

Brain and heart synchrony: Insights for youth

Usman Jaffer^{1*}
Ida Khadija Mohd Fazli²

^{1,2}Abdul Hamid Abu Sulayman Kulliyah of Islamic Revealed Knowledge and Human Sciences International Islamic University Malaysia, Jalan Gombak, Kuala Lumpur.

*Corresponding author: jafferu@iium.edu.my

Abstract: The prophetic ﷺ guidance to carefully select one's companionship aligns deeply with contemporary scientific findings on physiological synchrony. This paper thus explores the concepts of brain-to-brain and heart-rate synchrony as mechanisms for youth development, viewed through an integrated Islamic and psychophysiological view. Drawing on recent hyperscanning and cardiac coherence research, it purports that the company a young person keeps directly moulds their neural and autonomic regulation. This paper further examines the importance of synchrony in foundational social domains for youth, including parent-child bonds, friendships, and the wider community through practices like congregational prayer. It is argued that positive synchrony which is fostered in righteous company, is integral to the holistic well-being envisioned in Islam, encompassing cognitive, emotional, social and spiritual health. Conversely, negative synchrony, or co-dysregulation, can arise from detrimental social connections, hindering healthy development. Finally, this paper proposes practical applications, suggesting that by consciously choosing one's company, youth can actively cultivate the positive neural and cardiac connections that contribute to a balanced and spiritually grounded life manifesting as a valuable khilāfah in the human experience.

Kata Kunci:

Companionship,
heart rate variability,
inter-brain synchrony,
Islamic psychology,
physiological synchrony,
youth

DOI :

[10.20885/iscip.vol2.art15](https://doi.org/10.20885/iscip.vol2.art15)

Over fourteen centuries ago, the Prophet Muhammad (ﷺ) offered profound pieces of social and spiritual guidance: “A man is upon the religion of his best friend, so let one of you look at whom he befriends” (Tirmidhi, 2378) and “On the Day of Resurrection, Allah, the Exalted, will say: ‘Where are those who have mutual love for the sake of My Glory? Today I shall shelter them in My Shade when there will be no shade except Mine’” (Muslim). These statements highlight a timeless truth, that our social connections fundamentally shape our beliefs, behaviours, and very being not only in this earthly realm but even in the hereafter. Whilst these hadith are generally interpreted in the spiritual domain, cotemporary research, the fields of neuroscience and psychophysiology are beginning to uncover the biological mechanisms that underpin these deep influences as well, thus indicating this choice companionship enters the spiritual, biological, psychological as well as social domain of individuals as well as societies. Through advanced technologies, scientists, researchers as well as clinicians, can now observe how brains and hearts attune to one another during social interaction, a phenomenon known as physiological synchrony. Physiological synchrony refers to the coordination of biological processes between individuals during interaction (Feldman, 2017), which occurs largely outside conscious awareness and is a powerful indicator of connection and engagement. Contemporary advancements have thus allowed researchers to investigate this phenomenon at the level of the brain as well as the heart.

This paper therefore examines the science of inter-brain and inter-heart synchrony, inter-realm and inter-universe, integrating it with the Islamic perspective on companionship to offer holistic insights for the well-being of youth.

Brain-to-Brain Synchrony

Inter-brain synchrony is the alignment of neural activity between two or more individuals, often measured using electroencephalography (EEG) hyperscanning, which records brainwaves from multiple people simultaneously (Dikker et al., 2017). Research shows that this neural coupling is a marker of successful social connection. Dikker et al. (2017), as a case in point, found that students’ brainwaves synchronised more when they were engaged in classroom activities, with this synchrony predicting both their engagement and social dynamics. This alignment is motivated by shared attention and joint action, where individuals co-create a shared mental space (Yang et al., 2023). In terms of adolescents and youth, mindfulness meditation was shown to enhance inter-brain synchrony in the gamma band when peers experienced emotions together, suggesting that practices that foster present-moment awareness can strengthen neural connections (Deng et al., 2024). Moreover, Sängers et al. (2012) demonstrated that guitarists performing duets exhibited significant inter-brain phase synchrony in frontal and central regions, suggesting that musical coordination is affected by temporally aligned neural dynamics. Similarly, Hu et al. (2018) showed

