

Introducing the Theory of Neurosocial Interdependence: Moving Beyond the Person-In-Environment Perspective in Social Work

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Abstract: *Thoughts, emotions, and behaviors are linked fundamentally to the environments one inhabits. The person-in-environment perspective effectively captures these three aspects of the human experience and serves as a central fixture within social work research and practice. Many social workers use this perspective to guide every facet of the work they undertake, from case conceptualization to ethics of human subject research. At the same time, recent advancements in human neuroscience research and neuroimaging technologies have inspired social workers to embrace how the nervous system is integrally interconnected with one's environments. In turn, human neuroscience has catalyzed more biologically-informed practice and research in the field of social work, centered on elucidating social and psychological developmental domains within systems. The popularity of the person-in-environment perspective and the integration of human neuroscience in the field of social work has created a nexus that heretofore has not been adequately integrated into the literature. The present paper addresses this gap with a novel theory known as neurosocial interdependence, which integrates insights from human neuroscience into the framework of the person-in-environment perspective. This paper also bolsters the development of the theory of neurosocial interdependence by introducing a novel testing instrument and measurement scale, exploring how these tools might be used to implement the theory of neurosocial interdependence within social work research and clinical settings.*

Keywords: *neuroscience, person-in-environment, social work, brain, nervous system*

Social workers tend to view their clients as individuals firmly rooted in their social, cultural, perceptual, and political environments, with thoughts, feelings, and behaviors intimately connected to these environments (Germain & Gitterman, 1980; Gordon, 1969; Rodwell, 1990). This perspective of social work practice has been informed by years of theoretical research in the fields of biology and social science (Bowen, 1993; Bronfenbrenner, 1981; McKenzie, 1984; Park, 1915; Thomas & Znaniecki, 1958; Von Bertalanffy, 1969). This perspective took shape from the seminal work of Mary Richmond (1917) who championed what would later be called the person-in-environment perspective (PIE). PIE uses the contexts in which one is situated as a lens through which to view and understand an individual's behaviors (Richmond, 1917). PIE also introduces a notion of "reciprocity" to the relationship between a person and their environments: An individual can impact their environments in many ways, just as these environments can levy numerous influences on an individual (Richmond, 1917). PIE remains a popular perspective for social work clinicians and researchers (Kondrat, 2013; Schalock et al., 2020).

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Since the “decade of the brain” in the 1990s, human neuroscience has been used as a language, method, and tool with which to conduct novel research and perform novel interventions in the field of social work (Farmer, 2009; Levine, 2015; Miehl & Applegate, 2014; Porges, 2003; Schore & Schore, 2011; Shapiro & Applegate, 2018; Siegel, 2001; Van der Kolk, 2014; Van Cleave, 2016). In social work practice, for example, developmental theory uses phases of neuroanatomical growth in children and adolescents to conceptualize stages of cognitive development and patterns of behavior to enhance goal attainment (Arsalidou & Pascual-Leon, 2016). The clinical application of attachment theory has expanded from research into autonomic nervous system (ANS) function, emotional dysregulation, and fear/stress stimuli experienced during childhood to modify how individuals conceptualize the link between social relationships and their bodies (Cozolino, 2014). Theories of trauma have also begun to incorporate insights about the function of the amygdala in the human fear response, ANS dysregulation, and volumetric alteration of the hippocampus to help individuals conceptualize and moderate the physiological impacts of traumatic stress (Levine, 2015). In social work research, human neuroscience has been used as a tool to compare brain area activity during the implementation of different trauma therapies (Pierce & Black, 2023b; Pierce et al., 2023). Additionally, human neuroscience has aided social workers with identifying optimal interventions for children with different math performance and reading challenges (Ashkenazi et al., 2013). Research into the clinical treatment of addiction as well as complex presentations of childhood trauma exposure have also been enhanced by the introduction of research outcomes from human neuroscience (Cross et al., 2017; Klorer, 2005; Koob & Volkow, 2016; Volkow & Boyle, 2018). Human neuroscience has also helped inform policy makers around providing quality resources for adolescents experiencing adverse events within their home environments (Weems et al., 2021). Overall, the introduction of human neuroscience to the field of social work has presented many benefits to researchers, clinicians, and the clients they aim to impact.

Despite these benefits, researchers have addressed in a limited capacity how PIE might be used when filtered through the lens of human neuroscience. Additionally, this burgeoning interest in human neuroscience among social workers has not been thoroughly integrated into theories, frameworks, and perspectives important to research and practice. Thus, one might observe a tension that has formed at the nexus between social work theory and human neuroscience research. The present paper addresses this tension by proposing a novel theory that merges PIE with current insights from human neuroscience: the theory of neurosocial interdependence. This paper will briefly outline the contexts where neurosocial interdependence can fit into research and clinical discourse, briefly outline the theoretical framework of neurosocial interdependence, and discuss future directions for how this theory might be applied in clinical practice and research.

Theoretical Frameworks and Human Neuroscience

Human neuroscience is the study of the human nervous system and biological bases of various cognitive, affective, and behavioral processes and mechanisms (Oktar, 2006). Neuroscientists typically conduct their research using neuroimaging technologies, source separation techniques, and electrochemical methodologies (Cichocki et al., 2009;

Ganesana et al., 2017). Human neuroscience research is validated, like other scientific disciplines, through the process of replicating study designs, procedures, and results (Gutzen et al., 2018). Neuroscientists also rely on theories to direct their research endeavors and interpret evidence from prior studies (Levenstein et al., 2020). Theories provide frameworks through which studies can be designed and results can be analyzed.

