Asymmetry and Reciprocity in Hyperscanning Psychotherapy

Authors

Nicolás Hinrichs[1,2*], Irene Senatore[3], Nara Figueiredo[4], Elena Cuffari[5], Alejandro Fábregas-Tejeda[6]

Affiliations

1 Research Group Cognition and Plasticity, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany
2 Embodied Cognitive Science Unit, Okinawa Institute of Science and Technology, Okinawa, Japan
3 Berlin School of Mind and Brain, Humboldt Universität zu Berlin, Berlin, Germany
4 Department of Philosophy, Federal University of Santa Maria, Santa Maria, Brazil
5 Department of Psychology, Franklin & Marshall College, Lancaster, USA
6 Centre for Logic and Philosophy of Science, Institute of Philosophy, KU Leuven, Leuven, Belgium
* Corresponding author: hinrichsn@cbs.mpg.de nicolas.hinrichs@oist.jp

Abstract

Hyperscanning has been increasingly used to quantify the quality of social relationships by tracking the neural correlates of interpersonal interactions. This paper critically examines the use of hyperscanning to track the neural correlates of psychotherapeutic change, e.g., the patient-therapist relationship. First, we motivate our project by diagnosing a lack of complex models in this domain and, looking for the causes of this issue, we highlight the epistemic blindspots of current methodologies that prioritize neural synchrony as a marker of therapeutic success. Drawing on empirical studies and theoretical frameworks, we identify an asymmetry between the neural and behavioral conceptual toolkits, with the latter remaining underdeveloped. We argue that this imbalance stems from two key issues: the underdetermined qualitative interpretation of brain data and the neglect of strong reciprocity in neuroscientific second-person paradigms. In light of our critical analysis, we suggest that further research should address the complexity of reciprocal, dynamic interactions in therapeutic contexts. Specifically, drawing on enactivism, we highlight that the autonomy of interactions is one of the factors that undermines the synchrony paradigm. This approach emphasizes the co-construction of meaning and shared experiences through embodied, reciprocal interactions, offering a more integrative understanding of therapeutic change that accounts for neural correlates of the emergent and dynamic nature of social cognition.

Keywords

Hyperscanning, Neural Synchrony, Intersubjective Alliance, Philosophy of Neuroscience, Psychotherapy, Radical Enactivism, Second-person Neuroscience

1 - Introduction

The relationship between neural dynamics and interpersonal behavioral synchronization has been increasingly explored, ever since the idea of simultaneously recording several subjects' haemodynamic or neuroelectric activity involved in social interactions was proposed (Montague, 2002; Balconi and Molteni, 2015). Scientists working in disciplines such as developmental psychology (Nadel, 1999), social neuroscience (Dumas et al., 2010), cognitive neuroscience (Stephens et al., 2010), and educational neuroscience (Bevilacqua et al., 2019) have considered the central nervous system as a distributed network, further incorporating this perspective in behavioral hyperscanning paradigms. Inter-brain synchronization is inspired by the understanding of intra-brain synchronization, wherein coordinated neural oscillations allow for efficient communication across different brain areas. Similarly, inter-brain synchronization is thought to reflect the neural coupling between individuals during social interaction, allowing for shared understanding and coordinated behavior (Varela et al., 2001). To this day, there seems to be a consensus on the importance of investigating interactive phenomena on the basis of synchrony (Dumas, 2011; Schilbach et al., 2013; Konvalinka & Roepstorff, 2012). Hyperscanning holds appeal for researchers who study joint action, i.e., the coordination of actions across multiple individuals towards a shared goal (Sebanz et al., 2006), because it can address research questions regarding neural processes that happen not only 'within' individual group members (i.e., intra-brain processes) but also 'across' group members (i.e., inter-brain processes) and, in recent years, it has expanded from cognitive science and social neuroscience into psychotherapeutic research, aiming to track how neural synchrony between a therapist and a patient may serve as an indicator of therapeutic success.

This paper seeks to critically assess the hypothesis according to which neural synchrony predicts more successful social interactions. First, we identify two epistemic blindspots in the general hyperscanning literature: (i) asymmetry between behavioral and neural toolkits and (ii) neglect of strong reciprocity. Second, the paper zooms in on hyperscanning paradigms used to evaluate the quality of psychotherapeutic relationships. Here, it is hypothesized that repeated brain synchrony may correspond to a stronger therapeutic alliance and better mental health outcomes. We scrutinize such a hypothesis, by examining how the related blindspots are specifically at play in the context of hyperscanning psychotherapy.

In Section 2, we introduce the method of hyperscanning, exploring how it has been applied in social neuroscience and specifically in patient-therapist relation research. We review empirical studies that support the relationship between inter-brain synchrony and therapeutic alliance.