that cooperative tasks such as joint tapping increased inter-brain coherence in the theta and alpha bands, especially when individuals shared mutual goals. These findings therefore put forth, that human beings who are in each other's space have a direct and measurable influence on the brainwaves of others. What one brings into the space affects all those in that space, with neural resonance reflecting not just cognitive alignment, but emotional and intentional attunement. In romantic couples, for instance, Goldstein et al. (2018) found that holding hands during pain experiences increased inter-brain synchrony and reduced pain perception, illustrating how physical and emotional connection modulate shared brain states. Therefore, the human experience is deeply interconnected, where synchronised neural rhythms reflect a biologically embedded social attunement, and this is from a very young age, which has a profound effect on the various spiritual-biopsychosocial states of youth.

Heart Synchrony and Co-Regulation

The heart's rhythm also synchronises between interacting individuals. This cardiac synchrony is often measured by tracking Heart Rate Variability (HRV), which is the natural variation in the timing between heartbeats. HRV is a key biomarker of the body's capacity for emotional and social regulation, governed primarily by the vagus nerve (Williams et al., 2025). Higher resting HRV is associated with better regulatory abilities, emotional resilience, and cognitive flexibility (Beauchaine & Thayer, 2015). During social interactions, the heart rates of individuals can become linked, a process known as physiological linkage or co-regulation (Cook, 2020). This co-regulation can be positive, where individuals help each other maintain a calm and regulated state, or negative, where they amplify each other's stress responses, resulting in a state of co-dysregulation. Cook (2020) found that while late adolescent friends synchronised negative affect and physiological stress markers (cortisol and salivary alpha-amylase) during a conflict task, this synchrony was stronger in lower-quality friendships, indicating a pattern of co-dysregulation.

Expanding on this, Helm et al. (2012) showed that romantic couples display significant cardiac synchrony during conflict resolution, and greater synchrony was linked to more adaptive outcomes only when the relationship was perceived as supportive. Similarly, Felmand (2017) found that parent-child dyads exhibit heart rate synchrony during shared attention tasks, and this synchrony predicted emotional attunement and successful co-regulation, especially in secure attachment contexts. Importantly, cardiac synchrony is not limited to intimate relationships; Palumbo et al. (2017) reported that even strangers can exhibit HRV synchrony during shared emotional experiences such as watching a moving film. In therapeutic settings, heart rate synchrony between therapist and client has been associated with better alliance formation and emotional safety (Kleinbub et al., 2019). These findings highlight the

bio-social fabric of human interaction, where the heart's rhythm becomes a medium of connection or disconnection.

Thus, depending on the company one keeps, the impact may be one of inner peace or heightened distress, not only spiritually, but spiritual-biopsychosocially. This echoes the Qur'anic guidance: "O you who have believed, fear Allah and be with those who are true" (al-Tawbah 9:119) a reminder that one's associations influence not just the soul, but the heart and its physiological manifestations. Human interaction, therefore, becomes a site of transformation or tribulation affecting wellbeing across multiple dimensions of human existence.

The Importance of Synchrony Across Youth Social Domains

Youth is a critical period for developing regulatory skills and forming lasting social bonds (Fuhrmann et al., 2015). During this neurodevelopmental window, the brain undergoes significant maturation in regions responsible for executive functioning, emotional regulation, and social cognition, such as the prefrontal cortex and the temporoparietal junction (Blakemore & Mills, 2014). The quality of a youth's social environment, and the synchrony it fosters, is therefore pivotal. Supportive and attuned relationships during youth and adolescence promote healthy neural connectivity and strengthen emotion regulation networks (Blakemore & Mills, 2014). The family unit is the primary environment for learning emotional regulation. Healthy parent-child interactions provide a scaffold for developing self-regulatory abilities through consistent co-regulation (Williams et al., 2025). The Qur'an emphasises this foundational relationship, instructing believers to show utmost kindness to parents (Qur'an, 17:23-24). Such positive interactions can foster adaptive HRV patterns. However, research indicates that psychopathology, such as borderline personality disorder (BPD) traits in adolescents, is associated with altered synchrony patterns. Williams et al. (2025) found that while healthy mother-adolescent dyads showed HRV-synchrony during periods of rest after interaction, dyads where the adolescent had BPD traits displayed synchrony only during a stressful task, suggesting a maladaptive co-regulatory pattern linked to distress. This highlights how family dynamics can either build or hinder a youth's regulatory capacity.

