ESSAY

Togetherness in musical interaction [version 1; peer review: 2 approved, 3 approved with reservations]

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Abstract

Playing music as part of a group is challenging, but also rewarding. What factors come together to maximize rewarding group playing experiences? How do feelings of enjoyment, frustration, and social (dis)connection shape group performance as it unfolds? This paper addresses these questions with a discussion of the conditions and processes that underlie rewarding experiences in musical interaction. The concept of musical togetherness is introduced, and defined as the feelings of social connection and pleasure that result from being and acting as part of a group during musical interaction. It is argued that three conditions must be fulfilled for togetherness experiences to occur. First, participants in an interactive setting must be aware of one another as intentional co-performers capable of exchanging expressive ideas. Second, interaction must unfold reliably in real-time, allowing for a mutual perception of liveness. Third, participants must adapt and build off of one another in a way that allows for mutual perception of responsivity. Whether these conditions are met is codetermined by the constraints of the environment in which the interaction takes place and the skills and communication techniques that interaction participants are able to deploy. Togetherness experiences are further supported by alignment between group members in body rhythms and a sense of we-agency, or the feeling of shared contribution to the collective musical output. The social and emotional rewards that are associated with musical togetherness are strengthened through a shared positive emotional response to successful interaction. Musical togetherness is hypothesized to contribute to shaping group performance in real-time by motivating group members to interact in ways that lead them to feel more together. This framework provides structure for a construct that has been used casually in the music psychology literature, has

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implications for how the performance behaviour of ensemble musicians is understood.

Keywords
musical interaction, ensemble performance, social bonding, pleasure, musical expressivity

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Introduction

Worldwide, music participation happens socially and functions as a means of bringing people together, strengthening relationships, and building trust and a sense of community. Group music-making can be enjoyable, promote feelings of belonging, and improve self-esteem (Kokotsaki & Hallam, 2007; Kokotsaki & Hallam, 2011). Indeed, it has been theorized that the human capacities for musicality and culture co-evolved because of the benefits that arose for social bonding (Savage *et al.*, 2021).

The opportunity to play music with others motivates people to invest substantial time and energy in music participation. Yet not every group music-making experience is positive. It can be frustrating to play with partners who are distracted or disengaged, mismatched in their skill levels, or unwilling to negotiate over how the music should sound (Berliner, 1994). What factors must come together to maximize rewarding group playing experiences? How do feelings of enjoyment, frustration, and social (dis)connection shape group performance as it unfolds?

These questions are of practical and academic interest. On the practical side, music participation has demonstrated benefits for well-being (Williamson & Bonshor, 2019). Therefore, it is valuable to explore how interactive musical settings can be optimized to attract and retain participants and promote positive experiences and social connections. Particularly relevant is how musical interaction might be used to cross cultural boundaries and create feelings of community among people from different backgrounds (Kruse-Weber *et al.*, 2023). On the academic side, musicians' subjective experiences of playing with others should be considered as a dynamic factor that can shape their performance in real-time. As will be argued below, current models of musical interaction do not adequately account for the effects of musicians' social experiences on the quality of their performance or the behaviours that unfold during performance.

This paper proposes that members of music ensembles experience musical togetherness (MT), which shapes their behaviour during performance and forms a key aspect of what they collectively aim to communicate through their playing. The paper argues that MT should be accounted for in models of musical interaction.

What is musical togetherness?

MT can be defined as feelings of social connection and pleasure that result from being and acting together during musical interaction. While the term has been used broadly (and often casually, without clear definition) in the literature, in the current discussion, a specific conceptualization is developed. In this framework, MT comprises a spectrum of experiences that vary in strength: It is experienced weakly under some conditions and strongly under others. It is argued that MT fluctuates from moment to moment as interactions unfold, and moreover, that it serves as a form of positive reinforcement, guiding players to behave in ways that make them feel more strongly connected.