In Section 3, we argue that the prioritization of neural synchrony when analyzing the data that has been collected stems from a bias toward symmetry in brain patterns, which is assumed to be necessary for coordinated social behavior to emerge and, moreover, regarded as sufficient to yield a biologically realistic model of it. We argue that this neglects the importance of asymmetry, divergence, and realignment in social interactions, especially in therapeutic contexts where patient and therapist may experience moments of tension or disconnection that are of paramount importance for growth and change. In particular, we discuss: (1) the imbalance between neural and behavioral models and (2) the neglect of strong reciprocity in second-person neuroscience paradigms. Relating brain activity to psychological interpretations of behavior is an ever-standing problem in cognitive neuroscience research (see Boone & Piccinini, 2016; Egan, 2017; Gessell et al. 2021; Shapiro, 2017). Here, we aim to describe its specific instantiation and implications in hyperscanning research during psychotherapy sessions and introduce concepts such as meaning co-construction and dynamic interaction. On the one hand, the focus on synchronicity in retrieved neural patterns often leads to the underappreciation of other marks of behavioral and experiential dynamics that are equally crucial for understanding therapeutic change. On the other hand, the assumption that neural synchrony alone ensures successful interaction neglects the co-constructed and emergent nature of therapeutic relationships, which involve both alignment and misalignment.

Section 4 articulates the consequences of neglecting strong reciprocity in hyperscanning methodologies. We propose a specific characterization of reciprocity which, we argue, should be taken into account by future hyperscanning paradigms. Finally, we advocate for a shift toward enactive neuropsychology, a framework that highlights the role of embodied, reciprocal interaction in the co-construction of meaning. This section proposes that future research should integrate both neural and behavioral data to foster a more comprehensive understanding of therapeutic change, moving beyond neural synchrony to embrace the complexities of real-world interactions.

2 - Hyperscanning

Hyperscanning entails simultaneously scanning the brains of two or more participants during naturalistic interactions; techniques like EEG, fNIRS, and fMRI measure inter-brain coupling (IBC)—similarities in neural patterns between participants. (Dikker et al., 2017; Liu et al., 2018). Common measures include phase wavelet coherence (i.e., the alignment of wave spectrograms across fNIRS channels) and signal correlation (i.e., temporal co-variation of brain regions). EEG offers high temporal resolution, fNIRS captures hemodynamic responses, and fMRI provides high spatial resolution, though it limits interaction naturalness (Jiang et al., 2015; Pan et al., 2022; Liu et al., 2018; Cui et al., 2020). Neural data can be complemented by eye-tracking (e.g., gaze patterns) and video recordings (e.g., facial expressions, gestures, and body language), linking neural activity to social behavior. Recent technological advancements, such as the development of open-source Python libraries like HyPyP (Barraza et al., 2019), simply EEG-based hyperscanning and have enabled the implementation advanced statistical analysis and visualization of inter-brain connectivity using analysis such as phase coherence, wavelet coherence, and cross correlation (Hove & Risen, 2009).

The combination of these tools has opened up new avenues for investigating social interactions in naturalistic settings, including psychotherapy. Recently, hyperscanning has been applied in therapy session settings, where both a therapist and a patient are scanned during their interactions (Costa-Cordella et al., 2024). This approach explores the neural dynamics underlying the therapeutic process, with the hypothesis that inter-brain coupling could serve as a biomarker for therapeutic alliance and predict treatment outcomes. Video recordings and eye-tracking in such settings further allow researchers to examine how neural synchrony relates to gestures, facial expressions, and other non-verbal cues during therapy. The rationale behind these studies stems from the fact that inter-brain coupling has generally been shown to predict the success of social interactions in other studies (Fishburn et al. 2018). Building on this evidence, the hypothesis tested in hyperscanning during psychotherapy is whether repeated inter-brain coupling *predicts* a stronger therapeutic intersubjective alliance (Zhang et al. 2018). In turn, therapeutic alliance has been shown to predict symptom reduction in anxiety and depression cases when assessed using baseline and follow-up test anxiety and satisfaction questionnaires (Sened et al., 2025).

Specifically, inter-brain synchrony has been linked to enhanced social bonding in psychotherapy (Koike et al., 2016), increased empathy and social bonding during real-time social interactions (Kinreich et al., 2017), improved social cognition and understanding during face-to-face interactions (Reindl et al., 2018), and cooperative behavior and positive social outcomes in broader social contexts (Cui et al., 2012), further supporting the hypothesis that repeated inter-brain coupling may predict a stronger therapeutic intersubjective alliance (Zhang et al., 2018). A recent systematic review confirms the growing empirical interest in hyperscanning within clinical encounters, documenting both promising findings and the need for greater methodological rigor and conceptual clarity (Adel et al., 2025).

In particular, since difficulties in interpersonal relationships have been claimed to be one of the crucial symptoms in psychopathologies (Girard et al. 2017), the capacity of individuals to synchronize with other brains during social interaction has been argued to be crucial in psychotherapy-induced behavioral change (Sened et al., 2022b). In general, the literature on this topic taps second-person, interactive psychological and philosophical frameworks to evaluate and qualitatively interpret empirical data (Schilbach, 2013; 2024) in relation to their potential of being applied in therapeutic contexts, as depicted in Figure 1 below.