This relationship starts from the initial stages, Wass et al. (2020) found that caregiver-infant synchrony in early life predicted better attentional control and emotional regulation in later developmental stages.

Conversely, dysregulated or hostile social environments, marked by chronic conflict or neglect, can impair synchrony and lead to maladaptive outcomes, including heightened physiological stress responses and emotional dysregulation (Hostinar et al., 2015). Furthermore, longitudinal research by Feldman (2017) shows that social synchrony experienced in early caregiving relationships lays the foundation for the capacity to form deep and meaningful human connections well into

adulthood. Synchrony is therefore not just a biological or emotional process, it is an ongoing developmental resource that shapes who we become and how we relate to others throughout life.

Friendships and Peer Groups

As youth mature, the influence of peers becomes increasingly significant, validating the Prophet's (ﷺ) warning about the company one keeps. The choice of friends can determine whether an adolescent experiences positive co-regulation or harmful co-dysregulation. While cooperation with peers in adolescence and youth, positive peer interactions and synchronised physiological states, such as heart rate and neural activity, have been linked to increased empathy, prosocial behaviour, and reduced stress (Reindl et al., 2021; Hoehl et al., 2021) and enhances inter-brain synchrony (Yang et al., 2023), while sharing negative emotions and stress can also lead to physiological linkage. The finding that lower-quality friendships exhibit stronger physiological synchrony during conflict (Cook, 2020) implicates that unhealthy peer groups can trap youth in cycles of shared stress and negative affect. This aligns with the Islamic imperative to seek righteous companionship. The Qur'an advises, "And keep yourself patient [by being] with those who call upon their Lord in the morning and the evening, seeking His countenance. And let not your eyes pass beyond them..." (Qur'an, 18:28). Such company provides a context for spiritual and emotional co-regulation, fostering positive synchrony.

The Wider Community: The Case of Congregational Prayer

The principle of synchrony extends beyond dyads to group interactions. Islam establishes a powerful, structured context for positive group synchrony: the congregational prayer (salah). The unified, synchronised physical movements, the shared auditory experience of recitation, and the collective focus (khushu') on a single purpose are potent drivers of the very mechanisms—shared attention and joint action—that underpin inter-brain synchrony (Dikker et al., 2017). The Prophet (ﷺ) stated that prayer in congregation is 27 times more virtuous than prayer offered alone (Sahih al-Bukhari, 645), a reward that reflects not only spiritual merit but also the profound psychological and social benefits of collective worship. This practice fosters a sense of unity and brotherhood, as described in the Qur'an: "The believers are but brothers" (Qur'an, 49:10). The shared experience of congregational prayer may therefore be a powerful spiritual exercise in neural and cardiac attunement, strengthening community bonds from a biological level upwards.

Synchrony, the Heart (Qalb), and Holistic Well-being

In the Islamic tradition, the heart (qalb) is not merely a pump but the centre of intellect, emotion, and spiritual insight (Basit, 2025). It is the locus of consciousness

where thoughts and feelings are processed before influencing the body. This resonates with scientific findings that the heart and brain are in constant communication, with cardiac patterns influencing cognitive and emotional processes (Thayer & Lane, 2000).

Positive synchrony cultivated in the company of family, righteous friends, and the community aligns the individual's internal state with a healthy, regulated environment. This fosters the tranquillity of the heart central to Islamic spirituality. As the Qur'an states, "...Verily, in the remembrance of Allah do hearts find rest" (Qur'an, 13:28). A heart at rest is a regulated heart, likely exhibiting higher, more adaptive HRV. The social environment, therefore, acts as either a conduit for this remembrance and tranquillity or a source of agitation and dysregulation. The company one keeps directly impacts the state of their heart, influencing their holistic well-being.