Despite the utility of theoretical frameworks, neuroscience researchers have devoted little attention to the process of theory creation and implementation (Levenstein et al., 2020). To be sure, literature has covered an area that has been termed the “philosophy of neuroscience,” including discussions about how neuroscientific research interacts with philosophical questions and frameworks (Bickle et al., 2019). While important work has been done in this area (see Churchland, 1986), neuroscientists have yet to formally construct a theory that conceptualizes the work they conduct. Neuroscientists often employ theories to help them frame their scientific procedures (Bello-Morales & Delgado-García, 2015; Frank & Badre, 2015; Timme & Lapish, 2018), but neuroscience has been and continues to be as a discipline of scientific methodology, where theory does not apply to the discipline itself.

Without theory neuroscientists face potential challenges, such as lacking conceptual clarity to guide the work they do. “Conceptual clarity” in this case means the ability of a researcher to distinguish between or relate certain concepts within the field. When conducting a region of interest (ROI) analysis of the basal ganglia in substance use disorders, for example, neuroscientists observe that the ventral tegmental area (VTA) produces hormones that facilitate emotions of contentment and euphoria (e.g., serotonin, dopamine, and γ -aminobutyric acid). The release of these hormones contributes to pattern-based learning of substance use implicated in the orbitofrontal cortex (OFC; Bouarab et al., 2019; Natarajan & Yamamoto, 2011; Schoenbaum & Shaham, 2008). While researchers observe these functions occurring in the basal ganglia, they do not know why these functions work together to create the specific phenomenon known as addiction. There is no concept of why these ROIs in the basal ganglia work together this way, and thus there is no theoretical framework with which researchers might understand the neural processes underlying substance use and dependence.

The paucity of theory in human neuroscience lends also to a diminished capacity to standardize research procedures—such as studies implicating the use of neuroimaging technologies—that can be applied within the discipline. Functional magnetic resonance imaging (fMRI) or electroencephalography (EEG) are two of the most common neuroimaging methodologies that are used by neuroscientists. There are a plethora of articles that explain how these machines work (Glover, 2011; Thakor & Sherman, 2012), but no theoretical frameworks exist for how a researcher ought to operate one of these imaging machines to collect data about the human brain both effectively and ethically. This challenge limits neuroscientists’ attempts to implement standards of practice for using these technologies and to establish ethics around neuroimaging (Eglen et al., 2017; Garnett et al., 2011; Illes & Racine, 2005; Moss et al., 2021; White, 2010). When applied to the discipline of itself, theory would help avoid such pitfalls.

Strengths and Shortcomings of PIE

Unlike human neuroscience, the field of social work has embraced the process of theory creation and implementation for many years. Indeed, the field of social work has incorporated many theoretical perspectives such as behaviorism (Bronson & Thyer, 2001), the strengths perspective (Saleebey, 1996), and the biopsychosocial-spiritual framework (Berzoff & Drisko, 2015). The concept of intersectionality, for example, has greatly enriched social work practice by inviting clients and clinicians to explore how different areas of oppression (e.g., racism, heterosexism, homophobia, etc.) impact the individual and their relationships to the environments they inhabit (Almeida et al., 2019; Matsuzaka et al., 2021). Social work has also come to use feminist theory and critical race theory (CRT) toward breaking down patriarchal constructs of mental health and centering communities of color in discussions of resource provision and acquisition (Constance-Huggins, 2012; Kolivoski et al., 2014; Sands & Nuccio, 1992; Saulnier, 2000). Alongside these frameworks, PIE has increased in popularity across the field of social work and has brought many unique strengths to clinical practice and research (Engel & Schutt, 2016; Hepworth et al., 2016; Hutchinson, 2017; Kondrat, 2013; Reisch, 2019; Rogers, 2022; Rogge & Cox, 2001; Zastrow et al., 2018).

PIE is a theoretical framework that holistically conceptualizes an individual's lived experience within many areas of the environments they inhabit (Akesson et al., 2017; Bogo, 2021; Craik, 2000; Lei et al., 2021; Mathende & Nhapi, 2017; Murphy et al., 2022; Pitt, 2013; Richmond, 1917; Saleebey, 1992; Weick, 1981). This orientation is particularly useful for providing mental health services to clients and communities because mental health challenges occur in an interdependent relationship with one's environments (Guloksuz et al., 2016; Monroe, 1988; Mueller, 1980; Rice et al., 2010). In other words, thoughts, feelings, and behaviors can be influenced by many factors in one's environment, just as these same psychosocial features can impact one's environment.

Take, for example, post-traumatic stress disorder (PTSD): A condition with an onset linked to events in the environment (e.g., natural disasters, community violence, sexual assault, child abuse, etc.). These environmental factors directly connect to the severity and duration of the onset, like how someone who survives a single car crash might develop PTSD, and someone who survives years of abuse from caregivers, across multiple developmental periods, might develop more complex PTSD features (Briere & Scott, 2015; Elliott et al., 2021). With recent research into complex PTSD, it has been observed how these impacts can occur in reverse as well; namely, that single events can produce complex PTSD, and individuals who experience chronic exposure can produce PTSD (Cloitre, 2020). While some research has been conducted into the neural substrates implicated in resilience and post-traumatic growth (Pierce et al., 2023), more work is needed to understand how environmental impacts of trauma lead to different mental health challenges.

On the other hand, individuals living with major depressive disorder (MDD) might exhibit, among other symptoms, a marked disinterest in activities they previously enjoyed (Kennedy, 2008). An example of how this symptom might manifest is when an individual elects to socially withdraw (Teo et al., 2020), shrinking their sphere of social interaction and activity. Because the symptomological impacts of MDD can be incredibly burdensome to endure due to its chronicity, some individuals might also not have enough energy to

engage in activities of daily living (ADLs), such as cleaning their homes (Ojagbemi et al., 2018; Park & Jung, 2019), bathing (Shevchuk, 2008), or eating (Ljungberg et al., 2020). The draining effect of MDD might then spill over into other areas of one's life, such as commitments to attending work or school, spending time with friends or family, and so on (Askeland et al., 2020; Elmer & Stadtfeld, 2020; Lamichhane et al., 2018). The psychosocial impacts of the COVID-19 pandemic also come to mind, which brought about depressive symptoms in many populations due to prolonged social isolation, among other factors (Renaud-Charest et al., 2021). One might observe here how the person and their environments interact in complex ways, across various different levels with respect to MDD.