MT is conceptualized here as requiring a specific set of underlying criteria. These criteria are listed in the bottom (solid border) box of Figure 1. The criteria build upon each other and are listed from bottom to top in the order in which they become relevant. They distinguish situations where people might not have the sense of engaging in social interaction with co-performers at all (*e.g.*, accompanying a recording), from situations where there is some potential for MT experiences.

This first layer underlying MT depends partially on the environment in which the interaction takes place (including physical and social attributes) and partially on the skills and strategies that are used by the interaction participants. Using the terminology of the 4E cognition framework, musical activities are embedded within physical and socio-cultural systems that shape and are shaped by participants' behaviour. Affordances for action arise from interactions between systems properties and participants' knowledge (van der Schyff *et al.*, 2018). As an example, imagine an improvising ensemble performing together, standing close to one another, in an otherwise quiet room. The conditions of the performance space are ideal for live multimodal communication—but if one player chooses not to listen or watch the others, and instead does their own thing, then the rest of the ensemble may perceive the errant player as uncooperative and unresponsive, limiting MT.

The second layer of criteria (dashed line borders in Figure 1) can occur if the first layer criteria are fulfilled. Embodied alignment and joint agency vary in how strongly they manifest. We can quantify differences in how strongly co-performers' body systems align over time, for example, using mathematical techniques like cross-recurrence quantification analysis or Granger Causality, among others (see Demos & Palmer, 2023). Experiences of joint agency are typically quantified using self-report scales (Loehr, 2022). Embodied alignment and joint agency are hypothesized to be mutually influential and directly support MT experiences.

The top layer (dotted border in Figure 1) comprises the rewarding attributes of MT experiences. In the literature on the social rewards and benefits of joint music-making, measures of social connection (affiliation, liking, willingness to help or cooperate, among others) are typically tested offline, following the interaction (*e.g.* Rabinowitch & Knafo Noam, 2015; Stupacher *et al.*, 2017). Real-time fluctuations in participants' emotional responses to the social aspects of music-making—including feelings of social connection or disconnection, pleasure, excitement, disappointment, or frustration—are difficult to capture, yet might play an important role in maintaining the interaction. In the current framework, this top layer is hypothesized to feed back into the first and second layers in real-time, shaping the continued interaction between participants.

In the sections that follow, the three layers underlying MT are described in detail. The contribution that each level makes to MT experiences is explained, and relevant research is explored. Arguments are also made for how each level relates to the others. It is important to acknowledge that MT is an active

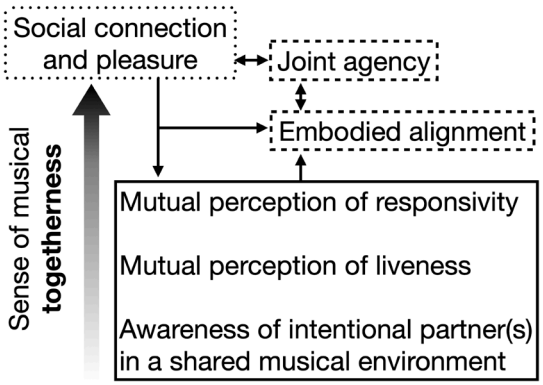

Figure 1. Framework for musical togetherness (MT). The bottom layer (box with a solid border) includes necessary conditions underlying MT experiences. The second layer criteria (boxes with dashed line borders) are contingent on the bottom layer, mutually influential, and contribute directly to strengthening MT experiences. The top layer (box with dotted borders) characterizes the rewarding outcomes of MT, which feed back to shape the continued musical interaction.

area of research, and there have been relatively few studies linking performers' subjective experiences with their behavioural interaction or physiological activity (*e.g.*, Bishop, 2023; Bolt *et al.*, 2016; Gaggioli *et al.*, 2017; Gibbs *et al.*, 2023; Saint-Germier *et al.*, 2021). Therefore, some parts of the discussion below have more empirical support than others.