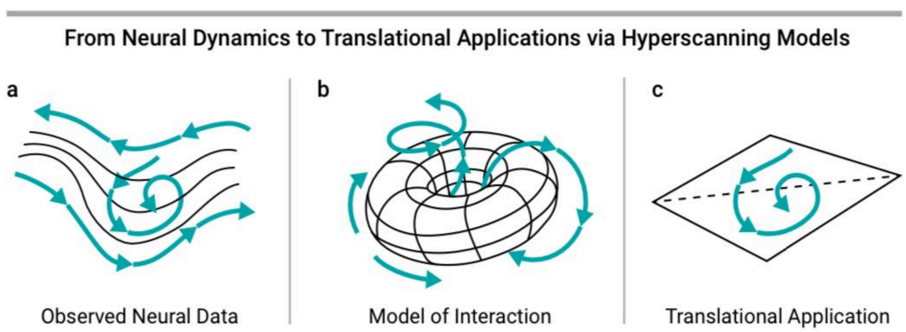

Figure 1. Different steps of research in hyperscanning: (a) observed neural data yield an instantaneous inter-connectivity state, which (b) undergoes coarse-grained, sequential mapping, which effectively links neural dynamics to interpretative models. Subsequently, these dynamics (c) are applied in translational praxis, such as clinical-behavioral diagnostics. Arrows represent information flow at each stage.

When being translated into clinical practice, hyperscanning research may face challenges that arise because of "epistemic messiness," as Scott-Fordsmand and Tybjerg (2023) have recently analyzed. In the context of hyperscanning, given the variety of concepts that are often applied in a somewhat imprecise and inconsistent manner (e.g., shared intentionality, interagency, mutual prediction theory, interpersonal synchrony, subject-subject relationship, among the most popular), it is crucial to remain mindful of researchers' epistemic assumptions and data analysis choices, particularly when drawing scientific and clinical inferences from statistical modelling of brain data (see also Zimmerman et al, 2024).[1] This is especially pertinent in hyperscanning research, where interpretations of inter-brain coupling are likely to be heavily influenced by the theoretical frameworks one decides to employ.

3 - Neural and behavioral scales: an asymmetry problem

We suggest that there is a fundamental asymmetry in hyperscanning research between the psychological phenomena and the supposedly "underlying neural mechanisms" of these very behavioral attitudes. This is the first epistemic blindspot that we identify in hyperscanning paradigms. This blindspot raises both epistemic and moral issues, especially when neuroscientific research is used to inform clinical practice in psychiatry and psychotherapy. We will focus on the epistemic issues here (see Lacroix, 2023 for a discussion on normative problems).

A clear instantiation of the asymmetry blindspot concerns distinguishing between *synchronized* and *coordinated* actions. Synchronized actions refer to the performance of the same actions in a synchronous manner by two or more individuals (Przyrembel et al. 2012, p. 10). Coordinated actions refer to the performance of collaborative actions in order to reach a shared goal, for example, two individuals collaborating in order to win in a basketball match perform coordinated but *different* actions in order to score two or three-point field goals.

In the scientific literature, both synchronized and coordinated actions are often mapped out onto similarity or synchronicity of neural patterns (Schilbach et al. 2013; Hakim et al. 2023). Moreover, both the performance of synchronized and coordinated actions are imputed to different behaviors involved in second-person perspective taking during social interactions, where *social alignment* and *social understanding* are not further distinguished. The extent to which someone is able to imitate the actions performed by peers—social alignment—does not necessarily entail a form of dynamic and complementary interaction (see Fusaroli et al. 2014; Galbusera et al. 2019). As Sened and colleagues acknowledge in their review, in-phase and anti-phase synchrony (i.e., when people are performing the same actions at the same time vs. when they are performing opposite actions a the same time) are usually aggregated in the analysis, as it is hard to mark the difference in the data. This precludes scientists from distinguishing between features of neural signals related to these very different situations.

Here it is crucial to notice that this qualitative interpretation of neural data clearly *underdetermines* both the observed overt behaviors and the cognitive capacities thought to account for these very behaviors. How would the similarity of neural patterns be justifiably inferred to be the underlying mechanism of different but coordinated actions vs. synchronous and identical actions? In this case, it seems that looking at the entire sequence of neural patterns (*whether similar or not*) could allow researchers to infer the neurobiological processes involved in more complex behaviors than just performing the same actions at the same time, as it is the case when individuals are performing coordinated actions, which seems to be the target of research in the domain of patient-therapist investigations (see Sened et al. 2022b). However,

[1] For a critical discussion of other relevant issues related to hyperscanning that fall outside the purview of this article, see Hamilton (2021).

such a nuanced qualitative interpretation that could better link models of neural data to models of overt complex behaviors seems to be missing here. In fact, here is exactly where the blindspot we are characterizing arises: we identify an asymmetry between the neuroscientific conceptual and experimental toolkit and the psychological/etiological one. The former models are underdeveloped to successfully account for phenomena analyzed using the latter ones. To sum up, a single relevant variable picked up from the interpretation of neural data (i.e., synchrony) is directly linked to a *variety* of overt behaviors that can be defined as "successful." We conclude that different types of social interactions and related overt behaviors are equally assumed to be underpinned by one neural signature, namely moment-to-moment synchronicity.

