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AN INTERDISCIPLINARY PERSPECTIVE ON MUSIC, RHYTHM, AND SOCIAL COMMUNICATION IN THE DIGITAL AGE: FROM PHENOMENOLOGY TO EMBODIED COGNITION

Over the past decade, we have observed a rapid and unprecedented increase in mental health problems among young people. Jonathan Haidt (2025) calls this phenomenon the “epidemic of mental health disorders of the smartphone generation,” citing the dramatic increase in rates of depression, anxiety, self-harm, and feelings of isolation among teenagers since 2013. According to Haidt, today’s youth are the first generation to have grown up online thanks to the constant presence of smartphones and social media. Digital technologies have replaced many traditional forms of play and physical interpersonal interactions. During this time, the social experiences that evolutionarily shaped human development have rapidly been displaced. Traditional face-to-face relationships, which were associated with cooperation and co-presence, have been replaced by digital contact reduced to visual stimuli, devoid of natural rhythm, and feedback between body, emotions, and speech. Digital relationships are largely devoid of bodily and social experiences, thus failing to activate the brain-body-environment synchronization that underlies cooperation, empathy, and a sense of community. Moving a significant portion of social relationships and communication to the digital world takes with it naturally evolved manners of acquiring social competencies that are fundamental to human psychosocial well-being.

This article presents an interdisciplinary approach to the relationship between music, rhythm and embodied cognition. It also outlines the role of

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rhythmic synchronization as a factor regulating the formation of social bonds in today's world, permeated by new technologies.

It is argued that music and rhythmic synchronization, understood as a form of embodied cognition, can serve as a binding agent for the fragmented and disembodied social interactions of the digital age. Joint rhythmic activities combine movement, attention, emotions, and social relationships, becoming a natural mechanism for integrating individuals with groups. Collaboratively performed music thus can serve as a neurobiological regulator of co-presence and social bonds.

The article combines three research perspectives—neuroscientific, phenomenological, and sociocultural—to propose a model in which music and rhythmic activities become a tool for restoring community in society, thus counteracting the isolation caused by the increasing digitalization of social communication. Sharing music and rhythmic activities in a group creates the appropriate conditions for the development of executive functions, emotion regulation, and a sense of belonging to a group. As a result, such activities can become an alternative to passive reception of digital stimuli. Hereby, they may become crucial elements in the prevention of various mental disorders in children and adolescents.

1. PHENOMENOLOGY AND THE EMBODIED PERSPECTIVE: A THEORETICAL FRAMEWORK FOR ANALYSIS

Phenomenology, from Edmund Husserl to contemporary representatives of the enactive tradition, stems from the belief that human experience is always embodied, temporal, and intersubjective (DURANTI 2010). Over the past two decades, there has been a noticeable convergence between phenomenology and the cognitive sciences, particularly within the embodied cognition movement (or rather, the model known in cognitive science as 4E, corresponding to *embodied*, *embedded*, *enactive*, and *extended* cognition), which explicitly draws on phenomenological categories.

In the field of research on rhythm and rhythmic synchronization, phenomenology plays a special role; namely, it allows us to capture the first-person structure of the experience of rhythm, and especially how sound-defined time intertwines with bodily experience and how an intersubjective area of joint action and interaction is created.

Unlike nonphenomenological approaches, which view rhythm as an objective temporal structure, phenomenology posits that rhythm is primarily an experience, originating from the way the body performs over time. This approach provides a complementary perspective to empirical research, enabling us to understand why rhythmic synchronization plays such a fundamental role in cognitive, emotional, and social development.

Synchronization, according to Thomas Fuchs (2016), one of the representatives of the phenomenological approach to communication and social relations, is the basis for intuitive understanding of emotions revealed in interactions with others. Thus, it becomes one of the fundamental mechanisms of social relationships and communication. The process of synchronization, including rhythmic synchronization, determines the basic form of emotional relationship, which does not require operations on mental representations. Fuchs introduces the concept of social musicality in his reflections as a sense of social attunement based on affective synchrony. The space in which we live, including the social environment, is filled with affective qualities, and therefore social relations cannot be reduced to mental phenomena based only on operations on mental representations, as assumed by the theory of mind (GALLAGHER 2008).

