structure of the ST framework, which aims to separate embodied, reflective, and witnessing aspects of Selfhood with greater precision.

Resting-State Dynamics, Intrinsic Timescales, and Power-Law Exponents (Northoff & Huang, 2017; Wolff et al., 2018)

The intrinsic neural timescales, power-law exponents (PLE), and slow cortical dynamics described by Northoff & Huang (2017) operate at a different level of analysis, focusing on the broad temporo-spatial organization of brain activity that supports consciousness in general. While resting-state spontaneous activity is indeed closely linked to self-related processing (Wolff et al., 2018), these measures do not distinguish among the specific aspects of Selfhood that constitute the core of the ST model. In this sense, they offer a valuable and complementary perspective, but one that is not directly comparable to the triadic differentiation of 'Self', 'Me', and 'I' proposed in the ST framework.

Self-Prioritization Effects (Sui et al. 2012)

The self-prioritization literature focuses on behavioural and cognitive biases that favour self-related stimuli. While these effects are robust, they do not differentiate among the witnessing, embodied, and narrative aspects of Selfhood that the ST model separates into distinct operational modules. As a result, self-prioritization findings offer important insights into self-related processing but do not map directly onto the stable spatiotemporal patterns (OMs) that define the ST framework.

Predictive Coding Models of Self (Friston, 2012; Seth, 2013)

Predictive coding (PC) conceptualizes the self as a hierarchy of self-related priors (a multilayered generative model) rather than as a multi-component experiential construct. Although one may speculate about theoretical connections, fundamental differences remain. As an abstract computational model, PC does not specify the spatiotemporal neural patterns that would correspond to its proposed priors, whereas ST does not adopt a Bayesian formulation. Nevertheless, there is a plausible point of theoretical convergence in relation to the 'Me'-OM, which underlies the "material me" and supports basic, minimal, and pre-reflective aspects of embodiment. These features resonate with predictive-coding accounts of bodily selfhood and interoceptive inference (Friston, 2012; Seth, 2013). In this way, PC offers a complementary perspective on certain embodied components of Selfhood, even if the two frameworks operate at different conceptual and methodological levels.

Summary

Overall, the ST model is unique in offering a finely differentiated decomposition of Selfhood that (a) identifies three fundamental and primary aspects of Selfhood (see Introduction in the main text for detailed arguments and references), (b) grounds these aspects in causal relationships between the functional integrity of specific SRN subnets and the expression of corresponding experiential aspects of Selfhood, and (b) distinguishes between the geometrical ('Me'-OM) and phenomenal ('Self'-OM) first-person perspectives, and also between emotional-experiential ('Me'-OM) and narrative ('I'-OM) autobiography aspects.

Unlike other conceptualizations, ST model explicitly employs neurophenomenological approach by linking phenomenological distinctions ('Self', 'Me', 'I'), derived from first-person experience, with measurable neurophysiological subnets of the SRN identified through qEEG operational synchrony. The model also targets specific SRN subnets rather than the entire DMN, thereby improving anatomical and functional precision, whereas many other models treat the DMN as a largely unitary self-network. Furthermore, the ST model provides empirical testability for each aspect of Selfhood by measuring qEEG-based functional brain modules. In contrast, many self-models remain primarily conceptual (e.g., Gallagher), computational (e.g., Friston and Seth), or not directly testable at the level of distinct self-components (e.g., predictive-coding models). Others rely on fMRI (e.g., Northoff), which provides only an indirect measure of brain activity and lacks the temporal resolution needed to capture rapid self-related dynamics.

