From inter-brain connectivity to inter-personal psychiatry

When it comes to symptom emergence and treatment of disorders, psychiatry and neuroscience do not always find common ground. On the one hand, neuroscientific research approaches mental disorders through their biological correlates using brain recordings; on the other, clinical psychiatry relies on self-report measures collected during face-to-face interviews. Taking into account both neural and experiential dimensions thus appears as one of the key challenges to the integration between neuroscience and psychiatry.

One aspect in which neuroscience and psychiatry do see eye to eye is in their restricted account of interpersonal dynamics. In psychiatry, the focus is primarily put on the mental state examination of the patient, although most mental disorders severely affect and are affected by social dynamics. Similarly, in neuroscience, the "social brain" has been paradoxically studied in isolated contexts, inferring that mere passive social perception and active social interaction are encoded in the same way at the brain level. Yet, research has widely shown that the development of children's social abilities requires subtle social interactions with their parents, involving an active and reciprocal co-regulation of the exchanges. Recent advancements in social neuroscience suggest that the relationship between brains and social dynamics might offer a unique opportunity for the neuroscience-psychiatry integration while acknowledging the inherent socialness of mental disorders.

In 2002, a groundbreaking functional magnetic resonance imaging (fMRI) study introduced a technique called hyperscanning[1], where the authors simultaneously scanned the brains of several participants while they were interacting through an economic game. This study paved the way for the design of realistic experimental protocols capable of capturing the crucial features of sociality, i.e. dynamicity and reciprocity, to investigate the neural mechanisms supporting social cognition and behavior.

The idea quickly spread to other brain recording techniques, such as electroencephalography (EEG) and functional near-infrared spectroscopy (fNIRS), which are cheaper and more flexible for social tasks requiring direct face-to-face interaction. This led to the discovery of specific neural circuits that support social interaction and that differ from those enabling the sole perception of social stimuli. For instance, both mirror and mentalizing networks are simultaneously engaged, with a subtle modulation of shared representations and the maintenance of a distinction between self and other.

Beyond this better understanding at the intra-brain level, the development of hyperscanning has also inspired several teams of researchers to look at the inter-brain level, i.e. between-participants brain activity. The underlying hypothesis was that communication of information across brains might follow the same principles that govern communication of information inside brains. Thus, it was expected to find coherent activity between one region and another, but extended to two or more individuals. This novel inter-personal and dynamic perspective on social cognition was strongly associated with the development of 4E cognition, arguing that the mind is not solely in the head, but is also embodied, embedded, enacted, and extended.

Thanks to hyperscanning recordings, a new type of neural correlate was identified: inter-brain connectivity (IBC)[2]. This can be defined as the synchronized brain activity of two or more people involved in a social scenario that can be attributed to their interaction rather than a shared external environment. All common neuroimaging techniques can be used to reveal IBC, from fMRI and fNIRS, which allow measuring amplitude correlation (i.e., when the brains activate regions at the same time), to EEG and magnetoencephalography, that provide sufficient temporal resolution to observe phase synchronization (i.e., when the brains present coherent oscillatory activity in time).

In the last two decades, the observation of IBC has grown from a few isolated studies to a whole new field now covering non-verbal and verbal exchanges, in dyadic and group contexts, with interaction between mother-infants, romantic couples, friends, but also complete strangers. Those experiments have identified many correlates of IBC, from behavioral synchronization and imitation of movement to language familiarity, empathic connection, and even human attachment. This massive growth has recently allowed the first meta-analyses and triggered the development of standardized IBC tools, consolidating both scientific progress and replicability in the nascent multi-brain neuroscience research.

But, how can psychiatry use this new form of multi-brain measurements? What can IBC bring to the understanding of psychiatric conditions, and how can it ultimately help in the daily practice of clinicians?

First, IBC can provide a neural correlate for core clinical features of mental disorders. For instance, the alteration of interactive social cognition may be more specific than that of perceptual social cognition[3]. In autism spectrum disorder, as an example, patients rarely mention misunderstanding of complex social plots in movies; they rather complain about their difficulties with improvising in real-time social interaction during daily life. Hyperscanning recordings can thus help in further exploring the mechanisms and manifestations of psychiatric conditions with a strong social dimension[4].