We can therefore conclude that communication is a social relationship that holds in the space between two agents and is based on an affective, embodied relationship (cf. HERDA 2025). What happens in this space of social communication can be described as bodily synchrony, the fundamental basis of which, as research shows, is rhythmic synchronization (HAIDT 2025; WILTERMUTH and HEATH 2009; LINDENBERGER ET AL. 2009; NOZARADAN, PERETZ, and MOURAUX 2012; COHEN ET AL. 2010; HAGEN and BRYANT 2003; TROST and VUILLEUMIER 2013).

Phenomenology thus brings crucial insight in the analysis of rhythmic synchronization. From this perspective, rhythm is not an objective sequence of stimuli, but an experienced temporal structure in which the present always contains traces of the past (*retentions*) and anticipations of the future (*protentions*) (THOMPSON 2007). The experience of rhythm relies on the dynamic tension between these dimensions and not on the recording of isolated moments.

In the context of social interaction, rhythmic synchronization enables the sharing of the temporal structure. Phenomenologists, emphasizing the principle of intersubjectivity, argue that a shared rhythm of action creates an “intercorporeal” space of experience in which the intentions and emotions of others

are directly accessible through perception, without the need for cognitive inference (FUCHS and DE JAEGHER 2009). Here, rhythm serves as a pre-reflective bonding agent for relationships.

The theoretical framework for the considerations presented in this article is defined by a phenomenological approach on the one hand, and the theory of embodied cognition on the other, as well as the neurocognitive foundations of social cognition theory. The phenomenological approach assumes that meaning and cognition are rooted in first-person embodied experience. In the explanations formulated on this basis, we do not refer to mental representations and the abstract processing thereof, but to direct cognition through the experiences and actions of embodied entities in the world. We understand relationships and social communication through the engagement of concepts such as interaffectivity and synchrony.

2. MUSIC AND RHYTHM: BETWEEN MUSICOLOGICAL AND COGNITIVE APPROACHES

For the purposes of the conducted analyses, it is necessary to clarify the conceptual distinctions existing within various scientific disciplines. Concepts such as rhythm and music possess well-established, historically and methodologically developed meanings in musicology, which cannot be ignored without risking interpretive simplification. At the same time, the growing interest in these phenomena from cognitive sciences leads to the emergence of new, often broader and more functional, semantic perspectives. Therefore, it is essential to identify conceptual differences and distinct ways of defining rhythm and music in both approaches. These differences stem not only from different terminological frameworks and research methods used, but also from differently formulated research questions and sought explanations.

From the perspective of embodied cognition, the digital age poses not only a threat but also a theoretical and practical challenge. The key question becomes not whether technology harms cognition, but how we can design educational and cultural environments that restore the rhythmic, bodily, and relational structure of experience (CLARK, TANNER-SMITH, and KILLINSWORTH 2015; GALLAGHER 2017).

In this context, music and rhythmic synchronization emerge as potential compensatory tools—practices that can rebuild the connection between body,

time, and community. An analysis of this possibility provides the starting point for the following theses in this article.

Music and rhythm are closely related phenomena, but not identical. In musicological research, rhythm is generally treated as one of the fundamental components of music, alongside melody, harmony, timbre, and form. It is defined as the way in which sounds and pauses are organized in time, resulting from the relationships between length, accents, and periodicity (LONDON 2012). It is therefore a structural component, subject to formal, notational, and performance analysis. On this take, rhythm allows music to be given shape, predictability, and dynamics. Many contemporary musicological analyses emphasize that rhythm is not limited to numerical patterns but is experienced through the body, which co-organizes metric perception (HAUGEN 2023). In cognitive science, rhythm is often defined as the ability of a cognitive system to identify, predict, and generate regular or quasi-regular temporal structures (LARGE and RIESS JONES 1999). Rhythm serves as a mechanism enabling the synchronization of perception and action, social entrainment, emotional regulation, and the organization of attentional processes. Research on neural tuning shows that rhythm is not only perceived by the brain but also constructed (NOZARADAN ET AL., 2011, 2012; VANDEN BOSCH DER NEDERLANDEN, TAYLOR, and GRAHN 2019). The nervous system naturally synchronizes its oscillations with rhythmic stimuli, whether these stimuli are part of music or non-musical motor activities.