Basic criteria underlying musical togetherness

Awareness of one or more interaction partners in a shared musical environment. Underlying all of the other criteria that characterize MT is an awareness of intentional interaction partners in a shared musical environment. For this awareness to occur, three conditions must be met: (i) a player must be aware of their interaction partner(s), (ii) it must be possible for partners to exchange expressive information bidirectionally, and (iii) this bidirectional exchange must enable the player to perceive their partner(s) as intentional.

An intentional partner in this context is one who has a flexible understanding of the rules governing the musical interaction that informs their actions. The rules that govern a musical interaction constitute constraints and affordances. These might be partially dictated by pre-defined structural information (*e.g.*, relating to a score or genre conventions), but they may also be negotiated or re-negotiated in real-time (Schiavio *et al.*, 2022). This is why flexibility is an important marker of intentionality: Since the rules don't necessarily remain constant throughout an interaction, intentionality is partially indicated through one's ability to participate in co-constructing them.

The perception of intentional others in a shared interaction space, leading to the emergence of social connection, has been termed "social presence" (Cui *et al.*, 2013). The concept of social presence is commonly discussed in the literature on mediated interaction, which often takes place in virtual environments where people cannot communicate as they normally would in physical proximity to each other (*e.g.*, social network games, distributed learning platforms, live streaming). This literature has sought to explain what factors must come together to give people the experience of "real human interaction" in virtual environments. Empirical studies show that social presence is not solely a feature of an environment, but also dependent on the skills and techniques that people use to engage (Chen & Liao, 2022). To be present and perceive one another's presence, interaction partners must be able to express themselves and perceive others' expressions (Gaggioli *et al.*, 2015).

Social presence theory, and its application to mediated interaction, can inform our understanding of what happens in musical settings when interactions are mediated by technology or constrained in some way. The conditions listed above are easily met in most live ensemble performance settings where players share the same physical space and express themselves via at least one modality. In contrast, performance with a non-adaptive partner (*e.g.*, a virtual partner or recording of a human performance) does not allow for bidirectional communication, and as such, arguably offers little or no potential for MT experiences.

It is also possible for an adaptive virtual musical partner to be perceived as non-intentional, precluding a sense of social presence. This situation arose in a case study by Van Kerrebroeck *et al.* (2021), where a pianist performed a duet in virtual reality with a human partner, and then with a computer-controlled agent. The pianist recognized that her partner was "not present" when she was playing with the agent and reported lower enjoyment and immersion following that performance. Clues that the agent was non-intentional were subtle, since it was programmed to adapt to the pianist's timing and its visual cues were based on motion data from human pianists. The authors concluded that the avatar lacked adaptive flexibility and the ability to re-negotiate the musical structure.

Mutual perception of liveness. Liveness in the context of ensemble playing refers to the perception that interaction with co-performers occurs in real time (Wilson, 2020). Liveness is primarily a matter of temporal alignment between the actions of performers and the reciprocal actions of co-performers (Vear, 2019). It comes into question when interaction partners do not share the same physical space, necessitating mediated communication (*e.g.*, via network). In such cases, real-time communication can be affected by latency in the network signal. What is meant by "real-time" and the effect that latency has on liveness depends on the music that is performed, how flexible its timing structure is, and how tightly players aim to synchronize. Empirical study has shown that latency has a severely disruptive effect on classical ensemble playing, negatively affecting basic coordination as well as players' ratings of musicality (Bartlette *et al.*, 2006). However, liveness might

be maintained if the music has a structure where players act intermittently (and not necessarily synchronously) to change repeating or continuous sound structures, as might happen in collaborative live coding.

Vear (2019) described an example of human interaction with a collaborative digital score where the perception of liveness is maintained. In *Movement 1, The Plumber* from *Black Cats and Blues*, the score samples audio from an improvising cellist and creates "a random sequence of short, repetitive, rhythmical aggregates of sampled sound that may change in pitch" (p. 197), resulting in a soundscape reminiscent of a plumbing system. The real-time processing of sound allows for a sense of collaboration on the part of the cellist. Performer Craig Hultgren reported on his experience playing with the score, "my relationship with the digital elements was like an improvisation with another person" (p.198).