Using PIE, social workers can conceptualize how one's environment impacts mental health as well as how mental health impacts one's environments. Accordingly, this perspective has led to various clinical interventions that factor in how person and environment interact. Consider, for example, prolonged exposure (PE), which is regarded as a frontline intervention for treating PTSD (Foa, 2011). PE like other exposure therapies (Deffenbacher & Suinn, 1988; Noordik et al., 2010; Pitman et al., 1991; Sars & Van Minnen, 2015) implicates the gradual desensitization of the fear stimulus in one's environment so that the survivor might be able to encounter this stimulus without experiencing distressing PTSD symptoms (Peterson et al., 2019). One might also consider Aymer (2016) who offers a case example of how psychoeducation in the framework of cognitive behavioral therapy (CBT) can be used to help people of color reframe the impacts of racism from a personal level to a systemic level. Using this technique allows these individuals to shift away from self-blame and other negative self-directed symptoms toward an externalized conception of systemic racism against which they might feel empowered to push back (Aymer, 2016). Beyond therapeutic modalities, social workers often provide case management services for their clients, such as connecting individuals with housing, legal, food, and health resources (Green & Ellis, 2017; Lukersmith et al., 2016). The positive psychological impacts correlated to integrating these environmental needs are numerous (Ziguras & Stuart, 2000).

For all its benefits, however, PIE exhibits a limitation: It does not clearly emphasize how the human brain is implicated in this interdependent relationship with the environment. Some researchers in the field note the importance of the link between one's neurophysiology and their environments (Black & Conway, 2018; Farmer, 2009; Hutchinson, 2017; Miehl, 2014; Shapiro & Applegate, 2018). However, researchers have not made a sufficiently strong link to PIE.

Hutchinson (2017), for example, includes helpful sections on basic brain structures, the endocrine system, the cardiovascular system, the musculoskeletal system, and the reproductive system. However, when integrating what Hutchinson (2017) terms as "the biological self" and the environment, attention is given to "environmental factors and exposures" and not the guiding framework itself (pp. 228–230). And when addressing "stress exposures," Hutchinson generally indicates negative biological impacts of environmental stress (Hutchinson, 2017, p. 230), but does not directly discuss the theoretical implications behind how the human brain relates to PIE. Additionally, Shapiro and Applegate (2018) present a thorough, user-friendly text that outlines clinical

implications of neuroscience research for social workers, but they appear to miss how the human brain relates to a perspective as crucial to social work as PIE. It is essential for social work theory to bridge with neuroscience because the structure and function of the brain serve as the bedrock for the interdependent relationship between a person and their environment. To bridge social work theory and human neuroscience, therefore, requires theory development that will enhance both fields and have the potential for adaptation beyond them.

Constructing the Theory of Neurosocial Interdependence

It has been observed that scientific theories require several key characteristics to be considered “high quality.” The theory must be 1) consistent in empirical observations, 2) precise, 3) parsimonious, 4) explanatorily broad, 5) falsifiable, and 6) promote scientific progress (Chijioke et al., 2021; Gieseler et al., 2019; Higgins, 2004; Payne, 2021; Robbins et al., 2011). Observing these characteristics, Shoemaker and colleagues (2004) devised a procedure for constructing a scientific theory that meets the criteria for “high quality.” This procedure includes the following steps: 1) define the theory; 2) identify core concepts associated with the theory; 3) find causes and effects for these core concepts; 4) specify theoretical and operational definitions for all concepts; 5) link concepts to create a hypothesis; 6) define rationale for this hypothesis; and 7) fit the hypothesis into a systemic framework (Shoemaker et al., 2004). These steps will be used to outline the theory of neurosocial interdependence.