From a cognitive science perspective, music is a complex social and biological phenomenon based on mechanisms of rhythmic synchronization and sensory-motor prediction (MOLNAR-SZAKACS and OVERY 2006). A key difference is that, in musicology, rhythm is a component of music, whereas in cognitive science, music is one of many manifestations of human rhythmicity. From a cognitive science perspective, music is a specific way of using rhythm for emotional and social co-regulation. Anthropological and neuromusicological studies show that shared music-making stimulates the neurochemical mechanisms of the brain's reward center, as well as that of attachment and the formation of social bonds (secretion of oxytocin and endorphins). Therefore, from the musicological perspective, rhythm is a component that allows music to exist in an orderly manner in time, while from the cognitive perspective, music is one of the contexts in which rhythm becomes a significant factor in the processes of emotion regulation and social interactions, and therefore a specific carrier of rhythm.

One might attempt to clarify it further and distinguish additional contexts for understanding rhythm and music. From the perspective of cognitive science, rhythm can be defined as the organization of sound phenomena in time. McAuley (2010) conceptualizes this in two ways. On the one hand, he views rhythm as a temporal pattern defined by sounds and pauses, and on the other, as the subjectively perceived temporal organization of this pattern. From this perspective, music, in turn, appears as a complex acoustic pattern engaging the mind. Researchers emphasize that the mind extracts recurring patterns from music, groups them, and anticipates a specific development of melody or meter. The perception of music is associated with the arousal of emotions. Music thus fulfills cognitive and emotional functions. Narrowing the perspective to a phenomenological approach, one can, following researchers, define rhythm primarily as a bodily experience. They point out that the perception of rhythmic structure occurs through bodily movements, for example, the gesture of tapping out a rhythm with the hand. This allows for the experience of rhythm even before its intellectual understanding. The phenomenological approach emphasizes the sensual, direct, and kinesthetic aspects of rhythm as primary to linguistic analyses. Music is therefore primarily a bodily and existential experience. Merleau-Ponty (1968) points out that music affects the listener through movement and vibration, and its reception occurs during its bodily experience. Phenomenologists also emphasize, as noted earlier, the intersubjective dimension of music. This phenomenon is experienced together, and therefore occurs between performer and listener, as well as between performers or among listeners (e.g., at a concert).

In the embodied paradigm, rhythm is conceptualized as a fundamental form of temporal organization of perception and action, which may or may not be present in music. Combining these two perspectives allows us to grasp both the structural and the corporeal-phenomenological nature of rhythm. This, in turn, allows us to identify a perspective in which rhythm appears as a fundamental, pre-reflective principle of social relations.

3. RHYTHMICITY AND SYNCHRONIZATION AS BASIC CHARACTERISTICS OF HUMAN FUNCTIONING IN THE ENVIRONMENT

Rhythmicity appears as one of the fundamental characteristics of humans, both as members of the biological species *Homo sapiens*, and as cognitive subjects and members of various communities and societies. It manifests itself

at successive levels of organization, from the cellular to the social. We can speak of the rhythm of individual brain waves generated by neurons, the rhythm of the heartbeat, the rhythm of breathing, the rhythm of movement, the rhythm of sleep and wakefulness (circadian rhythm), the natural rhythm that encompasses human life, the rhythm of behavior, and the rhythms of social life (calendars, schedules). Rhythm appears as a fundamental and natural principle of organization.