The forms this gap can take may be multiple. Here we just presented an example of the problem to illustrate it concisely. The upshot of our analysis is: neural analyses centered on synchrony underdetermine the complexity of different while closely related behavioral phenomena they are supposed to explain, thereby pointing to an underdeveloped interpretation of neural signal.

A second crucial blindspot is the neglect of the role of reciprocity in social interactions in current neuroscientific paradigms. Before tackling this issue, we zoom into the specific consequences of the asymmetry blindspot in the context of hyperscanning used to assess mental health interventions.

3.1 - Hyperscanning in Mental Health Intervention

During psychotherapy, it seems that what matters for a successful patient-therapist relation as well as therapeutic outcome is the *reflexive* (or personal) nature of second-person perspectives. This means that both the patient and the therapist are *consciously* engaging in a gradual joint process of meaning co-construction. As Fuchs has argued, the role of the second-person perspective in psychiatry is aimed at "the co-construction of narratives and interpretations regarding the patient's self-concept, relationships and conflicts" (2007). This process of co-construction of meaning—what we could also call *intersubjective alliance*—has two main features: (1) it follows a developmental trajectory; and (2) it has to do with the patient and therapist *as persons*. Persons as such, on an enactive view, are incomplete, in becoming, fundamentally unfinished (Di Paolo et al., 2018), and therefore not exhaustible in terms of biomarkers or any single, synchronous measure.

Psychotherapy has a developmental trajectory because it is not given from the first session. Rather, it develops in complex and unpredictable ways over the course of repeated interactions and advancements in meaning construction. It has to do with the patient as a person, because it concerns what De Haan would call the *existential dimension* (2020) of the patient's life. It has to do with the meaning that the patient consciously attributes to contexts and events in her very own life. In this sense, it is distinguished from the subpersonal level, which concerns all the processes that go on in the patient's brain and body, of which they are generally not in direct control or aware. The developmental trajectory of intersubjective alliance intersubjective alliance is often neglected by current hyperscanning paradigms as (1) changes in brain synchrony are generally not measured on a long-range base[2] (Carollo & Esposito, 2024); and (2) the developmental and processual changes are only compared in a binary standardised way (e.g., more or less synchronicity), instead of being investigated in their complex unfolding trajectories.

The fact that therapists and patients are affected as *persons* is neglected in a more subtle sense. We suspect that the talk about "underlying mechanisms" obscures the reflective, personal nature of second-perspective, intersubjective interactions.

Let us illustrate this with a brief thought experiment: imagine that a therapist and a patient report to be in the process of co-constructing a shared meaning of the patient's lifeworld, but the neural analysis signals an average asynchronicity between the two brains.[3] How would current hyperscanning frameworks interpret this situation by building on the notion of *underlying mechanisms*? They would probably point at the fact that in this case there must be a *different* underlying mechanism for this event to happen, which could realistically be the case. However, by crossing out the notion of "underlying" and just talking about processes that make it statistically probable for a certain phenomenon (e.g., a shared co-construction of meaning) to develop with a certain trajectory rather than another, scientists could better bring the focus back to the *existential nature* of psychological conditions. If we adopt this suggestion, neural activity becomes one of the elements in the bigger picture of unfolding therapeutic processes, which doesn't have a causal priority over other components of the phenomenon. Moreover, direct mappings between brain and behavior are very likely to unjustifiably simplify complex psychological interactions rather than make them more intelligible (for example, see "Neuroscientific evidence for multiple systems underlying social cognition", in Przyrembel et al. 2012).

Following our criticism would mean building an integrative experimental paradigm that considers reciprocal influences as continuous, rather than compartmentalized, will provide a richer and more comprehensive model, as therapeutic success in the form of an "intersubjective alliance" is shaped not only by measures of synchrony but by fluid, interactive processes that unfold within the therapeutic setting.

An effective model in psychotherapy accounts for the interactive dimensions of mutual communication, fostering an open-ended process in which the therapist takes on the responsibility of guiding the client toward a positive outcome..

We now turn our attention to the issue of patient-therapist *reciprocity* in psychotherapeutic contexts.

4 - In favor of strong reciprocity

Reciprocity is central to understanding the complexity of interactions in hyperscanning studies, particularly when examining therapeutic and interpersonal settings. For instance, Baedke et al. (2021) describe reciprocal causation as a framework where two interacting, yet separate entities (e.g., an organism and its environment) shape one another, establishing causal feedback loops that extend

[2] The inter-brain plasticity framework is trying to address this issue at a theoretical level (see Sened et al. 2022b).
[3] A somewhat similar situation has been reported already (see Paulick et al. 2018).

diachronically. In the context of hyperscanning, this reciprocal causation must go beyond simple neural synchrony to account for the reciprocity between participants.