Defining Neurosocial Interdependence

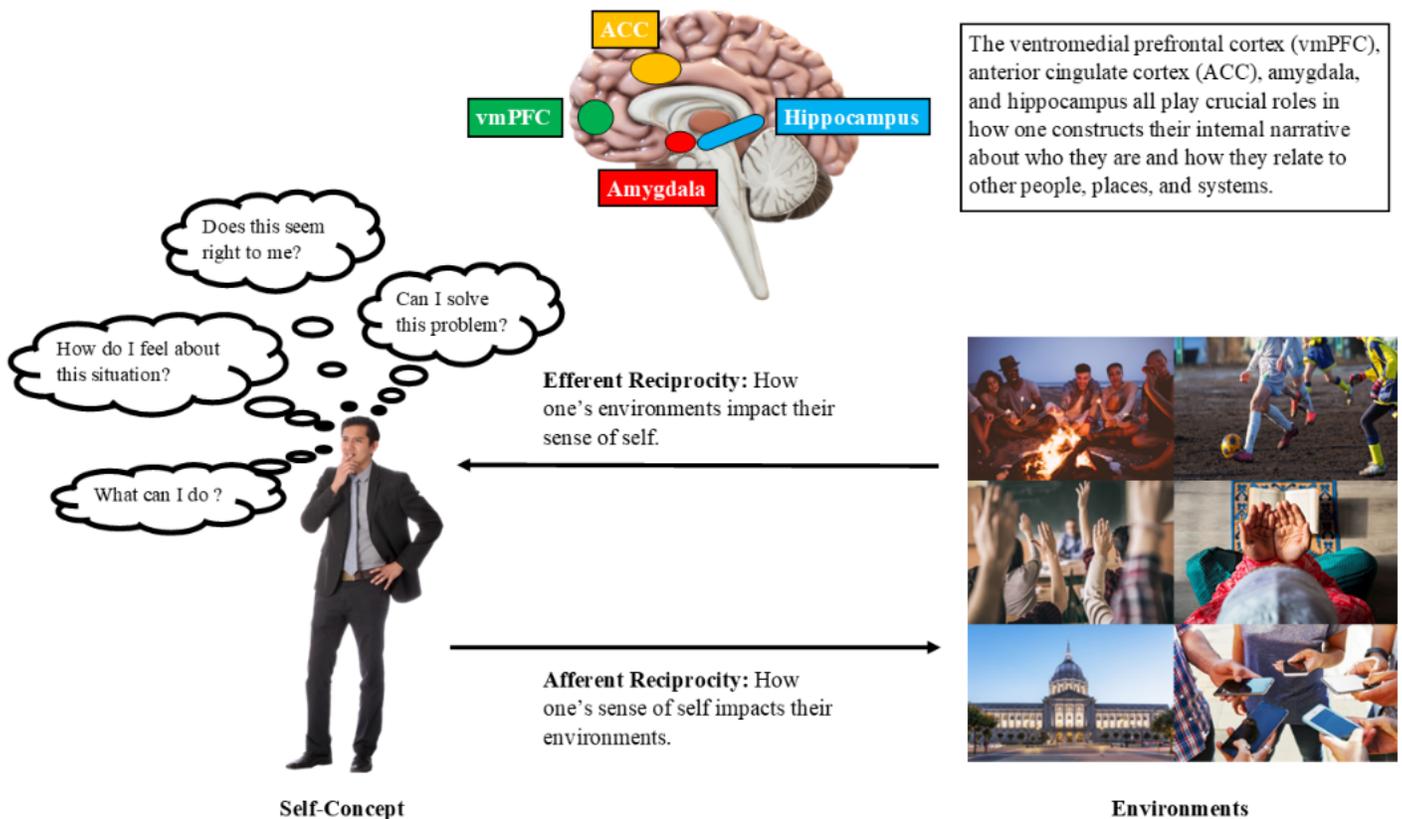
The first step involves creating a definition of the theory of neurosocial interdependence. *Neurosocial interdependence* is defined as the mutual reciprocity of processes and functions of the human brain with one’s environments. The phrases “processes and functions of the human brain” and “one’s environments” were included in this definition because the theory conceptualizes the human brain and the various environments in which one operates as a primary nexus through which to conceptualize cognition, affect, and behavior. Considering the relationship between these two components of the definition, the adjective “reciprocity” was used to capture the interdependent aspect of the relationship between one’s brain and their environments.

Core Concepts of Neurosocial Interdependence

From this definition two core concepts were derived: *efferent reciprocity* and *afferent reciprocity*. Efferent reciprocity relates to how one’s environments impact their sense of self. Afferent reciprocity relates how one’s sense of self impacts their environments. These concepts were derived from human neuroscience where efferent and afferent refer to neural signals that are sent toward or away from an indicated brain region, respectively (Gautam, 2017). In the present context, however, efferent and afferent indicate the directionality of connection that one experiences to themselves (inward) and to their environments (outward). Research on perception of internal self-states and external environments from

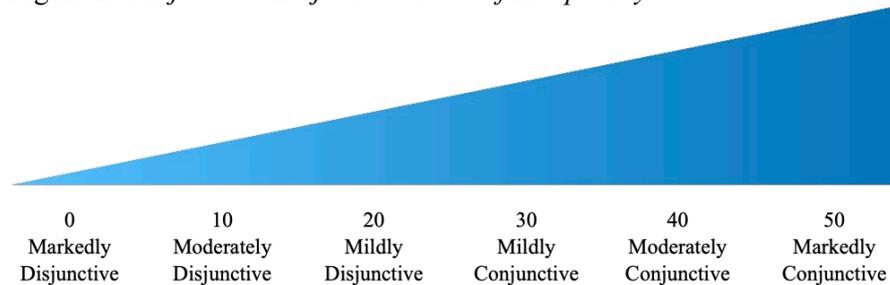
cognitive neuroscience was also incorporated to frame the concepts of efferent and afferent reciprocity. For example, when one perceives social support from others and assess the emotional value of that support, there is increased functional connectivity between the amygdala and the hippocampus, which informs the person that this social support is either helpful or unhelpful for their safety and wellbeing (Lu et al., 2018; Piretti et al., 2020). Additionally, the anterior cingulate cortex helps individuals to construct and act upon their worldviews, an internal narrative of who they are and how they might impact the people, places, and systems around them (Morita et al., 2014; Stevens et al., 2011). Lastly, the ventromedial prefrontal cortex (vmPFC) is responsible for self-referential processing of internal states of awareness and has been observed to play a key role in social relationship building and operationalizing desires for external change based on self-concept (D’Argembeau, 2013; Kim & Johnson, 2015; Moneta et al., 2023). As one might observe, the present theoretical model provides neural and social bases upon which inward and outward connection to oneself and their environments might be discussed and studied (Adolphs, 2003; Cacioppo et al., 2010; Cordeiro et al., 2021; Han et al., 2021; Heatherton, 2011; Ladouce et al., 2017; Park & Huang, 2010; Taylor et al., 2015). See Figure 1 for a model of the theory and these core concepts.