A further strength of the ST framework that distinguishes it from other models is its application across a wide range of distinct modes of (un)consciousness, including healthy, altered, and pathological conditions or states (Fingelkurts et al., 2023, Fingelkurts & Fingelkurts, 2025). This breadth allows systematic evaluation of both the variability of each Selfhood aspect and the relative stability of the Self–Me–I proportional configuration. These findings led to the formulation of *Selfhood metastability* (Fingelkurts & Fingelkurts, 2025), in which two tendencies – variability and stability – jointly constitute a metastable regime of Selfhood functioning. In this regime, variability of Selfhood aspects coexists with stability of Selfhood configuration (proportional relation between 'Self', 'Me', and 'I' aspects), forming a complementary rather than conflicting pair. In contrast, Gallagher's model is static (minimal vs. narrative), predictive-coding models treat self as a single hierarchical generative model, and Northoff's work emphasizes resting-state stability rather than dynamic triadic interactions. Finally, the ST model offers a clinically actionable framework for understanding self-disturbances by accounting for selective impairments of the 'Self,' 'Me,' and 'I' aspects observed in psychiatric and neurological

disorders (Fingelkurts et al., 2023; Fingelkurts & Fingelkurts, 2025). Other models rarely map specific disorders onto distinct self-components; and predictive-coding models typically explain pathology in terms of precision-weighting errors rather than neurophenomenological component-specific breakdowns or disruptions.

In conclusion, the ST model can be viewed as a potential meta-framework capable of bringing together diverse theories within a triadic, neurophenomenological structure by integrating insights from phenomenology, resting-state neuroscience, predictive processing, self-prioritization research, and hierarchical models of the Self.