Second-person neuroscience studies dyadic interactions where participants mutually influence each other. Recent work explores joint attention, information flow, and how past interactions shape future exchanges (Schilbach & Reedcay, 2025). We argue that even in such a framework nuanced bidirectional interactions are missed if strong reciprocity isn't considered. For example, in their seminal study, Fishburn et al. (2018) mention in the methods section that "*any asymmetries in connectivity would not be interpretable* (e.g. the presence of connectivity between the channel X of subject A to channel Y of subject B but not vice versa has no clear meaning)" (emphasis added). In fact, in this study symmetry was imposed post-hoc. Thus, in a paradigm as such, reciprocity in the neural signal cannot be meaningfully extracted, but has to be idiosyncratically presupposed. Thus, a crucial hallmark of subject-subject interaction (i.e., bi-directionality of the social interaction) becomes inherently uninterpretable.

Different correlation measures of neural synchronicity have one thing in common: they are taken as relevant neural signal sequences insofar as they match, predict or are similar to the one of another subject, remaining uninformative regarding the causal, directional influence of such signals. Nevertheless, they are taken to be directional at the macroscale; for instance, in claims about the ability of a therapist or a teacher to "change people's ability to synchronize" (Sened et al. 2022b, p. 07; Sun et al. 2020). These conclusions are epistemically unwarranted and likely fostered by loose assumptions about the stronger predictive ability of one subject of the other's mental states (LaCroix, 2023). Even when the directionality of IBC is not unwarrantedly claimed, the dynamic influence between participants in these paradigms seems to remain unaddressed entirely, albeit being recurrently referred to as "studies on interaction." In fact, rather than analyzing the interplay between the two (or more) neural signatures, these paradigms seem to track the moment-to-moment sequential way these converge to synchrony. Current paradigms seem to track convergence, not dynamic reciprocal interplay.

Strong reciprocity is likely to be neglected because of the fact that traditional measurements are informed by unidirectional theories of social interaction like ST and TT (Przyrembel et al. 2012), emphasizing similarity over a stronger manifestation of "constitutively interrelated experiential perspectives" (Zahavi, 2023, p. 95). Moreover, as de Haan and colleagues have emphasized, different flavours of Theory of Mind (ToM) models of social interaction all have in common the focus on theorizing or inferring mental states about the other, either in absence of them or by avoiding direct interaction with them (2011). We suggest that hyperscanning studies aiming to capture intersubjective engagement should treat each participant's neural and behavioral responses as dynamically integrated, each influencing and reshaping the other's responses.

After having outlined the multiple faces of the reciprocity blindspot, we turn to consider some available options of construing a strong form of reciprocity, which can ameliorate the shortcomings of current hyperscanning scientific paradigms. In the scientific study of cognition, scholars have proposed various models to frame organism-environment reciprocity. Di Paolo (2020) distinguishes between three types of relationships: interaction loops, transaction loops, and constitution loops. Interaction loops represent the simplest form, characterized by bi-directional reciprocal influences—usually visually depicted as two-way arrows—between organism and environment. These loops work well when describing well-defined systems with stable characteristics. However, this model becomes inadequate when diachronic changes need to be taken into account. When organisms and environments undergo structural changes through their protracted engagement, the concept of interactive coupling becomes less precise and useful. As systems transform over time, variables and parameters may shift, appear, or disappear, and functional relationships may change. Dewey and Bentley (1949) articulated the concept of *transaction* to describe these fluid situations, where labels remain provisional as relationships and processes continue to transform. This is integrated by Di Paolo (2020) as *transaction loops*. Beyond these diachronic transactions, we sometimes need to understand how organisms and environments come into being in the first place. Enactivists argue that an organism's continued existence depends on an ongoing and precarious process where the individual and its environment co-create each other through relations of constitution (Di Paolo 2020). While constitution loops often involve transactions, it is important to note that not all transactions lead to constitutional relationships, as the latter specifically include both important organizational and structural changes.

We contend that beyond mere interaction, both transaction and constitution loops richly illuminate the patient-therapist relationship, translating organism-environment reciprocity into the realm of subject-subject dynamics. Transaction loops emphasize a reciprocal flow in which each participant's neural and behavioral responses actively reshape the unfolding exchange. Yet an enactive perspective (Di Paolo et al., 2018) invites us to go further: in genuine intersubjective encounters, therapist and patient mutually constitute one another through the transformative arc of their interaction. For hyperscanning, this implies a need for variables that remain sensitive to the dynamic becoming of both partners. Though such methodologies are emergent, Baedke et al. (2021) propose a model for distinguishing between different types of reciprocal processes without collapsing the distinct identities of each interacting entity. Applied to hyperscanning, this approach calls for methodologies that explicitly measure both physical (eg., neural synchrony) and experiential (e.g., subjective responses) dimensions of the transactions at stake, acknowledging that synchrony is not the sole indicator of transformative communication; approaches that embrace both neural synchrony and experiential reciprocity—capturing the real-time, bidirectional pulse of the encounter—promise a more authentic window onto the heart of therapeutic engagement.