Figure 1. *Basic Framework of the Theory of Neurosocial Interdependence*



It should be noted that these concepts are not mutually exclusive, as functions of conceptualization of self and environment often overlap in the brain (Montemayor & Haladjian, 2017). It is posited, therefore, that these concepts can be measured on a spectrum, where increased reciprocity is indicated by the term *conjunctive*, and decreased reciprocity is indicated by the term *disjunctive*. Figure 2 represents our Conjunctive-Disjunctive Scale of Reciprocity (CDSR) which measures levels of conjunction or disjunction relative to one’s score on the Checklist of Efferent and Afferent Reciprocity (CLEAR; see Figure 3). Levels of conjunction and disjunction are qualified by the categories “mild,” “moderate,” and “marked.” The term “marked” was used instead of “severe” to prevent individuals from experiencing stigma associated with the negative connotation of a “severe” result on a psychometric instrument.

Figure 2. *Conjunctive-Disjunctive Scale of Reciprocity*



For mental health practitioners to measure these elements of reciprocity in a clinical setting, the authors of this paper have devised what is called the Checklist of Efferent and Afferent Reciprocity (CLEAR). The CLEAR is a 20-item self-reporting checklist that measures various features associated with efferent and afferent reciprocity. Items 1–10 measure features germane to efferent reciprocity, and items 11–20 measure features germane to afferent reciprocity. Items on the SCRC are structured using 6-point Likert scales, where the individual is asked to rate how their lived experience correlates with each item. Item response options range from 0 or “Not at all” to 5 or “Very often.” The CLEAR can be administered by clinicians using a short-term or long-term format. In the short-term format, the individual is asked to rate their experiences of efferent and afferent reciprocity during the past week. In the long-term format, the individual is asked to rate their experiences of reciprocity during the past month. These two formats were used to account for micro and macro changes that might occur with an individual’s experiences of reciprocity (Walentynowicz et al., 2018). Figure 3 below presents all questions delivered in the CLEAR, irrespective of time-dependent format. The CLEAR has yet to undergo reliability and validity testing and thus requires further assessment before implementation in clinical settings.

Figure 3. *The checklist of efferent and*

Answer each question according to your lived experience within the past (week/month).

Circle the number most accurately represents your answer below.						
0 = Not at all 1 = Not often 2 = Sometimes 3 = Somewhat often 4 = Often 5 = Very often						
In the past week/month ...						
Efferent Reciprocity						
1. My communities helped me feel like I belong.	0	1	2	3	4	5
2. My communities provided me with emotional support.	0	1	2	3	4	5
3. My communities validated my gender and/or sexual identities.	0	1	2	3	4	5
4. My communities encouraged body positivity.	0	1	2	3	4	5
5. My communities encouraged me to solve problems effectively.	0	1	2	3	4	5
6. My communities encouraged me to think creatively.	0	1	2	3	4	5
7. My communities informed me about what was 'right' and 'wrong'.	0	1	2	3	4	5
8. My communities informed me how to care about the wellbeing of others.	0	1	2	3	4	5
9. My communities encouraged me to pursue my goals.	0	1	2	3	4	5
10. My communities encouraged me to better myself.	0	1	2	3	4	5
Afferent Reciprocity						
11. I helped others in my communities feel like they belong.	0	1	2	3	4	5
12. I provided emotional support to others in my communities.	0	1	2	3	4	5
13. I validated the gender and/or sexual identities of others in my communities.	0	1	2	3	4	5
14. I regard others in my communities with body positivity.	0	1	2	3	4	5
15. I effectively solved a problem in my communities.	0	1	2	3	4	5
16. I thought creatively about how to better my communities	0	1	2	3	4	5
17. I addressed an issue in my communities using what I know as 'right' and 'wrong'.	0	1	2	3	4	5
18. I demonstrated care for the wellbeing of others in my communities	0	1	2	3	4	5
19. I pursued my goals in my communities.	0	1	2	3	4	5
20. I encouraged others in my communities to better themselves.	0	1	2	3	4	5

As has been discussed, efferent reciprocity indicates how one's environments impact their sense of self. For example, an individual who says, "I need to take care of myself tonight because I had a rough day at work" might be exhibiting conjunctive efferent reciprocity. The assumption here is that this person engages in self-care because they recognize the psychological impact of their work environment on their sense of self. On the converse, if the same individual with the same work day says, "I am feeling stressed out and I don't know why," they might be exhibiting disjunctive efferent reciprocity. Here, the individual is aware of their sense of self via their stress response, but they are unaware of the role of the environment in their stress response.

There is also afferent reciprocity, which indicates how one's sense of self impacts their environments. Conjunctive afferent reciprocity might be present if someone recognizes that they were raising their voice at a business meeting due to stress and apologizes to their colleagues for their behavior. In this example the individual recognizes the impact of their sense of self on the environment around them and engages in social

cognition to repair ruptured relationships with others in that environment (Zaki et al., 2010). On the converse, disjunctive afferent reciprocity might be indicated if this same individual expressing stress via a raised voice were to comment later on, “I know I yelled because I was stressed, but I don’t get why everyone avoided me after that business meeting.” Here, the individual was aware of their sense of self but did not recognize the impact of their sense of self on the surrounding environment. Of course, these examples are hyperbolic to emphasize the full scope of conjunctive and disjunctive aspects of efferent and afferent reciprocity.

Causes and Effects for Core Concepts

To further illustrate these core concepts of the theory of neurosocial interdependence, several vignettes will be presented, identifying possible causes and effects in which conjunction and disjunction might be observed for these concepts. First, consider a white male military service person named Michael. Michael was diagnosed with PTSD by a social worker at the Veterans Administration for trauma exposure during his military service. Michael is enjoying breakfast in his apartment on a Saturday morning. Suddenly, a news helicopter flies over his apartment, and the sound of the helicopter’s blades reverberate throughout Michael’s apartment. The noise of the helicopter blade’s reminds Michael of a traumatic event that occurred during service, where a close friend in his battalion was shot down while riding a Blackhawk helicopter. The sound of the helicopter blades functions as a trauma trigger for Michael. Unfortunately, this trigger caused Michael to experience an episode of dissociation, where he was perceptually transported to the day of his close friend’s tragic passing. Then, Michael’s limbic system activates and causes his body to tense up, produce sweat, and experience harrowing feelings of panic (Pierce & Black, 2023a, 2023b; Pierce et al., 2023; Sherin, 2011).