When co-performers are physically together, multimodal communication might enhance liveness by offering convergent cues. Direct gaze from one player to another, expressive body motion, and breathing are communicative gestures that suggest a co-performer's intention to interact and their investment of physical effort in the interaction. Musicians playing with virtual reality partners experience stronger social presence when their partner is displayed with a 3D rather than 2D avatar (Campo *et al.*, 2023), and when an avatar partner produces facial expressions (Kimmel *et al.*, 2023). Skilled classical ensemble musicians exchange multimodal cues when it is possible for them to do so (Bishop *et al.*, 2019a, Bishop *et al.*, 2019b), although multimodal communication might be less important for expert ensemble players who know each other well (Bishop *et al.*, 2023; Høffding *et al.*, 2023).

Mutual perception of responsivity. Also critical for MT experiences is players' perception of their partners as responsive or adaptive to the player's own expressions. Mutual perception of responsivity is contingent on players perceiving one another's liveness. For partners to be perceived as responsive, they should produce expressions that are complementary to the player's own in timing and content.

What this complementarity means in practice depends on the form and demands of the music as well as players' expectations for how the interaction should unfold. Some adaptation in music is imitative (*e.g.*, players adjust their output to match one another's timing, maintaining synchronization; Leman, 2008, pp. 104–111), but more generally, players adapt to one another by adjusting their actions with reference to a shared understanding of what they collectively aim to express. Their collective expressive goals, furthermore, may be loosely defined and fluid, and may not always be explicitly negotiated, but rather, derive from compatible playing styles (Canonne & Aucouturier, 2016). Thus, adaptation might take the form of performing actions that support, elaborate, contrast, or conflict with the actions performed by one's partner(s) (Golvet *et al.*, 2021).

Players perceive when their partner fails to adapt or adapts in an unexpected way. For example, classical pianists rate their duet partners as less responsive when they and their partner are privately assigned different tempi, compared to when they choose their tempo together (Bishop, 2023). Jazz musicians have reported that playing with co-performers who fail to listen or anticipate incorrectly is unrewarding, as is playing with overly responsive drummers who forget that they are supposed to be time-keepers (Berliner, 1994). Anecdotal evidence suggests that a virtual duet partner who is unreliably adaptive (sometimes adapting less than it should, sometimes adapting too much, for example by playing unreasonably fast or slow for the musical style) is perceived as untrustworthy and distracting (Cancino-Chacón *et al.*, 2023). In another study, pianists evaluated their interaction with unresponsive duet partners as more pleasurable and their synchronization as better when the unresponsive partner was introduced as an experimenter than when the partner was introduced as a fellow participant, suggesting that social status influences how partner responsivity is evaluated (Demos *et al.*, 2017).

Embodied alignment

When co-performing musicians are together in one bodily modality, they are often together in other modalities as well. We commonly see coordination in sound accompanied by coordination in expressive body sway (Goebl & Palmer, 2009), predictable patterns of mutual gaze (Bishop *et al.*, 2019a), and coordinated changes in cardiac or respiratory rhythms (Lange *et al.*, 2022). Synchronization in neural oscillations also arises during musical interaction and may support behavioural coordination (Müller & Lindenberger, 2022; Sänger *et al.*, 2012; Zamm *et al.*, 2021). Embodied alignment describes temporal alignment that occurs between co-performers across body systems during musical interaction, over and above that which the structure of the music demands. Basic coordination of musical features as dictated by the music structure—synchronizing chords, maintaining the tempo and key, blending of pitch and timbre, using the same bowing—is important but insufficient for strong MT experiences.