Synchrony with the Immediate Unseen

Human existence, as portrayed in Islamic cosmology, is never in isolation; rather, it unfolds within a multidimensional reality wherein unseen beings such as Mala'ikah (angels), Jinn, and Shayatin (devils) are ever-present and interactive. This metaphysical coexistence implies not just proximity, but dynamic synchronisation which is a form of spiritual resonance or interference that may either uplift or derail human conduct. In a state of heightened remembrance (dhikr) or righteous action, for example, believers attract the synchrony of Mala'ikah, who are described in the Qur'an as protectors and recorders (Qur'an 13:11; 50:17–18), and who descend upon gatherings of dhikr, enveloping them with tranquillity and divine mercy (Sahih Muslim, Hadith 2689). This spiritual harmony between the human soul and angelic presence may reflect an unseen alignment, an inter-realm resonance in which the human heart, when purified and God-conscious, synchronises with the obedience and light of the angelic realm.

Conversely, when heedlessness or disobedience overtakes the human condition, the Shayatin find access. They are not mere external enemies but exist in a kind of negative synchrony, whispering evil (waswasah) into the chests of men (Qur'an 114:4–6), promising deceit (Qur'an 4:119–120), and operating through the qareen, a constant companion assigned to every individual (Sahih Muslim, Hadith 2814). The Qur'an also suggests that Shayatin can influence mental disturbance and emotional dysregulation (Qur'an 2:275), thus synchronising not just ideationally but psychospiritually with human susceptibility. In this sense, the heart becomes a resonant chamber, either aligned with the rhythmic presence of the angels or distorted by the dissonance of demonic whisperings.

The Jinn, beings of free will created from smokeless fire (Qur'an 15:27), hover in an ambiguous synchrony with humanity. While some among them accept Islam upon

hearing the Qur'an (Qur'an 72:1–2), others incline toward mischief and deception. Their abilities to whisper, possess, or collaborate in sorcery (Qur'an 2:102) highlight another layer of interaction, an energetic intrusion or synchronisation that occurs when spiritual boundaries are compromised. Such synchrony, whether voluntary or imposed, reflects the reality that humans are never spiritually neutral: they are always resonating—either in harmony with divine light or in distortion with destructive forces.

Thus, Islamic theology urges believers who include the youth to be spiritually vigilant, emotionally anchored, and cognitively attuned to their metaphysical environment. The rhythms of the unseen, angelic or otherwise, are not abstract notions, but concrete albeit immaterial, continuous presences that align with the human condition. An individual's behaviour, moral and spiritual state serves as a tuning device either attracting the light of the Mala'ikah, or resonating with the darkness of the Shayatin. In this way, the concept of synchrony transcends neurobiology and physiology, extending into the spiritual ecosystem affirmed by the Qur'an and Sunnah, a cosmos where Allah is constant, dhikr becomes a tuning fork and taqwa the firewall against unwanted entanglements with the unseen.

Synchrony with all of Creation

In both Islamic theology and emerging scientific inquiry, the human being is portrayed not as an isolated, mechanistic entity but as a conscious, interconnected presence resonating with the cosmos. The Qur'anic concept of Khilāfah (vicegerency), “Indeed, I will place a vicegerent on Earth” (Qur'an 2:30), implies a spiritual, ethical, and ontological responsibility for humans to maintain harmony within the created order. This harmony, or synchrony, extends beyond the physical to include the energetic and unseen dimensions of reality.

Recent neurophysical and cosmological research (Idris et al., 2021) proposes that the human brain is not merely a localised biological organ but an open quantum system that interacts with the cosmos quantum field (QF), an infinite, wavy, nonlocal energy permeating the universe. This aligns closely with the Islamic metaphysical worldview in which all creation, including the human being, is interconnected through Tawhīd, the principle of Divine Oneness. Within this framework, the human role as khalīfah necessitates spiritual attunement to both the physical world and the unseen forces that underpin it, including the Mala'ikah, Jinn, and cosmic energy fields.

From the scientific side, Idris et al. (2021) describe two fields that shape brain function: the electromagnetic field (EMF) and the quantum–light field (QLF). The EMF is associated with physical stimuli and bodily functions, while the QLF is subtle, diffuse, and reflective of a deeper state of consciousness, a resonance with what the authors call infinite wavy energy, akin to the quantum field described in string theory.