If the theory of neurosocial interdependence were applied to Michael’s episode of dissociation, he might be experiencing both disjunctive efferent and afferent reciprocity. Michael’s episode of dissociation caused him to disconnect from his sense of self and his immediate environment due to the overwhelming nature of his trauma trigger, which included hearing a news helicopter flying over his residence. The effects of this trigger were the resultant episode of dissociation and limbic system response. Studies have shown that during a dissociative episode, functional brain activity is concentrated on emotion processing centers in the limbic system—principally, the amygdala—which produce concomitant neurotransmitter impulses that trigger the body to fight, run away, or freeze in a manner similar to the traumatic event (Kozłowska et al., 2015; Morey et al., 2012). Within these activated areas is the hippocampus, or the primary memory encoding center in the human brain. During dissociation the hippocampus activates, and this activation is correlated with the experience of one being immersed in the time and place of a vivid traumatic memory (Bourne et al., 2013). With these neurological phenomena, Michael’s nervous system was perceptually disconnected from his sense of self and his environment around him during this episode of dissociation because he was immersed in the experience of a vivid traumatic memory (Yron-di et al., 2020). Thus, with respect to the theory of neurosocial interdependence, Michael’s episode of dissociation indicates that he might be experiencing disjunctive efferent and afferent reciprocity because he experienced

disconnection from how his environment impacted him and how he potentially impacted his environment.

Consider a second example, where a Black female named Danielle is journaling on a back porch with a picturesque woodland view in the background. Danielle thoroughly enjoys journaling because this exercise prompts her to reflect on all that she did in a given day. She sees the mountain she hiked yesterday in the distance and reflects on the various thoughts, feelings, and body sensations that arise when recounting the momentous accomplishment of summiting its peak. This moment, in part, inspires Danielle to volunteer with a local environmental conservation organization to ensure that others might be able to share in her experience of admiring this woodland view and hiking that mountain for generations to come.

Using the framework of the theory of neurosocial interdependence, one might observe that Danielle is experiencing both conjunctive efferent and afferent reciprocity. She identified the impact of her environment on her sense of self by journaling and then observing the mountain she hiked the previous day, where she reflects on thoughts and feelings she experienced during her hike. What is more, Danielle identified how her sense of self was connected to her environment by not only recognizing but also catalyzing her sense of self to give back to her environment through conservation efforts. Accordingly, Danielle's robust interdependent connection between her sense of self and her environment indicates conjunctive efferent and afferent reciprocity.

Lastly, consider a Latinx female basketball player named Samantha. Samantha plays the power forward position on her high school basketball team, which requires her to shoot layups while drawing foul contact from opposing players, thus leading to opportunities for foul shots. Samantha has been practicing her foul shots consistently to ensure that she is able to maintain a high level of accuracy when the game is close to finishing and the score is close or tied. Samantha practices her foul shots wearing a pair of headphones that play the noises of a jeering crowd to desensitize and disconnect herself from the disorientation of an opposing team's fanbase. Several days later, Samantha's team is playing an away game, and they are down 70–72 with 7 seconds to play in the game. Samantha is calm and focused, and she uses her sense of self to spot an open section of court near the hoop to move toward. Her teammate passes her the ball as opposing players converge. Samantha goes up for a layup and is fouled. She scores the basket. The game is now tied 72–72 with 3 seconds left to play. Samantha walks to the free-throw line to shoot one basket to put her team ahead by one point. Having prepared for this moment, Samantha tunes out the opposing crowd and focuses on her shooting form. Samantha shoots and scores the free throw. Samantha's team ended up winning 73–72.

Referring back to the theory of neurosocial interdependence, Samantha's performance in this basketball game might have demonstrated conjunctive afferent reciprocity but disjunctive efferent reciprocity. Samantha was aware of her sense of self at the end of the game and leveraged it to find an open position from which to score a basket and draw a foul from an opposing player. When it came time to shoot her free throw, however, Samantha disconnected from the potential impacts of his environment by focusing on her shooting form, which led to her sinking the game-winning basket (Purcell et al., 2019).

Theoretical and Operational Definitions

According to criteria outlined by Shoemaker and colleagues (2004) about creating strong theory, the concepts of efferent reciprocity and afferent reciprocity require theoretical and operational definitions. First, efferent reciprocity is theoretically defined as the recognition of the impact of one's environments on their sense of self. One might recall how Danielle identified her thoughts, feelings, and bodily sensations in her journal from the previous day's hike to signal that she recognized the impact of the environment on her sense of self. Similarly, a theoretical definition of afferent reciprocity implicates the recognition of the impact of one's sense of self on their environments. Consider how Samuel's sense of calm and focus led him to move through his environment to find an advantageous position from which to shoot the basketball on the court. Next, there are operational definitions of efferent and afferent reciprocity. Efferent reciprocity measures how brain regions of perception and self-concept formation are impacted by stimuli from one's environments. Efferent reciprocity can be measured in clinical settings using the CLEAR as well as other psychometric self-concept instruments like the five-factor self-concept questionnaire (AF5; Garcia et al., 2018), the Robson self-concept questionnaire (SCQ; Addeo et al., 1994), or Rosenberg's self-esteem scale (RSES; Park & Park, 2019). Afferent reciprocity, on the other hand, measures how brain regions of perception and self-concept formation react when impacting one's environments. Afferent reciprocity might also be measured using the CLEAR, as well as other instruments like a sociometric test (Sabin et al., 2014) or one of numerous community engagement surveys (Attree et al., 2011; Cyril et al., 2015; Hood et al., 2010). In laboratory settings, both forms of reciprocity can be measured with an electroencephalography (EGG) or fMRI (Glover, 2011; Thakor & Sherman, 2012).