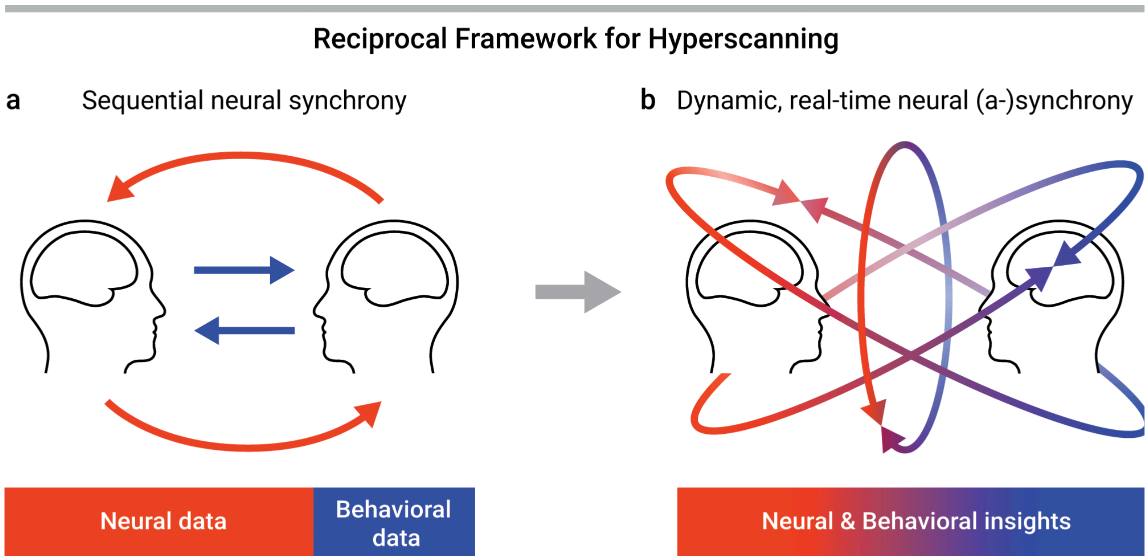

Figure 2. Suggested framework shift in hyperscanning-based research, from (a) neural synchrony, characterized by distinct, sequential neural and behavioral data streams, to (b) dynamic, real-time, and reciprocal neural-behavioral processes, where asynchrony emerges as a potential marker of meaningful interaction.

Based on these considerations, we suggest focusing more on how subjects relating through a second-perspective attitude do so in a reciprocal, transactional and constitutive way,[4] both for theoretical considerations and for further developments in neuroscientific paradigms (see Figure 3 above). For this, we offer the general contours of an enactive neuropsychology that could aid hyperscanning research by foregrounding the reciprocity between patients and therapists.

4.1 - Enactive Neuropsychology

Enactivism suggests that cognition is always interactive, whether through engagements with environments or distributed across individuals through social interactions. As we mentioned above, while a transactional-loop relationship between patient and therapist could account for the dynamical nature of reciprocity, we still need to consider the other ways participants are affected and the interactional autonomy arising in subject-subject interactions. Participants' actions also affect themselves. One's actions, the other's actions, and the interaction dynamics also keep affecting oneself in ways and at timescales that we cannot easily capture. This is why we should also acknowledge constitutive loops in interaction: because our interactive histories are a constitutive part of our identities. This alone presents a big challenge for neuropsychology because it introduces another layer of complexity, namely the autonomy of interactions, which we term anew as the *heteronomous pull of interactions*.

[4] A silver lining congeals in Husserlian phenomenology, which reverses the naturalistic tendency to subordinate the subjective to the objective, where the other (subject) is treated as an empirical or theoretical derivative. Instead, it posits that consciousness of both self and others precedes and shapes the empirical, particular self and others. Phenomenologically, this suggests that intersubjective intentionality underlies and conditions objective intentionality (Hinrichs & Guzmán, 2024; Cuffari & Figueiredo, 2025). By re-centering intersubjective intentionality as the basis for, rather than a byproduct of, tools for knowledge generation, a critical dimension often overlooked in many second-person neuroscience paradigms is revealed: reciprocity.