Rhythm can also be considered an epistemological category, one that influences how an embodied subject learns, understands, and constructs the world. Rhythm is not merely another acoustic parameter here. Rather, it constitutes the structure of experienced time and relationships.

In the context of the phenomenology of corporeality, rhythm appears as a modality of embodied action in the world. This refers to rhythms that emerge in the subject's everyday experience as patterns and orderings (MERLEAU-PONTY 1968; FUCHS 2016). It is through such rhythms that the body maintains contact with the environment and organizes perception. According to Fuchs (2017), the rhythms of embodied interactions position the subject in both the physical and social worlds.

Rhythm, therefore, constitutes the fundamental structure of our experience of the world and social communication. The experience of rhythm itself is primary to its conceptualization. Rhythm also appears as a framework for organizing communal activities. Dunbar and Shultz (2010) develop the hypothesis that the ability to synchronize rhythmically within a group was an evolutionary adaptation that resulted in the formation of bonds and the maintenance of group cohesion. This mechanism enabled the formation of large and stable human groups. Fuchs (2016), in turn, argues that rhythm is an additional structure that organizes human perception.

Rhythm is therefore a spatial and temporal structure that constitutes a matrix for social relations and pre-reflective communication, the most natural one, which does not require the use of additional tools such as language.

Rhythm can be assimilated within a community through a medium, such as music. The rhythmicity of music evokes specific emotions, behaviors, and reactions in participants in shared activities. Therefore, for the purposes of this discussion, we can look at music from a completely different perspective than musicology and define it as a technology for rhythmic attunement of the group. As a result of shared rhythmic activities, resonance occurs on many different levels—from the physiological, through the behavioral, to the emotional one (BERNATZKY ET AL. 2011). What is rhythmized together (music,

singing, dancing) not only synchronizes people's actions in time but also synchronizes their inner consciousness in the context of time. Being together in rhythm means being together in the here and now.

The neurophysiological perspective cannot be ignored when considering rhythm. In short, in a situation of shared musical experience, emotional synchronization occurs among group members as a result of their brains being stimulated by the same musical stimuli. The mechanism of this process is the secretion of specific neurohormones through stimulation of specific brain areas (SALIMPOOR 2011). An additional mechanism may involve the activity of mirror neurons (although the concept of the nature and function of mirror neurons is debatable), stimulated by observing other participants' reactions to the shared stimulus, which in turn triggers specific individual behaviors (TARR, LAUNAY, and DUNBAR 2014). As a result, a coordinated emotional response occurs, coupled with coordinated behaviors, which underpin the emergence of bonds between group members (SAVAGE ET AL.; MEHR ET AL.). This results in increased cohesion within the group participating in the event (WILTERMUTH and HEATH 2009). A musical stimulus is a specific rhythmic stimulus with a specific sonic structure, which, through its physical properties, interacts with the electrical activity of neural networks in the brain (TROST and VUILLEUMIER 2013). This allows for appropriate responses to the stimulus and the ability to modulate reactions according to the changes in the stimulus.

4. RHYTHM AS A BASIS FOR SOCIAL BONDING FROM THE PERSPECTIVE OF EMPIRICAL RESEARCH

Contemporary research indicates that music and rhythmic synchronization play a crucial role in interpersonal communication and the formation of social bonds. Rhythm emerges as a principle rooted in the human body—not only do phenomena such as the heartbeat, blood circulation, and breathing rate have their own rhythm, but also our movements (dancing, walking, writing) and sounds (speech, singing, laughing, crying) are inherently rhythmic. From a phenomenological perspective, rhythm and synchronization are the ways in which our bodies constitute both time and relationships with others.

Research in neuroscience, psychology, and anthropology provides growing evidence that shared rhythmic activities foster social bonding. At the neurobiological level, physiology has been found to be synchronized among concertgoers. Czepiel and colleagues observed that specific musical features (tempo,

structural transitions) evoke similar physiological responses in different audience members. Listeners' excitement and increased engagement converge at key moments (CZEPIEL ET AL. 2021). Similarly, research by Launay, Tarr, and Dunbar (2014) shows that dancing in synchrony with others raises pain thresholds (increased endorphin release) and intensifies feelings of social closeness.