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Supplement 2

Demographics and dataset details

		Random ID	Age (years)	Gender	Hand	Diagnosis	Duration of condition and/or medication	Medication		Assessments interval duration (months)	EEG data accepted (post-rejection) (minutes)		Functional integrity difference (2nd–1st)		
								1st assessment	2nd assessment		1st assessment	2nd assessment	Self	Me	I
E	H	2	52.5	F	R					7.40	5	5	-0.40	-3.20	7.00
E	H	3	62.9	F	R					4.53	5	5	-0.60	0.40	-9.20
E	H	4	59.8	F	R					4.57	6	3	-6.80	-6.40	-5.00
E	H	5	39.4	F	both					7.47	3	4	3.80	-1.50	3.60
E	H	6	62.2	F	L					3.30	4	4	-4.90	0.80	8.90
E	H	7	67.95	M	R					3.30	4	3	-7.80	0.20	-2.70
E	H	11	56.21	F	R					3.23	3	4	-8.60	-2.00	3.20
E	H	13	65.15	F	R					3.23	4	4	3.00	19.60	6.90
E	H	14	61.66	F	R					3.07	6	5	-0.70	-2.30	-3.70
E	H	18	29.54	M	R					8.63	3	3	-4.60	28.30	11.90
E	H	21	41.33	F	R					8.63	5	4	-1.40	6.90	11.97
E	H	22	42.57	F	R					8.63	4	3	-1.80	-4.00	5.23
E	H	23	40.69	F	R					8.67	3	4	4.50	17.50	18.10
E	H	25	41.4	M	R					8.67	5	3	-1.00	7.40	1.30
E	H	26	28.02	M	L					14.13	3	4	-2.10	5.50	3.50
E	H	27	44.81	M	R					2.83	5	3	0.90	8.80	21.20
E	H	30	52.53	F	R					3.03	3	3	-3.00	-0.60	-1.70
E	H	31	61.44	F	L					3.00	4	4	5.00	13.80	9.20
E	H	32	58.21	F	R					3.03	4	4	0.90	6.80	-9.40
E	H	33	50.21	M	R					3.03	4	3	-0.50	-5.40	3.40
E	H	34	41.26	M	R					13.47	3	4	-6.30	-5.40	-1.60
E	H	35	43.4	F	R					22.17	3	4	-4.70	-4.20	3.80
E	H	36	45.81	M	R					7.43	3	3	-1.50	-7.70	-13.70
E	H	37	34	M	R					14.07	3	4	-1.50	-4.10	-6.80
E	H	39	39.61	M	R					5.37	3	3	2.70	-4.30	-14.60
E	H	40	40.53	M	R					5.33	4	3	3.30	-1.00	11.20
E	H	41	50.94	M	R					5.33	5	4	0.10	-3.80	-13.10
E	H	45	54.62	F	R					3.50	4	3	-5.90	-16.20	-7.60
E	H	48	38.9	F	R					3.57	3	4	-0.70	0.50	8.00
E	H	49	44.86	F	R					6.53	3	3	-1.40	-1.50	-2.00
E	H	51	32.74	M	R					6.77	5	4	-2.60	6.80	-0.40
E	H	52	46.5	F	R					6.80	3	4	1.00	-3.60	2.60
E	H	53	44.81	M	R					6.53	4	3	1.10	-7.40	-1.90
E	H	54	54.6	M	R					10.10	3	3	0.70	0.30	-5.40
E	H	55	39.89	F	R					5.87	3	3	-0.10	-4.20	-2.70
E	H	56	46.13	M	R					5.63	3	3	2.10	1.00	3.70
E	H	58	38.9	F	R					5.83	3	3	1.70	15.40	1.60
E	H	59	58	M	R					5.83	3	4	3.90	6.80	9.30
E	H	61	46.03	F	R					16.80	5	3	-2.20	14.50	4.80
E	H	62	45.43	M	R					17.77	3	3	-1.90	1.90	7.80
E	H	64	47.12	M	L					7.27	3	3	0.70	1.20	-9.80
E	H	65	45	M	R					7.27	3	3	0.00	3.20	-2.10
E	H	66	42.97	F	R					5.70	4	3	2.50	7.30	5.40
E	H	67	43.32	M	R					5.83	4	3	6.40	3.30	1.70
E	H	68	37	F	R					5.83	4	3	0.90	4.60	10.30
E	H	69	45.27	F	R					5.83	3	3	1.70	8.60	20.10
E	H	70	50.7	M	R					5.83	4	4	0.40	-4.90	-14.50
E	H	72	44.81	M	R					5.87	3	3	-0.10	-0.80	-0.50
E	H	76	51	F	R					17.50	5	4	3.20	-5.50	5.20
E	H	79	75.1	F	R					5.57	3	3	0.30	-9.30	1.30
E	H	80	49.2	F	R					31.03	4	3	-0.10	-9.70	-0.10
E	H	81	46.7	F	R					9.77	5	6	0.20	5.40	5.90
E	SP	12	70.58	F	R	Hypertension, insomnia	6 years	Amlodipine 5mg 1x day	NO change	3.30	3	3	0.60	-1.40	-3.80
E	SP	15	75.24	M	R	Hypertension	3 years	Orisantin 200/25mg 2x day, Losarstad 100mg 1x day, Atorvastatin 40mg 1x day	NO change	5.43	5	3	1.40	2.90	-6.50
E	SP	16	74.31	F	R	Hypertension	15 years	Losartan 50mg 2x day , Simvastatin 20mg 1x day	Siblin (soucre of fiber)	6.53	5	6	5.90	4.20	-10.70