Autonomy is defined as “[t]he property that describes a far-from-equilibrium, precarious, operationally closed system in any domain. Autonomous systems are self-individuating and depend on their associated milieu, which nevertheless does not fully determine its states” (Di Paolo, Cuffari & De Jaegher, 2018). In social interaction, participants produce meaning together. This is captured by the concept of *participatory sense-making* (De Jaegher & Di Paolo, 2007) in the enactive literature. *Participatory sense-making* is the adaptive engagement of agents in their environment with others where the differential implications of their actions for their own form of life open and restrict possibilities for action, while they are affected by the dynamics of the interaction, its coordination patterns, breakdowns and recoveries (Di Paolo, Cuffari & De Jaegher, 2018). This means that a new domain emerges, a domain in which bodies engage in mutual coupling and regulation which is highly dependent on the situations at play, but also on the very persons in action. Peoples’ historicity not only accumulates but it also reflexively determines their agency in a constant feedback of coordination and miscoordination in which we learn to be together or break up connections. The special challenge here is that there is a sustaining dynamic that is always underdetermined by the actions of its participants, let alone by their brains, which are only parts of this whole process. While interactive dynamics is not something that can be investigated merely by looking at two brains, the big question that remains open is precisely what the role of the brain is in this process. Moreover, we should acknowledge brain plasticity in interactive encounters, since subjective experiences and actions continuously influence back the flow of interaction by inducing changes in plastic neural structures, thus altering experiences and behaviours (Fuchs, 2011).

Despite the many challenges, we do acknowledge that hyperscanning techniques can provide data to support an enactive view on cognition by showing how neural processes coordinate between interacting partners in real-time. We would like to highlight second-person neuroscience's (Schilbach 2010, Schilbach et al., 2013) employment of enactive commitments and to acknowledge the challenges it poses. As we mentioned above, the key ingredients considered in second-person neuroscience are (i) acknowledging we immediately experience others as subjects instead of merely engaging in individual inference processing; (ii) acknowledging the affective dimension of interactivity by considering feelings of engagement and emotional responses in interaction; (iii) considering reciprocal relations in social interactions in which actions and reactions are themselves perceived and reacted upon; (iv) acknowledging that interaction involves different roles or modes of participation; (v) that it involves shared intentions which may emerge from the very interaction; and (vi) that it involves historicity, and should consider past and developmental trajectories (see Schilbach et al., 2013).

It is clear that second-person neuropsychology is up to date with the key enactive concerns regarding interaction:

> [...] interaction and feedback are not only a way of gathering data about the other person, that is, observing effects one may have on the other, but rather, as De Jaegher et al. (2010) have argued persuasively, one’s knowledge of the other resides – at least in part – in the interaction dynamics “between” the agents. Thus, taking social interaction seriously suggests that there may not be an absolute epistemic gulf between self and other, which would make an inferential detour necessary, but rather, that the dynamics of the social interaction contribute to and – at times – constitute our awareness of other minds. (Schilbach et al., 2013, p. 397)

Yet, even with the important steps taken by second-person neuroscience, an adequate understanding of the complexity of real-world interactions with integrated brain information is yet to be achieved by means of hyperscanning. As we have pointed out throughout this text, synchrony alone cannot offer such an understanding, and reciprocity should be considered in more transactional terms and in light of Baedke's et al. (2021) framework, which is a more enactivist-friendly approach, for it takes into account how interacting entities mutually shape each other in successive iterations. In empirical research, such as hyperscanning, this first step of admitting transactional loops translates into measuring symmetry in both directions in real time and acknowledging the influence each participant plays on the other. Constitution loops, on the other hand, could translate into analysing reports that consider changes in each other's perspectives, behaviors and habits. In addition, these measurements should be integrated with other measurements and subjective reports, forming a richer picture of intersubjective experience, given that synchrony alone is not an indicator of effective communication nor of participatory sense-making.

We suggested that (i) interactions must be considered as processes with emergent features—they present self-organizing principles that do not reduce to the sum of participants actions (see also Di Paolo & De Jaegher, 2012). We also suggested that (ii) brain activity, being one part of a system that involves the whole person, the other, and the environment, is in a complex relation with the interactive system as a whole (Froese, 2022), which makes inner-outer correlations a much too restrictive way of considering its role.

Following Di Paolo & De Jaegher (2012) in the context of science regarded as a socio-material elaboration (Froese, 2022; Barad, 2006), we highlight that the brain is “participating in a dynamical process outside its full control” and so we should think about “explanatory strategies in terms of dynamical concepts”. The authors’ main point is: “interactive experience and skills play enabling roles in both the development and current function of social brain mechanisms” and “the link between coordination dynamics and social understanding can be best grasped by studying transitions between states of coordination” (p.01). Studying and measuring these transitions is important because periods of coordination—how they come to be and end—play an important role in social understanding-orienting actions and intentions and in shaping individual mechanisms (Di Paolo & De Jaegher, 2012). It is important for enaction to engage in phenomenologically guided research because it is the most promising way to bridge the supposed gap between objectivity and subjectivity or, in better words, to embrace the claim that ‘reality’ is made up of evolving processes that are equally physical and experiential” (Frank et al., 2019). In intersubjective research the underdetermination of the phenomenon by the neuroscientific data and the emergent constraints of interactions are key features that require phenomenology for clarification and definition, once it is an important aspect of the reality of the phenomenon. Although we cannot fully develop this idea here, we are suggesting that phenomenologically-guided research can help us better understand the dynamics between people and this is how the interaction needs to be addressed due to its autonomous nature.