Making music together is also fundamental to strengthening bonds. Dunbar and others (2012) have shown that actively performing music (singing, dancing, playing drums) increases endorphin levels (again measured by the pain threshold) and induces a positive mood, whereas listening to music in isolation does not produce the same results. Similarly, Daniel Weinstein and colleagues (2016) examined the social impact of shared choral singing in small and large groups. After 90 minutes of rehearsal, the participants' sense of belonging, bonding with the group, and positive emotions increased, so did endorphin release (elevated pain thresholds). This effect was observed in both small and large choirs (232 participants). Singing with strangers increases the sense of closeness between participants, which the authors attribute to the evolutionary function of music as a mechanism for bringing large groups together.

Developmental psychology highlights early forms of rhythmic interaction between mother and child. Infants, even in their first months of life, engage in protoconversations—reciprocal, structured vocal exchanges with their caregiver (usually their mother) based on turn-taking. Trinh Nguyen, Zimmer and Hoehl (2023) demonstrated that the intensity of such infant–mother exchanges correlates with neural synchrony between the parent and child's brains and, importantly, with accelerated language development. Kirschner and Tomasello (2010) obtained similar results. Their study showed that four-year-old children who played and sang together (in synchrony) were significantly more helpful and cooperative in tasks, compared to a control group without music. In other studies, an increase in prosocial behavior was observed after hour-long sessions of group rhythmic exercises (PARDO-OLMOS, MARTÍ-VILAR, and HIDALGO-FUENTES 2025).

In summary, both the phenomenological tradition and empirical cognitive and anthropological research point to the crucial role of musical rhythm and synchronization in building social bonds. Rhythmic interactions (whether dance, vocal, or parent–child conversations) create a shared temporal-corporeal matrix that sustains communication, empathy, cooperation, and a sense of belonging. When people act together to a shared rhythm, they literally fulfill a shared reality, with profound developmental and evolutionary consequences—from the rapid establishment of understanding among young chil-

dren to the unification of large communities. Future research may deepen our understanding of the neural mechanisms underlying these phenomena, but we already see that music and rhythm are fundamental media of interpersonal communication, extending far beyond simple information transmission. They can therefore restore and enhance the fundamental, corporeal and synchronous dimension of communication in the digital world.

5. COMMUNICATION IN THE DIGITAL WORLD IN THE CONTEXT OF CREATING BONDS AND HUMAN MENTAL WELL-BEING

The development of digital technologies over the past two decades has fundamentally changed the environment in which cognitive, emotional, and social processes are shaped. Smartphones, social media, and streaming platforms are not merely communication tools but serve as ubiquitous cognitive environments that reorganize attention, the temporal organization of experience, and the relationship between users' bodies and environment (CLARK, TANNER-SMITH, and KILLINSWORTH 2015). From the perspective of embodied cognition, this translates into a shift in the conditions of meaning-making in which the mind remains coupled with the environment.

A key characteristic of digital environments is their high temporal discontinuity. Information streams, notifications, and rapid switching between environments promote short and interrupted attention cycles and a weakening of the ability to maintain stable rhythms of action (DRODY, PEREIRA, and SMILEK 2025; OPHIR, NASS, and WAGNER 2009). The result is a shift from a rhythmically structured experience to a discrete response mode, in which the body and attention follow external stimuli rather than internally regulated temporal patterns.

From a phenomenological perspective, digital technology introduces a specific type of mediation that modifies the subject's relationship to their own body. Fuchs describes this phenomenon as a form of "functional disembodiment," in which experience is shifted from the sensorimotor level to the visual-symbolic level. Digital interactions engage the body in a limited way, often reducing movement to repetitive, monotonous gestures (scrolling, clicking), devoid of rich proprioceptive and kinesthetic information (FUCHS 2014, 2020).

