The interpersonal brain: What neuroscience tells us about our ability to understand self and others

Biologically, we are born from a relationship between two individuals. Psychologically, our notion of self emerges and develops within the significant interpersonal matrices in which we are embedded.

The major developmental tasks that we face across the life cycle are accomplished within the context of the interpersonal relationships we are exposed to, starting with the relationship with our first attachment figures when we are babies and continuing to the relationships we establish with romantic partners in adulthood. Indeed, our psychological adaptation is strictly dependent on our ability to deal with the complexities of social interactions. Thus, it is not surprising that the majority of psychopathological disorders are characterized by alterations in interpersonal functioning.

Paradigmatic examples of disorders marked by social impairments are antisocial personality and autism. Other examples include social phobia, marked by very high levels of anxiety in social interactions; schizophrenia, characterized by severe social anhedonia or paranoid ideation in the context of social interactions; depression, associated with perceived social rejection and isolation; and borderline personality, which is defined, among other features, by the fear of abandonment and the difficulty in establishing stable relationships.

Those who work in the mental health field know from clinical experience that most psychopathological disorders are characterized by social difficulties and that interpersonal problems by themselves constitute one of the major and more frequent reasons that people seek help. This is why counselors often work to promote their clients' social abilities, including effective communication skills, the capacity to deal with conflict and the regulation of negative affect that emerges in the context of intimate relationships.

Ever since beginning work as a psychotherapist 13 years ago, I have understood that most psychological disorders, from depression to obsessive-compulsive disorder, disturb the individual's capacity to interact with others and, in turn, these interpersonal difficulties aggravate the clinical distress. The research I conducted during my doctoral studies on psychotherapeutic outcome and process confirmed the role that social difficulties play in clients' psychological distress and the centrality of intersubjective negotiation between the therapist and the client for therapeutic success. Five years later when I started my postdoctoral studies in social neuroscience, I retained my interest in human interpersonal behavior but added a focus on its neurobiological basis.

In joining a neuroscience lab, I initially found that the research paradigms neuroscientists typically used to study complex psychological constructs such as personality, empathy, emotional regulation and social interaction lacked the ecological validity I had been accustomed to when I conducted psychotherapy research. I had come from a research paradigm in which I had analyzed moment-to-moment therapist-client interactions in 201 sessions of a sample of real therapeutic dyads. At first, I perceived the experimental tasks seen in the neuroscience literature as unable to capture the complexity of such high-level psychological phenomena.

Damian Stanley and Ralph Adolphs mentioned this issue in an opinion paper published in the journal *Neuron* in 2013, talking about the tensions that arise in the field of social neuroscience because of its multidisciplinary nature. In the paper, the authors wrote that "psychologists often find the methods of neuroscience impressive but its concepts and theories impoverished. Neurobiologists find the questions of social psychology intriguing but its methods limited." This paradox illustrates an important dilemma faced by those who intend to understand the neural dynamics underlying complex human behavior such as social behavior. Part of this difficulty comes from the need to ensure methodological or internal validity by developing well-controlled experimental tasks for neuroscience studies without sacrificing external or ecological validity.

In an article published this past year in the *Canadian Journal of Counselling and Psychotherapy*, I and two co-authors, Kristin M. Perrone-McGovern and Oscar F. Goncalves, elaborated on this issue. We proposed a set of guidelines that can be used by applied psychology researchers who intend to use neuroimaging methods in counseling or psychotherapy studies. Specifically, we discussed the possible limitations of the application of neuroimaging in counseling research, both at the conceptual (e.g., the reverse inference problem or the danger of *neurorealism*) and methodological (e.g., preprocessing, multiple comparisons correction) levels.

Research on empathizing with significant others

My research at the moment is an example of the application of neuroscientific methods to the study of complex psychological phenomena such as our ability to empathize with significant others. To study the neural basis of social processing as it occurs in a real interpersonal context, our team developed a research project that allowed us to study both peripheral and central nervous system activity while participants were engaged in real interpersonal interactions.

In doing so, we sought to overcome a methodological gap present in most of the prior research. That research typically evaluated social processing using self-report measures or experimental tasks in which participants were exposed to imagined or fictional targets instead of real-life scenarios. Both approaches have important limitations. Self-report measures do not capture an individual's actual ability to empathize with others but rather the individual's perceived ability to do so, which can be biased by social desirability. On the other hand, functional magnetic resonance imaging (fMRI) tasks that use fictional stimuli have ecological validity issues considering that, for example, empathy toward a stranger is not the same as empathy toward familiar individuals (see Tania Singer et al., 2010). This is particularly important when we want to understand empathy toward significant others because something that influences empathic ability is whether the emotion is expressed toward the empathizer or someone else.

Believing that social neuroscience must explain aspects of human interaction that we daily experience as social beings, our goal was to develop a task that allowed the study of real-time social encounters in a truly interactive manner. For that, we selected the context of a couple's relationship as a model because romantic relationships are a very rich source of emotional interchange. They are also the most central relationship for most adults and have an important temporal duration in the human life cycle (see Theodore Robles and Janice Kiecolt-Glaser, 2003).

This project assessed 43 couples (corresponding to 86 individuals) involved in a monogamous romantic relationship for at least one year prior to the study. The protocol included empathy and dyadic adjustment questionnaires; peripheral (heart rate and electrodermal) and neuroendocrine (cortisol and oxytocin) measures; and behavioral measures of couple interaction and fMRI acquisitions. In Phase I, participants engaged in a structured interaction task in the lab consisting of a conversation about positive and negative aspects of their relationship. During this interaction, skin conductance level and heart rate from both partners were being registered using the Biopac System.