Coordination in body sway or head motion is an emergent process that strengthens when players see one another (Bishop *et al.*, 2019b), when they aim to play expressively (Chang *et al.*, 2019), as they rehearse together (Wood *et al.*, 2022), and when the music is more complex (Badino *et al.*, 2014). Patterns of body sway relate to the structure of the music (D'Amario *et al.*, 2023; Demos *et al.*, 2018), and in ensemble playing, might function to communicate players' understanding of musical structure alongside communicating their attention and engagement in the music.

Ensemble musicians' eye gaze not only functions to gather visual information but can also communicate their focus of attention to audience members (Kawase & Obata, 2016) or other players. Direct gaze from one player to another is particularly meaningful, since direct eye gaze in humans signals an intention to interact (Senju & Johnson, 2009). Although glances

between ensemble co-performers account for a small percentage of performance time (Bishop *et al.*, 2023; Vandemoortele *et al.*, 2018), they tend to occur at predictable moments, including at sudden tempo changes (Kawase, 2014), at the start and end of a piece, and during passages where musical timing is irregular (Bishop *et al.*, 2019b).

Coordination in physiological rhythms like heart rate is, in some cases, largely attributable to shared demands on respiration—for example, in people who are singing in unison (Vickhoff *et al.*, 2013). However, cardiac synchrony has also been observed in string musicians, whose respiration does not directly influence their sound production. Høffding *et al.* (2023) found stronger cardiac synchrony between expert players than between students, and reduced coordination in playing conditions where players could not see one another only for students. They proposed that cardiac synchrony reflects shared absorption that occurs when players become collectively immersed in their performance. Supporting the interpretation that cardiac synchrony is linked to shared absorption, correlations in heart rate arise between partners coordinating non-musical improvised movement (Noy *et al.*, 2015) as well as people who share emotional responses without synchronizing body movements, such as people listening to the same music (Bernardi *et al.*, 2017) or performers and observers during ritualistic fire-walking (Konvalinka *et al.*, 2011).

Embodied alignment is hypothesized to be supported by real-time multi-directional information flow between players. In this view, it is not sufficient that musicians are engaged in playing the same music and understand the music similarly, although these factors also contribute to body systems aligning; physical proximity between musicians is also needed. To date, the literature offers some support for this hypothesis: Some forms of embodied alignment, such as coordinated head motion and cardiac synchrony, strengthen when players can see one another (at least for non-experts, Bishop *et al.*, 2023; Høffding *et al.*, 2023), suggesting that real-time visual interaction between players contributes to the effect (Bishop *et al.*, 2019b). However, a stronger test would be to compare the strength of alignment between players under normal real-time interaction conditions to conditions where multi-directional interaction is prevented (for example, by pre-recording some parts).

Maintaining behavioural coordination requires players to strike a balance between distinguishing their own actions from those of others (self-other segregation) and integrating others' actions into their own plans (self-other integration; Heggli *et al.*, 2021). These complementary processes can be indexed by cortical alpha oscillations, with increased activity occurring during periods of low behavioural entrainment, suggesting self-other segregation, and suppressed activity occurring during periods of high behavioural entrainment, suggesting self-other integration (Novembre *et al.*, 2016). Christensen *et al.* (2023) observed enhanced alpha activity in orchestral violinists when they played a canon passage or took a leading role, and suppressed alpha activity in violinists who played in unison or followed another player's lead.

Players sometimes choose to minimize their access to co-performers' body signals—strengthening self-other segregation, when they are at risk of losing control over their own playing. For example, singers were found to look away from their duet partners when singing in canon, but not while singing in unison (Palmer *et al.*, 2019). These findings suggest that visual cues from their partners interfered with singers' abilities to maintain their own parts independently. Thus, in some settings, players must relinquish some low-level alignment in order to maintain alignment at the higher-order level f expressive goals.

Joint agency

Perceiving one's partner(s) as responsive helps to support a player's sense of contributing to the collective output of the group. Players' sense of contribution relates to their sense of agency—the feeling of being in control of (or the author of) one's actions and the effects that they have on the world (Haggard, 2017).