Create a Hypothesis and Define its Rationale

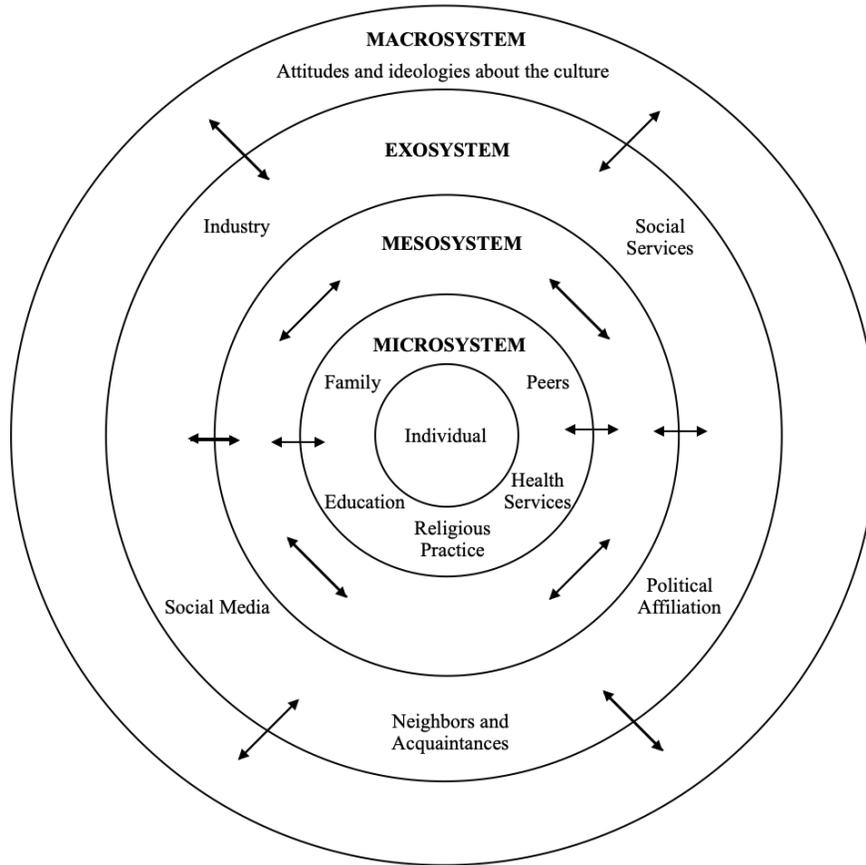
Having theoretically and operationally defined efferent reciprocity and afferent reciprocity, these concepts will be synthesized to create a working hypothesis for the theory of neurosocial interdependence. The hypothesis is as follows: How someone perceives their sense of self can impact, and be impacted by, their environments. People experience various cognitions, sensations, and affects in response to stimulus cues from their environments, and people can similarly impact their environments by using these cognitions, sensations, and affects as guides for response (Beer, 2008; Dotov, 2014; Pretty et al., 2017; see Will et al., 2021). This phenomenon is captured in the core concepts of the theory of neurosocial interdependence: the human nervous system and one's external environments are in a commutual relationship where one's self-concept is informed by cues from the environment (efferent reciprocity), and one's self-concept can be used to impact the environment (afferent reciprocity). These core concepts from which this hypothesis was derived can be measured using the CLEAR instrument described above. The general format of the CLEAR is structured in a way that will maximize the potential for both high internal validity and reliability, considering that the number of items in the checklist can account for nuances in participant responses (Chang, 1994; Deniz & Alsaffar, 2013; Taherdoost, 2019) Therefore, the hypothesis presents promise for accurate predictive value

for measuring what it intends to measure (Heston & King, 2017). Further testing of the CLEAR is needed, however, to validate these initial claims.

Proposing a Systemic Framework for Neurosocial Interdependence

The present hypothesis might best fit into a systemic framework like the ecological systems model posed by Bronfenbrenner (1981; see Figure 4). Bronfenbrenner's four-tiered model represents different levels of environmental contexts in which one might engage in their daily life (e.g., microsystem, mesosystem, exosystem, and macrosystem). This model provides a framework for which aspects and outcomes from the theory of neurosocial interdependence might best be observed and measured. For example, social workers might use this framework to compare efferent and afferent reciprocity for a teenager who lives in a home with two siblings and two parents (e.g., a microsystem) versus the same teenager once they begin taking classes at a large state university (e.g., an exosystem). Social workers might also compare efferent and afferent reciprocity among members of a friend group hailing from different neighborhoods (e.g., a microsystem) with their sociopolitical beliefs about what it means to be part of a community (e.g., a macrosystem). Overall, the ecological systems model (Bronfenbrenner, 1981) serves as a useful tool to help clinicians and researchers situate individuals' neurosocial interdependence within their respective environments.

Figure 4. *Bronfenbrenner's Ecological Systems Model*



Limitations

For all of the helpful insights and provocative questions that the theory of neurosocial interdependence may bring to the field of social work, there are some limitations worth consideration. First, it should be stressed that the CLEAR has not yet undergone formal testing and validation. Once this instrument has been sufficiently assessed with various populations, then the discussion can be enriched with respect to its validity and reliability for assessing concepts germane to the theory of neurosocial interdependence. Second, the implementation of the CLEAR instrument might present some challenges to accurately measuring efferent and afferent reciprocity considering the nature of the instrument. The CLEAR instrument was designed to be a self-report assessment. Unfortunately, self-report assessments introduce a number of potential biases that could skew results. For example, individuals who fill out the CLEAR with their clinician might avoid answering questions that demonstrate either efferent or afferent disjunction because they might infer that there is a deficit with how they interact with the environment, thus engaging in a social desirability bias (Bergen & Labonté, 2020; Larson, 2018; Latkin et al., 2017). Like social desirability bias, participants in a neurosocial interdependence study might fill out answers on the CLEAR that are generally more affirmative in nature to indicate that they agree, for

example, that they have marked conjunction in both efferent and afferent reciprocity, which is defined as acquiescence bias (Kreitchmann et al., 2019; Lelkes & Weiss, 2015).