Our first results, published in *Applied Psychophysiology and Biofeedback* in 2017, showed that during interactions discussing the negative aspects of their relationship, couples presented higher levels of autonomic arousal (heart rate) and hypothalamic pituitary adrenal (HPA) axis activation (cortisol level) when compared with levels presented during positive interactions. These findings can be understood in the context of Stephen Porges' polyvagal theory, which proposes that perceptions of a threatening environment result in cardiac acceleration through an increase in sympathetic activity and a withdrawal in vagal tone.

Thus, our study suggested that the discussion of conflictual themes by the couple was associated with a perception of challenge or threat that triggered a stronger autonomic nervous system and HPA response. This may help us understand why it is so difficult for couples to maintain an empathic stance in situations of open conflict. It may also explain the process of stonewalling, described by John Gottman in 1994 and commonly observed by couples counselors, in which partners withdraw in an attempt to escape from conflict and calm themselves down during an interaction that is physiologically overwhelming. Counselors can select interventions to help regulate each partner's physiological arousal, either through cognitive therapy to de-escalate partners during conflict or to express vulnerability rather than anger, or through relaxation techniques.

Our findings of higher heart rate and cortisol in negative interactions are also important for the documented effects of marital strain on physical health. Distressed marriages are a risk factor for negative health outcomes, including heart disease and cancer. This may be due to the repeated elicitation of negative affect experienced by these couples and the cumulative effects for health of the associated activation of the sympathetic nervous system or HPA axis.

Finally, our peripheral nervous system data showed that negative interactions had higher levels of physiological synchrony or linkage between spouses/partners. These results, currently in press in *Family Process* journal, support the earlier findings of classical studies on couples' physiology. In 1983, Robert Levenson and John Gottman found that the degree of physiological synchrony between partners might be more indicative of their level of dyadic adaptation rather than physiological activation. This is an intriguing and very rich idea from a clinical point of view: Being in touch with others and empathizing with them implies an autonomic state that tends to simulate that of another person. In fact, this is true for human dyads other than couples, such as mother-child dyads or therapist-patient dyads.

Our work supported the idea that very low levels of synchrony may reflect disengagement between partners, but very high levels of synchrony may reflect conflict escalation and increased autonomic reactivity to the other's negative affect that occurs in the context of repeated stress. Thirty years ago, Levenson and Gottman found that greater physiological synchrony reflects more reciprocity of negative affect. This corresponds to a type of interaction in which one partner becomes angry or physiologically activated, and his or her partner responds by mirroring these changes, which leads to an even greater physiological activation in the original partner.

Moderate levels of synchrony may thus reflect an adaptive process of physiological coregulation, such as when one spouse/partner increases their autonomic activation in response to a stressor, and the other spouse/partner manages to deactivate their own. This optimal "physiological dance" between partners allows the system to stabilize around intermediate levels of arousal.

Simulating the other's experience in ourselves

And what about the central nervous system? After looking at the autonomic nervous system response, our challenge was to measure the brain activity of both spouses when confronted with real emotional communications directed toward them by their partner.

To address this, in Phase II of our project, we developed an fMRI task. While inside the scanner, participants watched real video vignettes of their partner extracted from the previously videotaped interaction that had taken place in the lab during Phase I. This made an innovative contribution to the understanding of the neural markers of dyadic processes as they naturally unfold in real-life situations. The creation of this type of fMRI task was labor-intensive, but its major advantage was to conciliate both ecological and internal validity concerns by capturing the phenomena as it naturally occurs without sacrificing experimental control.

For this study, we departed with an idea derived from the perception action models of empathy. When trying to make sense of someone else's feelings and actions, we start by simulating the other person's experience in ourselves and use this vicarious emotional experience to cognitively understand the other person's internal states. On the basis of previous research (see Jean Decety et al., 2012), we knew that the more affective or bottom-up dimensions of empathy that allow us to experience another person's affective states recruit brain circuits composed of the anterior insula, amygdala and anterior cingulate cortex. On the other hand, top-down or conceptual dimensions of empathy, such as our ability to cognitively understand another person's feelings and thoughts, recruit the medial prefrontal cortex, temporal parietal junction and posterior cingulate cortex (see Haakon Engen et al., 2013). Therefore, an individual's ability to make sense of significant others depends on a flexible interplay of distinct psychological functions rooted in a complex interaction of different social brain networks.

Our next step was to clarify how the brain integrates the emotional (or embodied) and the cognitive (or abstract) dimensions of social processing in complex social situations. The previously mentioned fMRI task that we created for this study was designed to allow us to differentiate these two major routes of interpersonal understanding.

The task had two conditions. In the first condition, participants elaborated on their own experience when viewing their partner expressing positive and negative contents. In the second condition, participants were exposed to the same videos but now had to switch position and elaborate on what their partner was feeling.

Our assumption was that the self-awareness task requiring first-person information would engage the more affective, embodied or ventral brain pathway, whereas the other condition would activate a more dorsal brain path of mentalizing that uses more abstract and cognitive information. Initial results seem to support this hypothesis.

Conclusion

My work as a clinician led to my scientific interest in looking at how humans understand and make sense of one another and how this takes place at the brain level. I believe the kind of research we are doing now will get us a little bit closer to answering this fascinating question. For example, it will help us clarify whether our capacity to understand another's mind relies on access to our own mental states.

This will have major implications not only for couples therapy but also for all the other human dyads such as mother-infant or helping professional relationships such as physician-patient and teacher-student. This will also have a major impact on the understanding and treatment of a wide range of disorders marked by social difficulties. ❖

Joana Fernandes Pereira Coutinho holds a doctorate in clinical psychology. She is a postdoctoral researcher at the Psychological Neuroscience Lab at the University of Minho in Portugal and also works as a psychotherapist. Contact her at *joanafpc@gmail.com*.

Letters to the editor: *ct@counseling.org*