E	SP	17	55.11	F	R	Migraine*, hypertension**, osteoarthritis***	*many years, **8 years, ***25 years	Exforge 5/80mg 1x day, Bisoprolol 5mg 1x day, Etoricoxib Krka 60mg 1x day, Panadol 1g 1x day, Maxalt Rapitab 10mg as needed	The same + Somac (selective proton pump inhibitor) 40mg 3x week	8.67	3	3	-7.50	0.50	-4.10
E	SP	28	58.02	F	R	Hypothiroidism	many years	Thyroxine15-25µg/day 1x day	NO change	9.37	5	5	2.00	-10.20	-13.60
E	SP	38	64.48	F	R	Migraine, hypertension	4.5 years	Clopidogrel 75mg 1x day, Atorvastatin 40mg 1x day	NO change	5.37	4	4	-6.30	0.90	3.10
E	SP	42	62.81	M	R	Hypertension	4 years	Antihypertensive (not specified)	Probably NO change	5.37	4	3	0.80	6.10	-4.30
E	SP	43	58.59	M	R	Hypertension	5 years	Diovan Combo 160/12.5mg 1x day, Atorvastatin 40mg 1x day, Primaspan 100mg 1x day	NO change	5.37	5	3	-0.40	6.90	11.00
E	SP	44	59.7	F	R	Hypertension	20 years	Diovan Combo 80mg 1x day	NO change	5.40	5	3	1.20	5.30	1.40
E	SP	46	33.5	F	R	Migraine	19 years	Mirtazapine 7.5mg 1x day	NO change	3.43	4	3	3.50	0.00	-1.00
E	SP	47	76.5	F	R	Hypothyroidism	25 years	Thyroxin 100/25µg 1x day, Ezetimibe 10mg 1x day	NO change	3.30	4	3	-3.20	3.50	10.30
E	SP	50	45.78	M	R	Migraine	3.5 years			6.57	5	3	3.50	-16.20	-6.10
E	SP	63	43.34	F	R	Hypothyroidism	5 years	Thyroxin 100µg 1x day	NO change	10.33	3	3	-0.70	-2.70	-5.70
E	SP	71	58.13	F	R	Hypertension, osteoarthritis	6 years	Atacand 16mg 1x day	NO change	5.83	4	4	-0.70	20.90	10.60
E	SP	73	47.51	F	R	Hypothyroidism	8 years	Thyroxin 100µg 1x day	NO change	6.23	3	3	0.40	-21.00	-17.00
E	SP	74	69.7	F	R	Hypertension	10 years	Bisoprolol 5mg 1x day	NO change	26.20	5	5	-0.10	0.50	-2.70
E	SP	75	50.86	F	R	Hypertension	4 years	Cardace 5mg 2x day, Amlodipine Orion 5mg 2x day	NO change	26.80	4	3	1.10	0.70	13.20
E	SP	82	74.9	F	R	Hypertension, Hypothyroidism	5 years	Asasantin Retard 25mg 1x day, Emcocncor 2.5mg 1x day, Cardace 5mg 2x day, Thyroxin 25µg 1x day	NO change	9.10	5	3	-1.30	-6.00	-1.90
E	SP	83	70.3	F	R	Hypothyroidism	12 years			13.60	4	3	-0.70	9.00	4.40
E	SP	84	45.9	M	R	Low testosterone	6 years	Tostran gel 2% 50mg 1x day		3.30	4	3	-2.30	-0.80	3.50
E	PP	1	40.4	F	R	Anxiety, depression	2 years			2.87	6	6	-1.60	-0.50	0.70
E	PP	8	67.06	F	R	Anxiety	3.5 years			3.23	4	3	-3.30	2.10	-7.60
E	PP	9	74.93	F	R	Depression	25 years	Optipar 20mg 1x day	NO change	3.07	5	5	3.00	-4.70	5.80
E	PP	10	47.96	F	R	Anxiety	9 years			3.40	5	3	1.20	-6.30	3.60
E	PP	19	42.8	F	R	Burnout, insomnia	1.5 year			8.63	3	3	4.10	1.90	20.00
E	PP	20	45.53	F	R	Depression	12 years	Escitalopram 10mg 1x day	NO change	8.63	4	5	1.60	13.80	15.30
E	PP	24	47.1	F	R	Anxiety*, fatigue**	*8 years, **1 year			8.70	4	3	10.60	14.70	-4.60
E	PP	29	38.62	M	R	Anxiety, ADHD	3 years			3.90	4	3.3	-1.90	7.90	1.40
E	PP	57	49.01	F	R	Depression	2.5 years	Escitalopram 10mg 1x day	NO change	5.83	5	5	1.80	13.60	5.90
E	PP	60	45.45	F	R	Fatigue	many years	Ketipinor 25mg 1x day	NO change	5.37	3	3	-1.50	15.30	12.40
E	PP	77	45.95	F	R	Burnout	1.5 year			17.03	4	5	0.20	-1.40	4.20
E	PP	78	66.4	F	R	Depressive mood	1 year			3.30	4	4	-5.00	16.60	-3.90
E	PP	85	40.67	F	R	Anxiety disorder, depersonalization symptoms	1 year	Venlafaxine 75mg 1x day, Oxamin 12mg 1x day, Ketipinor 50mg 1x day	NO change	27.77	5	4	1.70	1.20	1.60

E: entire study sample (N=85), H: Healthy subgroup (N=52), SP: SomaticPathology subgroup (N=20), PP: PsychoPathology subgroup (N=13). Randomly assigned IDs were given to participants (different from the IDs in the database); F: female; M: male; R: right hand; L: left hand.