As a result, the coupling between movement, perception, and emotion—three key components of embodied cognition—is weakened (GALLAGHER 2017). The experience of time loses its rhythmic character, and in its place emerges a subjective sense of acceleration, dispersion, and the constant avail-

ability of stimuli. These phenomena are particularly important during the developmental period, when cognitive and emotional self-regulation capacities are still being formed.

Research in cognitive psychology and neuroscience indicates that prolonged exposure to digital environments with high stimulus variability is associated with difficulties in attention control, working memory, and executive functions (WILMER, LAUREN, and JASON 2017; OPHIR, NASS, and WAGNER 2009). From a dynamic perspective, these difficulties can be interpreted as a result of disruptions in the rhythmic organization of cognition.

Embodied cognition posits that stable attention and action planning require relatively consistent temporal cycles that enable predictive thinking (THOMPSON 2007, 38–43). Digital environments, however, through their irregularity and overstimulation, hinder the formation of such cycles. As a result, the body and nervous system operate in a constant state of reactive alert, which promotes cognitive overload and weakens deeper engagement.

Another crucial aspect of embodied cognition is its intersubjective dimension. Enactive and phenomenological theories emphasize that meaning and affective regulation emerge in relationships with others, through the synchronization of movement, gestures, gaze, and rhythms of action (DE JAEGHER and DI PAOLO 2007; FUCHS and DE JAEGHER 2009). Screen-mediated interactions often lack these elements or offer them in an impoverished and delayed form.

While digital communication enables us to maintain contact remotely, it does not fully replace direct experiences of physical co-presence. A lack of shared rhythmic synchronization can lead to a weakened sense of connection and difficulties with emotional regulation, which is particularly important in the context of the social development of children and adolescents.

6. RHYTHMIC SYNCHRONIZATION AS A MECHANISM FOR CREATING CONNECTIONS AND REBUILDING COMMUNITY IN THE DIGITAL AGE

The above analyses clearly contrast the experience of rhythmic synchronization with dominant forms of digital interaction. Screen-mediated communication is characterized by limited corporeality, time delays, and fragmented attention, which hinders the development of a shared rhythmic structure (FUCHS 2014). From a phenomenological perspective, this translates into a weakening of co-presence and a reduction of relational experience to an informational dimension. Although digital environments offer new forms of co-

ordination (e.g., synchronous online gaming or music platforms), they often lack the full sensorimotor coupling that underlies deep rhythmic synchronization. Consequently, social relationships may lose their regulatory potential, which is crucial for psychological well-being, especially during developmental periods.

One of the most consistent findings from research on rhythm and music is their role in building and maintaining social bonds. Sharing rhythmic synchronization—in movement, speech, or music—leads to an increased sense of belonging, trust, and willingness to cooperate (TARR, LAUNAY, and DUNBAR 2014; HOVE and RISEN 2009). From a cognitive perspective, these phenomena are explained by mechanisms of synchrony (entrainment) and affective co-regulation, which enable the fine-tuning of the physiological and cognitive states of interaction participants.

Music represents a particularly intense form of rhythmic synchronization because it combines temporal structure, emotion, and bodily engagement in a highly coordinated manner. Phenomenological descriptions of musical experience suggest that the listener does not so much receive the music as be temporarily and bodily drawn into it (LEMAN 2007, 111–14). Music organizes attention, modulating tensions and releases, expectations and fulfillments, that leads to a profound sense of participation.

Making music together—singing, playing in groups, dancing—intensifies this effect, enabling synchronization not only at the level of movement but also at the emotional and intentional levels. Research shows that such practices promote emotional regulation and strengthen a sense of group belonging (KOELSCH 2014; SAVAGE ET AL. 2021). Phenomenologically, this can be described as an experience of *being together in time*, in which individual boundaries of experience are temporarily relaxed.

Both cognitive science and phenomenology suggest that rhythm and music can compensate for the deficits of the contemporary digital environment. By engaging the body, regulating emotions, and creating shared temporality, rhythmic practices enable the reconstruction of basic mechanisms of intersubjectivity and self-regulation (TARR, LAUNAY, and DUNBAR 2014; THOMPSON 2007, 38–43).