Second, IBC can provide an objective measurement of the empathic connection or other social phenomena that are fundamental to the psychotherapeutic process but remain hard to capture at the biological level. For instance, hyperscanning studies have started to uncover the biological correlates of complex inter-personal phenomena such as the analgesic effect of affective touch[5] or the therapeutic alliance[6]. In both cases, the alignment at affective and cognitive levels is reflected in the alignment at the neurobehavioral level.

So, IBC promises to better capture the underlying biological factors impacting psychiatric manifestations and treatment, without necessarily reducing them to only intra-personal processes.

Beyond these recent developments, we can also wonder what are the next steps for multi-brain neuroscience, and especially what potential avenues it can open for psychiatric research and clinical practice.

First, while early work was done in humans, the recent increased interest in IBC comes from multiple papers published with animal models[7]. Not only have these studies replicated the early observation of inter-brain correlates in humans, but they have also uncovered for the first time cellular mechanisms. This move from mesoscopic to microscopic levels opens possibilities to decipher which biological mechanisms can be targeted pharmacologically to potentially enhance IBC and with them neurobehavioral inter-personal dynamics.

Second, another recent trend is the move from multi-brain recording to multi-brain stimulations. The burgeoning field of hyper-stimulation[8] may thus represent the next technological step to go from inter-brain correlational measurement to direct causal manipulation. Preliminary results already demonstrate that induction of inter-brain synchronization of neural processes shapes social interaction within groups of mice, and facilitates motor coordination in humans. If multi-brain electromagnetic stimulation provides insights about the causal factors modulating IBC and eventually sheds light onto biological mechanisms, a long-term challenge will be to move even beyond the traditional "correlation vs. causation" debate and provide an integrative explanation of the IBC phenomenon[9]. Ultimately, inter-personal neuromodulation through pharmacological compounds, electromagnetic stimulations, and even both, could open the way to new forms of therapeutics in psychiatry.

We have seen how the nascent multi-brain neuroscience may lead to transformative applications in psychiatry, from inter-brain measures for clinical characterization to inter-brain neuromodulation for treatments. Interestingly, this inter-personal psychiatry will also help take seriously our biological grounding as much as our social embedding.

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Continuous outcome measurement in modern data-informed psychotherapies

Continuous outcome measurement in psychotherapies has become a central research topic only in the last two decades[1]. Here we provide a short introduction to the relevant concepts and discuss the opportunities and challenges of their implementation in clinical practice.

Most continuous outcome measurement systems comprise short self-report questionnaires which assess patient progress on a session-by-session basis. Feeding this psychometric information back to therapists enables them to evaluate whether their current approach is successful or adaptations are necessary. In order to help therapists judge whether a particular patient is improving or at risk for ultimate treatment failure, many routine outcome monitoring (ROM) systems include feedback and empirically-based decision rules.

Decision rules are generated based on datasets from clinical practice settings[1]. Based on such large archival datasets, expected recovery curves can be estimated and used to build thresholds indicating which scores are reflective of an increased risk for treatment failure. Having identified a patient as at risk, some ROM/feedback systems provide therapists with additional clinical support tools[2]. These support tools have incorporated process measures designed to assess specific change factors within and outside treatment that impact outcome.

Originally, these tools comprised two elements to help therapists adapt treatments specifically for patients at risk for treatment failure: a) an additional assessment of potential problem areas (e.g., suicidal ideation, motivation) to elucidate the patient's individual risk profile, and b) a decision tree directing therapists to specific interventions depending on the identified risk profile. New developments have built on these ideas and included multimedia instruction materials and machine learning prediction models in order to help therapists provide the specific interventions that are most promising for a particular patient[3].

Over 40 randomized clinical trials (RCTs) and several meta-analyses provide a compelling evidence base for ROM and feedback. Feedback-informed treatments have been shown to result in improved outcomes, reduced dropout, and higher efficiency than standard evidence-based treatments[2,4]. The most recent and comprehensive meta-analysis reported a significant effect size advantage of d=0.15 for progress feedback compared to treatment as usual[4]. This effect was slightly higher for the subgroup of patients showing an initial treatment non-response (d=0.17).

When evaluating the size of these effects, it is important to keep two issues in mind. First, these effects come on top of the effects of effective evidence-based treatments. Second, feedback is a minimal low-cost technological intervention that does not put much of a burden on either patients or therapists. Accordingly, the largest RCT to date (N=2,233) demonstrated the cost-effec-