A more phenomenologically guided interaction—before, during, and after hyperscanning—could aid understanding transitions between coordination states. For a potential protocol, we take inspiration from De Jaegher et al. (2017)’s PRISMA methodology: a theoretically grounded, empirically validated tool for investigating interactive experience. PRISMA offers a systematic approach to studying participation dynamics through embodied methodology, engaging researchers both as instruments and subjects. It emphasizes three modes of perception—sensing, feeling, and thinking—to explore when and why coordination transitions occur, and how they are experienced. Participants retrospectively identify salient moments, offering insights often inaccessible to neural measures alone. We envision three ways PRISMA might inform hyperscanning: (1) Hyperscanning during PRISMA, using portable tools (e.g., dual-EEG, fNIRS, motion tracking) synchronized with audio-video; (2) Using PRISMA results to design hyperscanning experiments targeting specific interaction phenomena; (3) Enabling participants to reflect on their own hyperscanning data via evaluation sessions—jointly framing or reframing experimental results. We believe there are many different ways in which participants could reflect on their own data, which we cannot specify further in this paper.

Indeed, the pretension towards a meaningful empirical intervention during dyadic dynamics of interaction demands giving prominence to a socio-material milieu. We believe that the enactive, second-person framework is particularly well-suited to modeling all scales of intersubjective interaction—from the micro (immediate, moment-to-moment exchanges) to the macro (longer-term relational dynamics) scale, including scalar thresholds and feedback loops—because of its holistic approach to cognition and interaction and its emphasis on dynamic, real-time engagement and sense-making. Any neuroscientific praxis of mental health intervention—for instance, via dual-EEG—will only bear a translational potential to inform bio-psycho-social models of (clinical-behavioral) etiology if, as De Haan (2021) points out, “the interaction of the physiological, psychological, and environmental processes involved” is accounted for in an integrated manner.

5 - Concluding remarks

In this paper, we critically analyzed standard hyperscanning paradigms, their epistemic strengths and weaknesses. In particular, we focused on emerging paradigms that are aimed at tracking neural correlates of psychotherapeutic interactions. We began by characterizing current hyperscanning paradigms and discussed two epistemic blindspots as well as their significance for the advancement of the field. First, we argued that there is an asymmetry between the current neural and behavioral toolkits, where the latter is underdetermined by the former. Second, we highlighted how current hyperscanning paradigms crucially neglect a strong form of reciprocity, thereby failing to address the target phenomenon in its dynamic unfolding. Lastly, we proposed an enactive neuropsychological framework to address the issues we pointed at throughout the paper. Here, we outline how, by incorporating the PRISMA methodology, neuroscientific hyperscanning paradigms could be better equipped to address forms of real-time, complex interactions.

In sum, we emphasized that intersubjective exchanges are typically reduced to neural synchrony, with little attention paid to reciprocity or the nuanced dynamics of interaction. In contrast, successful therapy depends not only on alignment but also on productive asymmetry. We argue that more integrative approaches—incorporating subjective experience and behavioral markers such as mutual responsiveness and emotional resonance—are needed to better capture the relational dynamics central to therapeutic alliance. We have shown that in the case of hyperscanning, that is, simultaneous recording of the neural substrate of two or more individuals, the problem of asymmetry emerges, that is, rich, dynamic social interactions are simplified to patterns of neural synchrony, leaving out the nuances of coordinated, asymmetrical behavior that often characterize authentic, real-world exchanges. Current methods often emphasize synchrony in brain patterns as the causal primary marker of successful interaction, aligning only partially with the complex, bidirectional influences inherent in meaningful social and therapeutic relationships.

Moreover, a focus on reciprocity brings into view the active, co-constructed nature of meaning-making that is essential to second-person perspectives in therapy. Current frameworks inadequately capture this intersubjective alliance, which unfolds as a joint and evolving process over time. To address this issue, frameworks based on enactivism and dynamical systems theory may offer useful models that shift from predictive to emergent, embodied accounts of social interaction. An enactive perspective proposes a neutral, process-oriented approach to resolving the limitations discussed here, offering a promising way to understand the dynamic, reciprocal, and co-constructed nature of human interaction in therapeutic settings.

To conclude, we acknowledge that third-person methods are often criticized as inherently incapable of capturing intersubjective experience. However, this view neglects how other fields have advanced from subjective calibration to objective reliability—such as fMRI, which has evolved from introspective roots to a robust neuroimaging tool. Hyperscanning faces similar challenges, particularly the "standoff problem" between subjective reports and neural data. Yet, cases like Anton’s Syndrome and placebo studies show that such gaps can be bridged through methodological refinement (Pauen & Haynes, 2021). By integrating neural, behavioral, and subjective data, hyperscanning can move beyond current limitations and become a powerful tool for studying intersubjectivity.

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