In this sense, music and rhythm are not merely cultural additions or aesthetic tools, but fundamental cognitive and social resources. Their importance becomes particularly evident in the context of the challenges faced by the generation of young smartphone and internet users. Rebuilding the embodied,

rhythmic, and relational structure of experience can be a crucial element of educational and preventative strategies.

As previously noted, empirical research documents that participation in music training improves executive functions (attention, working memory, emotion regulation). A meta-analysis conducted by Yanan Lu, Shi and Musib (2025) demonstrated significant benefits of music training for impulse inhibition, cognitive flexibility, and working memory in children aged 3–6. Similarly, the therapeutic program “Rhythm and Movement for Self-Regulation” (RAMSR) (WILLIAMS, SAVAGE, and EAGER 2020), based on synchronizing movement to a specific rhythm, improved self-regulation and executive functions in struggling preschoolers. In the experiment, teachers without musical training led weekly sessions with music and movement. The experimental group performed better on tests of emotional regulation than the control group (WILLIAMS ET AL. 2024). Children with ADHD who practiced rhythm games (e.g., tapping a beat on a tablet) also showed improvements in rhythmic abilities and executive functioning compared to the control group (JAMEY ET AL. 2025).

Analyzing the available data, it’s hard to deny that shared music and rhythmic movement foster stronger social bonds and enhance emotional well-being. In practice, schools can organize activities such as singing songs together, playing percussion instruments, or dancing together. The Dalcroze method, which involves learning through movement and improvisation, has demonstrated wide-ranging benefits—from increased self-esteem, through the development of movement-music coordination, to strengthening social skills and emotion regulation (JANTUNEN 2020). For example, van der Merwe and Morrelli’s meta-analysis (2022) indicates that active, collaborative rhythm playing gives children a sense of belonging, increases positive emotions, and reduces anxiety, which is crucial for psychological well-being. It also increases a sense of achievement and joy, which translates into better engagement in the learning process.

CONCLUSIONS

One aspect of the rapid development of modern technologies, particularly in the area of communication, is the increasing isolation and loss of social bonds. Combining three research perspectives—neurocognitive, phenomenological, and cultural-social—it can be demonstrated that music and rhythmic activities can be a tool for restoring community in society and the embodied

nature of social relationships, which are an evolutionarily grounded feature of our species. Sharing music and rhythmic activities in a group create conditions for the proper development of executive functions, emotion regulation, and a sense of belonging to a group. Such activities can be proposed as an alternative to passive consumption of digital stimuli and an important element in the prevention of various mental disorders in children and adolescents.

This conclusion is reinforced by phenomenological analyses, which indicate that rhythm is primarily an experience, and its source lies in the way the body functions in time. This approach allows us to establish a perspective in which rhythm appears as a fundamental, pre-reflective principle of social relations. Empirical research, in turn, shows that rhythm is one of the fundamental characteristics of humans as representatives of the biological species *Homo sapiens*, on the one hand, and as cognitive agent and members of various kinds of communities, on the other. As demonstrated in this article, contemporary empirical research also indicates that music and rhythmic synchronization plays a key role in interpersonal communication and the formation of social bonds.

Such research becomes particularly relevant when we note that, although digital communication enables maintaining contacts at a distance, it does not replace, and may even weaken, direct experiences of embodied co-presence. This article notes the emerging contrast between the experience of rhythmic embodied synchronization and dominant forms of digital interaction. Screen-mediated communication is characterized by limited corporeality, time delays, and fragmented attention, which hinders the development of a shared rhythmic structure. The lack of shared rhythmic synchronization can, in turn, lead to a weakened sense of connection, difficulties with emotional regulation, impaired cognitive development, and a greater sense of social isolation, which is particularly significant in the context of the social development of children and adolescents.