The QLF may be thought of as the substrate through which cosmic synchrony operates, much like the unseen *amr* (command) that governs creation as referenced in the Qur'an (e.g., "His command is only when He intends a thing that He says to it, 'Be,' and it is" — Qur'an 36:82).

Importantly, the Qur'an presents the human being as possessing *Rūḥ* (spirit), breathed by Allah (Qur'an 15:29), which may be likened to what Idris et al. refer to as infinite consciousness. Though the human brain operates with limited consciousness, collapsing wave potentials into perceived matter thus, the soul remains ontologically open to the infinite. Through this lens, *Khilāfah* requires aligning the self (body, mind, and spirit) with the greater cosmic order, a synchronisation of intent (*niyyah*), action (*ʿamal*), and perception (*baṣīrah*) with Divine Will (*irādah*).

Thus, synchrony between humans and the universe is not a poetic notion, it is a Qur'anic, neurological, and quantum reality. The brain becomes the seat of dynamic convergence: a projection point where finite projected waves (EMF) interact with infinite wavy fields (QF), producing what may be called the total brain field or the mind field. When properly aligned, through worship, moral action, remembrance, and humility, this field synchronises with the Divine order, the unseen realms, and the natural world, fulfilling the true potential of *Khilāfah*.

The Islamic view of the human being as *khalīfah* on Earth finds remarkable resonance with contemporary quantum neuroscience. As articulated by Idris et al. (2021), the human brain is a site of multidimensional synchrony, energetic, cognitive, and possibly metaphysical. To fulfil the role of *khalīfah*, humans must cultivate internal coherence that resonates with the external harmony of the universe. This calls for a revival of spiritual consciousness grounded in both revelation and reason, where brainwaves echo Divine rhythms, and human life becomes an act of resonance with the cosmos.

Improving Synchrony

Consciously Choosing Friends

The prophetic ﷺ counsel to choose one's companions carefully is rooted in the understanding that individuals are profoundly influenced by their social environment. For youth, this means deliberately surrounding themselves with peers who demonstrate emotional stability, moral integrity, and spiritual awareness. From a scientific standpoint, such companions enhance healthy co-regulation of emotional states and reinforce inter-brain synchrony. When two individuals align in thought, mood, and intention, their neural rhythms begin to mirror one another, promoting psychological resilience and inner peace. Thus, wise companionship is not merely social advice, it is a neurophysiological safeguard and a spiritual imperative.

Engaging in Shared Positive Activities

Engaging in cooperative activities, such as sports, group study, or community service, creates rich opportunities for synchronisation on both a neurological and emotional level. Studies have shown that joint tasks requiring mutual focus and coordination, such as those involving shared goals or timing, significantly increase inter-brain synchrony (Yang et al., 2023). In Islam, such acts are also encouraged as manifestations of unity and mutual support (ta'āwun). These activities don't just build teamwork; they forge neural and spiritual bonds that cultivate empathy, discipline, and cohesion, qualities essential for leadership and vicegerency (khilāfah).

Prioritising Face-to-Face Interaction

In a world increasingly dominated by screen-mediated communication, prioritising face-to-face interaction becomes an act of intentionality. Recent findings confirm that in-person engagement stimulates stronger and richer inter-brain coherence compared to text-based communication (Schwartz et al., 2024). This affirms the Islamic emphasis on physical presence in communal activities, such as ṣalāh in congregation, Friday prayers, or even the simple practice of exchanging greetings with a smile. Human beings are designed to synchronise through eye contact, voice modulation, and embodied presence, all of which are muted in digital spaces. To nurture depth in relationships, youth must choose presence over convenience.

Practising Shared Spiritual Activities

Shared spiritual practices provide one of the most powerful contexts for deep synchrony. Congregational prayers, remembrance and knowledge circles (ḥalaqāt dhikr), acts of charity, and spiritual retreats synchronise not just brainwaves but also heart rhythms and intentions. The presence of malaa'ikah (angels) at gatherings of dhikr (Sahih Muslim, 2689) and the spiritual upliftment experienced during collective worship suggest a synchrony that transcends the physical. These shared rituals align the human heart and consciousness with divine rhythms and may even facilitate coherence with the quantum field of the universe, as proposed in contemporary brain science. Spiritual synchrony, therefore, elevates both individual and collective well-being.