Another limitation of neurosocial interdependence might implicate cross-cultural transferability. One might imagine that the western, empirical, and neuroscientific framework of the theory of neurosocial interdependence might not resonate with cultures for whom ways of being and knowing do not implicate these above-mentioned perspectives. Indeed, the western foundation of neurosocial interdependence might preclude individuals from cultures impacted by western colonialism from receiving the full benefits of this framework in both research and treatment. One possible avenue with which to navigate this limitation might include changing the language and adapting the format of the theory for use within non-western cultures with different ways of knowing (Al-Krenawi & Graham, 2001; Graham et al., 2009; Marsiglia & Booth, 2015). Indeed, it is necessary to support efforts to adapt and decolonize western research in a way that includes the voices of those silenced and marginalized along the imperial periphery.

Future Directions for Clinicians and Researchers

From this introduction of the theory of neurosocial interdependence and its related concepts, there are several implications that this theory holds for clinical practice and research in the field of social work. Efferent and afferent reciprocity address the interdependent relationship between the person's perception of themselves and their environments. Additionally, the CLEAR instrument is designed to measure how efferent and afferent reciprocity figure in one's capacity to notice how they impact, and are impacted by, the spaces they occupy. Therapeutically, the theory of neurosocial interdependence could be applied to interventions involving mindfulness. Mindfulness exercises implicate the practice of noticing the impact of stimuli in one's environment and avoiding judgment of those stimuli and their impacts (Hofmann et al., 2010). The conceptual framework of efferent and afferent reciprocity invites individuals to notice how their nervous systems interact with their environments in a way that harmonizes with the goals of mindfulness exercises.

Concepts from neurosocial interdependence also hold import for practice with dialectical behavioral therapy (DBT). Distress tolerance interventions, for example, are used during the course of DBT and often implicate mindfulness exercises (Elices et al., 2017; Lothes et al., 2021). Efferent and afferent reciprocity could serve as useful concepts for framing treatment outcomes with respect to managing distress tolerance, since introducing mindful awareness of how nervous system interacts with their environments has been shown to aid with increasing distress tolerance (Navarro-Haro et al., 2019). Additionally, the CLEAR instrument and the Conjunctive-Disjunctive Scale of Reciprocity (CDSR) could be used to measure efferent and afferent reciprocity, and then introduce psychoeducational and empowering conversations between client and clinician that gives new perspective to everything from distress tolerance to resilience and growth.

Efferent and afferent reciprocity likewise dovetail with interventions designed for individuals living with PTSD, such as cognitive processing therapy (CPT), eye movement desensitization (EMDR), and prolonged exposure (PE). These interventions, among others,

help individuals manage the sense of overwhelm associated with traumatic stress symptoms and rebuild their sense of self after a traumatic event has occurred (Gallagher & Resick, 2012; Hendriks et al., 2018; Pierce et al., 2023; Valiente-Gomez et al., 2017). Concepts undergirding the theory of neurosocial interdependence explore how the human brain impacts, and is impacted by, one's environments. Reframing how the nervous system interacts with one's environments can be useful for helping individuals not only manage distressing symptoms but also cognitively restructure unhelpful beliefs about the world and oneself associated with the trauma, thus potentially refining or reinforcing action plans and clinical interventions (Wilkinson, 2017).

Lastly, clinicians might find purchase within the theory of neurosocial interdependence during interventions with individuals who live with attention deficit hyperactivity disorder (ADHD). While ADHD might present vastly different strengths and challenges for individuals who live with the condition, a hallmark feature of ADHD implicates varied challenges associated with attention (Depue et al., 2010; Lenartowicz et al., 2018; Mette et al., 2013). The theory of neurosocial interdependence might help provide space for clinicians and clients to explore how attentional skills might be enriched by engaging one's brain with their environments in new ways, such as "sensory breaks" introduced throughout a long, contiguous project (Herbert & Esparham, 2017).

With respect to social work research, the theory of neurosocial interdependence maintains several implications for systems-related studies. One might recall the two examples provided above that addressed the utility of Bronfenbrenner's (1981) ecological systems model within the theory of neurosocial interdependence. Reciprocal impacts of the brain's perception of self on the environment can be compared between different levels of this model, particularly using large research cohorts or discrete experiment and control groups (Gilleard, 2004; Manson, 2008; Stokols et al., 2013). Findings from studies that apply the theory of neurosocial interdependence in this way could help expand the knowledge base concerning how the brain reacts within, and responds to, disparate environmental contexts.

One might also consider how to combine assessments of efferent and afferent reciprocity using the CLEAR assessment and neuroimaging technologies. For example, research teams could compare efferent and afferent reciprocity among children who are receiving treatment for sensory processing disorder (SPD). An example study might employ a control group and experimental group with SPD. Both groups would undergo pre- and post-test fMR imaging as well as completing of the CLEAR before and after the experiment. A study using this design would be able to show which brain areas might be implicated in attentional and sensory aspects associated with neurosocial interdependence and compare how neurosocial interdependence might figure differently for individuals who live with sensory conditions like SPD.

Overall, the theory of neurosocial interdependence shows promise for a variety of settings within social work research and clinical practice. This theory can be observed and tested within a variety of age groups, with different mental health conditions, and within different systems contexts. The theory of neurosocial interdependence can greatly enrich

the field of social work and advance current knowledge about how individuals interact with, and are part of, their environments.

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