Self-agency arises when one's actions produce outcomes that are expected in terms of content and timing. In a joint action context, self-agency is not necessarily affected by what others are doing, although it can be disrupted if there is substantial overlap between partners (Ternström, 1999). It is important for musicians to have a sense of self-agency while playing in a group, so that they can maintain control over their own playing.

Joint agency arises in joint action settings, where people act together to accomplish a shared goal (Loehr, 2022). Joint agency specifically relates to a sense of acting together rather than merely being together. Pacherie (2014) argued that having a sense of agency for a joint outcome is different from having a sense of we-agency ("we are the authors of our joint action"). Self-agency is maintained when one has a sense of agency for a joint outcome, she proposed, but reduces when one has a sense of we-agency. Thus, for Pacherie, we-agency is characterized by a reduction in self-other differentiation. Others have suggested reconceptualizing we-agency in terms of how people cooperatively contribute to a shared goal while maintaining self-agency over the actions that comprise their contribution to the goal (Salmela & Nagatsu, 2017). In this view, no reduction in self-agency is required for we-agency.

During joint action, rhythmic alignment between individuals is thought to strengthen agency for a joint outcome by making individuals more predictable to one another. Empirical findings support this hypothesis. For example, joint agency strengthens as coordination between co-performers improves and is stronger during mutual coordination (players adapt to one another) than during unidirectional coordination (one player adapts to the other; Bolt *et al.*, 2016). It is also stronger when interaction partners' synchronized actions yield a musical duet rather than constant pitch sequences (Zhou *et al.*, 2023). Saint-Germier *et al.* (2021) explored skilled improvisors' ratings of agency following a joint performance and found that a we-agentive identity (operationalized in terms of how immersed players felt within the group) was stronger when players felt

more integrated and dependent on one another. Ratings of we-agentive identity were also higher when improvisors' playing was more interdependent.

Literature on the phenomenology of joint agency is concerned with how it feels to act together. The sense of we-agency is associated with shared emotions, which Salmela and Nagatsu (2017) suggest are supported by interpersonal alignment in cognitive and body systems. One source of emotional response relates to the challenges and unpredictability of joint action. Participants might feel excitement, anxiety, pleasure, and/or disappointment before, during, and after an interaction, as joint goals are negotiated and either achieved or not.

We-agency may be linked to the sense of effortlessness coordination that skilled musicians report sometimes experiencing during ensemble playing. Some musicians have described this as "knowing without knowing" what will happen, feeling or "knowing telepathically" what their co-performers will do (Berliner, 1994), or sharing a "hive-mind" (Høffding, 2019). This seemingly effortless mode of coordination can be distinguished from coordination that requires explicit and effortful prediction and communication (see also Schiavio & Høffding, 2015). Høffding (2019) suggests that coordination without explicit communication may involve "intrakinesthetic affectivity", where players activate a joint body schema, allowing for kinesthetic coupling between them. Adopting a different theoretical angle, Seddon and Biasutti (2009) use the term "empathetic attunement" to describe a mode of collaboration in which musicians decenter and see things from their co-performers' musical perspectives, reducing the need for explicit communication and supporting increased exploration and creative risk-taking.

Forlè (2021) proposed vitality attunement as a factor that might boost the sense of we-agency. *Vitality* refers to aspects of the style with which a phenomenon unfolds in time and/or space that communicate a sense of animation or aliveness. Forms of vitality are perceived as "dynamic Gestalts whose qualitative specificity is not reducible to and describable in terms of physical features" (p. 11). Both human behaviours and inanimate phenomena (*e.g.*, sounded music) display vitality. For example, human motion can convey a sense of forcefulness or gentleness, and so can a passage of music. For both motion and music, these qualities emerge from a combination of low-level features relating to timing, amplitude, and articulation. *Vitality attunement* occurs when individuals are aligned in the forms of vitality that are displayed through their behaviour. Since vitality is a dynamic attribute of behaviour (or events), alignment in vitality involves alignment over time of the body systems that shape the behaviour. Forlè (2021) argues that through this mechanism of body alignment, which, as discussed above, has the effect of making interaction partners more predictable to each other, vitality attunement can strengthen the sense of we-agency.