Practising Self-Care

Sustaining synchrony with others and with the broader universe begins with internal coherence. This includes caring for one's physical body, regulating one's emotions, and tending to one's soul. Islamic teachings encourage wasatiyyah (balance) and tazkiyyah (purification), both of which mirror the scientific emphasis on emotional regulation, sleep, nutrition, and rest as prerequisites for optimal brain and heart function. Self-care ensures that one's electromagnetic and quantum fields remain balanced, making the individual more receptive to positive synchrony with others and with the cosmic order. As khalifah, one cannot bring order to the world without first cultivating order within the self

CONCLUSION

The ancient wisdom of Islam, encapsulated in the prophetic guidance on companionship, finds remarkable parallels in the modern scientific study of physiological synchrony. Brain and heart synchrony are not abstract concepts; they are tangible, biological processes that are constantly shaped by our social interactions. For youth, a period of immense change and development, the quality of their social connections is critical. Positive synchrony with family, friends, and community provides a biological foundation for emotional regulation, social bonding, and spiritual growth. The choice of company is therefore a choice of regulation. By integrating the timeless wisdom of faith with contemporary scientific insights, we can empower young people to build relationships that foster not just social success, but a deep, holistic well-being of the mind, body, and soul as well as becoming a meaningful khalifa.

REFERENCES

- Basit, A. (2025). Discovering the mind-heart connection: Thoughts in the mind pass through the heart before influencing the body. *Journal of Clinical and Basic Psychosomatics*. Advance online publication. <https://doi.org/10.36922/jcbp.7798>
- Beauchaine, T. P., & Thayer, J. F. (2015). Heart rate variability as a transdiagnostic biomarker of psychopathology. *International Journal of Psychophysiology*, 98(2), 338–350. <https://doi.org/10.1016/j.ijpsycho.2015.08.004>
- Blakemore, S.-J., & Mills, K. L. (2014). Is adolescence a sensitive period for sociocultural processing? *Annual Review of Psychology*, 65, 187–207. <https://doi.org/10.1146/annurev-psych-010213-115202>
- Cook, E. C. (2020). Affective and physiological synchrony in friendships during late adolescence. *Journal of Social and Personal Relationships*, 37(4), 1296–1316. <https://doi.org/10.1177/0265407519895106>
- Deng, X., Lin, M., & Li, X. (2024). Mindfulness meditation enhances interbrain synchrony of adolescents when experiencing different emotions simultaneously. *Cerebral Cortex*, 34(1), bhad474. <https://doi.org/10.1093/cercor/bhad474>
- Dikker, S., Wan, L., Davidesco, I., Kaggen, L., Oostrik, M., McClintock, J., Rowland, J., Michalareas, G., Van Bavel, J. J., Ding, M., & Poeppel, D. (2017). Brain-to-brain synchrony tracks real-world dynamic group interactions in the classroom. *Current Biology*, 27(9), 1375–1380. <https://doi.org/10.1016/j.cub.2017.04.002>
- Feldman, R. (2017). The neurobiology of human attachments. *Trends in Cognitive Sciences*, 21(2), 80–99. <https://doi.org/10.1016/j.tics.2016.11.007>
- Fuhrmann, D., Knoll, L. J., & Blakemore, S. J. (2015). Adolescence as a sensitive period of brain development. *Trends in Cognitive Sciences*, 19(10), 558–566. <https://doi.org/10.1016/j.tics.2015.07.008>
- Goldstein, P., Weissman-Fogel, I., Dumas, G., & Shamay-Tsoory, S. G. (2018). Brain-to-brain coupling during handholding is associated with pain reduction. *Proceedings of the National Academy of Sciences of the United States of America*, 115(11), E2528–E2537. <https://doi.org/10.1073/pnas.1703643115>
- Helm, J. L., Sbarra, D. A., & Ferrer, E. (2012). Assessing cross-partner associations in physiological responses via coupled oscillator models. *Emotion*, 12(4), 748–762. <https://doi.org/10.1037/a0025036>
- Hu, Y., Pan, Y., Shi, X., Cai, Q., Li, X., & Cheng, X. (2018). Inter-brain synchrony and cooperation context in interactive decision making. *Biological Psychology*, 133, 54–62. <https://doi.org/10.1016/j.biopsycho.2017.12.005>
- Hoehl, S., Fairhurst, M., & Schirmer, A. (2021). Interactional synchrony: Signals, mechanisms and benefits. *Social Cognitive and Affective Neuroscience*, 16(1–2), 5–18. <https://doi.org/10.1093/scan/nsaa024>