Both cognitive science and phenomenology indicate that rhythm and music can compensate for the deficits of the contemporary digital environment. By engaging the body, regulating emotions, and creating shared temporality, rhythmic practices enable the reconstruction of basic mechanisms of intersubjectivity and self-regulation. This perspective offers significant opportunities to counteract emerging deficits and difficulties in the cognitive and social development of children and adolescents. Implementing relatively simple solutions related to group rhythmic activities is, on the one hand, possible in various school and extracurricular settings, and, on the other, as empirical research

indicates, can yield real results in supporting cognitive and social development at every stage of life.

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AN INTERDISCIPLINARY PERSPECTIVE ON MUSIC, RHYTHM, AND SOCIAL
COMMUNICATION IN THE DIGITAL AGE:
FROM PHENOMENOLOGY TO EMBODIED COGNITION

SUMMARY

The aim of this article is to present an interdisciplinary approach to the relationship between music, rhythm, and embodied cognition, and to outline the role of rhythmic synchronization as a factor regulating the formation of social bonds in the contemporary world, saturated with new technologies.

This proposed framework integrates three research perspectives—neuroscientific, phenomenological, and sociocultural—to develop a model in which music and rhythmic activities become tools for restoring community in society, thereby counteracting the isolation caused by the increasing digitization of social communication. Shared rhythmic activities integrate movement, attention, emotions, and social relationships, constituting a natural mechanism for integrating individu-

als into groups. Collective music-making may therefore serve as a neurobiological regulator of co-presence and social bonding.

The theoretical framework underpinning the considerations presented in this article is defined by a phenomenological approach on the one hand and the theory of embodied cognition on the other, as well as by the neurocognitive foundations of social cognition theory. The phenomenological approach assumes that meaning and cognition are grounded in first-person embodied experience. Accordingly, the explanations formulated within this framework do not appeal to mental representations and their abstract processing, but rather to direct cognition arising through the experiences and actions of embodied agents in the world.

Keywords: music; rhythm; embodied cognition; social bonding; communication; phenomenology

INTERDYSCYPLINARNE SPOJRZENIE NA MUZYKĘ, RYTM I KOMUNIKACJĘ
SPOŁECZNĄ W DOBIE ROZWOJU CYFRYZACJI:
OD FENOMENOLOGII DO POZNANIA UCIELEŚNIONEGO

STRESZCZENIE

Celem artykułu jest przedstawienie interdyscyplinarnego podejścia do relacji między muzyką, rytmem i poznaniem ucieleśnionym oraz nakreślenie roli synchronizacji rytmicznej jako czynnika regulującego kształtowanie więzi społecznych we współczesnym świecie, prześiąkniętym nowymi technologiami.

Przedstawione ujęcie łączy trzy perspektywy badawcze – neuronaukową, fenomenologiczną i socjokulturową – aby zaproponować model, w którym muzyka i zajęcia rytmiczne stają się narzędziem przywracania wspólnoty w społeczeństwie, przeciwdziałając w ten sposób izolacji spowodowanej postępującą digitalizacją komunikacji społecznej. Wspólne działania rytmiczne łączą ruch, uwagę, emocje i relacje społeczne, stając się naturalnym mechanizmem integracji jednostek z grupami. Wspólnie wykonywana muzyka może zatem służyć jako neurobiologiczny regulator współobecności i więzi społecznych.

Ramy teoretyczne rozważań przedstawionych w artykule wyznacza podejście fenomenologiczne z jednej strony, teoria poznania ucieleśnionego z drugiej, a także neurokognitywne podstawy teorii poznania społecznego. Podejście fenomenologiczne zakłada, że znaczenie i poznanie są zakorzenione w pierwszoosobowym doświadczeniu ucieleśnionym. W formułowanych na tej podstawie wyjaśnieniach nie odwołuję się do reprezentacji mentalnych i ich abstrakcyjnego przetwarzania, lecz do bezpośredniego poznania poprzez doświadczenia i działania ucieleśnionych podmiotów w świecie.

Słowa kluczowe: muzyka; rytm; poznanie ucieleśnione; więzi społeczne; komunikacja; fenomenologia