In musical settings, this might be the case where players perform similar roles or intend to convey the same affective state. However, much music requires individual players (or instrument sections) to perform with complementary rather than identical expressive goals. Aucouturier and Canonne (2017) showed that pairs of skilled free improvisors could communicate complex social attitudes like being domineering, conciliatory, or insolent through their playing. Social attitudes like these cannot be communicated through one voice alone, or even two voices performing in a similar style, but rather require two players (or more) working together to simulate either side of the relationship (*e.g.*, the one being domineering and the one being dominated). Thus, the music requires that players adopt different forms of vitality to collectively achieve an expressive outcome.

Social connection and pleasure

Small (1998) introduced the term *musicking* to describe music participation in all of its forms—producing, listening, playing, and dancing. He wrote that "the act of musicking establishes in the place where it is happening a set of relationships, and it is in those relationships that the meaning of the act lies" (p. 13). The relationships that he refers to are between sounds and between people, with the latter representative of "relationships between person and person, between individual and society, between humanity and the natural world, and even perhaps the supernatural world" (p. 13). In effect, he argues that the relationships that people establish (and/or simulate) when musicking have broad implications for their ability to relate to others and how they act in the world.

In the current framework, what distinguishes rewarding MT experiences from other rewarding music participation experiences is that feelings of social connection and pleasure are causally tied to the active and creative interaction that players share. That is to say, while players might also enjoy the physical and cognitive effort of performing their instrument and the sound of the music that they produce, in MT experiences, some aspect of the pleasure that they get from playing is specifically linked to the success of their interaction with their partner(s). This argument is in line with Salmela and Nagatsu's (2017) suggestion that the interaction process itself is a source of shared emotion.

A growing body of literature has shown that rhythmic synchronization in musical and non-musical settings strengthens affiliation for synchronization partners (Hove & Risen, 2009), has a positive effect on social attitudes (Rabinowitch & Knafo-Noam, 2015), and promotes prosocial behaviour (Stupacher *et al.*, 2017). These effects can strengthen when synchronization is more successful (Launay *et al.*, 2013), when it takes place in a musical setting (Stupacher *et al.*, 2017), and when partners share an intention to synchronize (Reddish *et al.*, 2013). The prosocial effects of synchronization are thought to be linked to the brain's reward system, which is activated by rhythmic synchronization of body movements (Kokal *et al.*, 2011; Tarr, 2014).

Often in this literature, prosociality is measured using implicit rather than explicit measures. Participants are not typically prompted to reflect on their experiences performing, and indeed,

it has been important to show that social bonding effects are not attributable to participants' knowledge of the predicted effects of synchronization. This is in contrast to what naturally occurs during musical interaction, where participants easily reflect on how their relationship with interaction partners has been affected. Several studies have used interviews to investigate the rewards and challenges of ensemble playing, in the context of professional, student, or community groups. The results are sometimes broader than what is strictly relevant here, with participants commenting on factors such as musical development and sense of community (Taylor *et al.*, 2011), conflict resolution and maintaining relationships (Lim, 2014), and obstacles to participation such as health problems and other commitments (Pitts *et al.*, 2015).

A subset of studies have specifically addressed the question of how it feels to play music together, rather than the broader question of how it feels to be a member of a music ensemble. Orchestral musicians have described a sense of dynamic energy deriving from and contributing to successful performance, which they try to communicate to the audience (Gaunt & Dobson, 2014). This energy is something that they feel, with one musician stating, "you get onto the platform and the adrenaline starts, and you're just completely taken over by being part of such an incredibly energetic animal" (p. 305). They also spoke about the pleasure that comes from contributing to a outcome that is greater than what they could produce individually: "Playing in a section is one of the most thrilling and fun things that you can do... being part of something that is so much more powerful than you are on your own" (p. 305).