- Hostinar, C. E., Sullivan, R. M., & Gunnar, M. R. (2015). Psychobiological mechanisms underlying the social buffering of the hypothalamic–pituitary–adrenocortical axis: A review of animal models and human studies across development. *Psychological Bulletin*, 140(1), 256–282. <https://doi.org/10.1037/a0032671>
- Idris, Z., Zakaria, Z., Yee, A. S., Fitzrol, D. N., Ghani, A. R. I., Abdullah, J. M., Wan Hassan, W. M. N., Hassan, M. H., Abdul Manaf, A., & Ooi, R. C. H. (2021). Quantum and electromagnetic fields in our universe and brain: A new perspective to comprehend brain function. *Brain Sciences*, 11(5), 558. <https://doi.org/10.3390/brainsci11050558>
- Kleinbub, J. R. (2019). State of the art of interpersonal physiology in psychotherapy: A systematic review. *Frontiers in Psychology*, 10, 2053. <https://doi.org/10.3389/fpsyg.2017.02053>
- Palumbo, R. V., Marraccini, M. E., Weyandt, L. L., Wilder-Smith, O., McGee, H. A., Liu, S., & Goodwin, M. S. (2017). Interpersonal autonomic physiology: A systematic review of the literature. *Personality and Social Psychology Review*, 21(2), 99–141. <https://doi.org/10.1177/1088868316628405>
- Reindl, V., Gerloff, C., Scharke, W., & Konrad, K. (2021). Brain-to-brain synchrony in parent–child dyads and the relationship with emotion regulation and social interaction: A systematic review. *Developmental Cognitive Neuroscience*, 48, 100927. <https://doi.org/10.1016/j.dcn.2020.100927>
- Sänger, J., Müller, V., & Lindenberger, U. (2012). Intra- and interbrain synchronization and network properties when playing guitar in duets. *Frontiers in Human Neuroscience*, 6, 312. <https://doi.org/10.3389/fnhum.2012.00312>
- Schwartz, L., Levy, J., Hayut, O., Netzer, O., Endevelt-Shapira, Y., & Feldman, R. (2024). Generation WhatsApp: Inter-brain synchrony during face-to-face and texting communication. *Scientific Reports*, 14, 2672. <https://doi.org/10.1038/s41598-024-52587-2>
- Thayer, J. F., & Lane, R. D. (2000). A model of neurovisceral integration in emotion regulation and dysregulation. *Journal of Affective Disorders*, 61(3), 201–216. [https://doi.org/10.1016/S0165-0327\(00\)00338-4](https://doi.org/10.1016/S0165-0327(00)00338-4)
- Wass, S. V., Whitehorn, M., Marriott Haresign, I., Phillips, E., & Leong, V. (2020). Interpersonal neural entrainment during early social interaction. *Trends in Cognitive Sciences*, 24(4), 329–342. <https://doi.org/10.1016/j.tics.2020.01.006>
- Williams, K., Fuchs, A., Kuehn, J., Fleck, L., Lerch, S., Cavelti, M., Koenig, J., & Kaess, M. (2025). Individual patterns and synchrony of heart rate variability in adolescent patients with borderline personality psychopathology and their mothers: A case-control study. *Borderline Personality Disorder and Emotion Dysregulation*, 12(12). <https://doi.org/10.1186/s40479-025-00289-0>
- Yang, M., Li, X., Sang, B., & Deng, X. (2023). Age differences in interbrain synchronization during peer cooperation: An EEG hyperscanning study. *Cerebral Cortex*, 33(18), 9987–9997. <https://doi.org/10.1093/cercor/bhad308>