A recent study by our group involved a qualitative analysis of semi-professional classical singers' and pianists' experiences of MT (D'Amario & Bishop, unpublished report). Participants described feelings of "joy", "fun", "freedom", and "relaxation" resulting from MT experiences. They also described less rewarding situations in which MT was limited. Unprepared or inattentive co-performers, differences in social status (*e.g.*, playing with a teacher), and difficulty jointly connecting with the musical material were listed as factors that reduced MT.

Many participants spoke about MT being a central aim or "one of the most important things" in an ensemble performance. They tied feelings of pleasure to social connection, which they spoke about in terms of feelings of "oneness" or "intimacy":

> "But when we began, before we played or before I sang, I didn't really know which emotion I would find, because I had in my head one emotion that I wanted to express... I found another emotion just from that being together with this pianist. And it felt really free being out there together with someone who gives you also the freedom to find and express what you found. And it's totally amazing feeling. And it felt intimate also, and also understanding without words before, really just from being together."

Several participants distinguished between basic coordination ("playing the notes together") and the sharing of an emotional connection that characterizes strong MT experiences:

> "But it's so much more fun if you really can make music together and not just play the notes. So for me that difference is the big difference of a performance where I would say: 'Tonight was nice' and the performance where I would say: 'Wow that was so touching and so moving and felt so good'."

In a study of what they called "kinaesthetic togetherness", Himberg *et al.* (2018) gave two groups of participants the task of creating a rhythm to perform together using whatever body movements they liked (clapping hands, stomping feet, etc.). During a "rhythm battle", the two groups walked past each other while trying to maintain their own rhythm. A positive relationship was found between how closely individual participants maintained their group's tempo and their self-reported enjoyment of the game. A positive trend was also found in correlations between the tempo similarity of group members and their ratings on a version of the Inclusion of Other in Self scale, which is commonly used as an index of social closeness (Aron *et al.*, 1992). These findings support the idea that people can draw "aesthetic pleasure" from moving together, and that close alignment of body motion supports experiences of togetherness.

Peak experiences and group flow

Feelings of reward, immersion, and effortlessness are associated with group flow, an extension of the construct of individual flow, which is also associated with intense concentration and a loss of self-consciousness and time awareness (Csikszentmihalyi, 2014). Vear (2019) described flow as "the experience of musicking from the perspective of being inside the activity". Sawyer (2006) linked group flow specifically to performance on collaborative, creative tasks like group music-making or theatre improvisation. He conceived it as an emergent group property, meaning that it arises from interaction between group members independently of whether or not group members are experiencing individual flow.

Group flow is not a defining feature of group performance, but rather can happen when a group performs at its peak. Cochrane (2017) proposed that the alignment between performers' intentions and realized outcomes are central to group flow states. That is to say, group flow emerges when performers' intentions are completely satisfied by the group's actual output. This is possible when performers defer their intentions to the unfolding music, forming intentions based on their "sense of momentum of the music—what the music itself seems to be suggesting should come next" (p. 139). Spontaneity facilitates this process because it prevents performers from constructing expectations about how the music should sound. Such a basis to group flow could help to explain why musicians sometimes report feeling as though the music is playing

itself: "We just followed the music wherever it wanted to go. We would start with a tune, but the way we played it, the music just naturally evolved" (Buster Williams, quoted in Berliner, 1994).

How does group flow fit into the framework for MT that is developed here? It accounts for the small portion of interaction experiences where the rewards associated with successful performance are at their peak. However, group flow experiences are not the only cases of musical interaction where participants feel social connection and pleasure, as these rewards, albeit to a lesser degree, emerge during most instances of interaction where the basic (first level) criteria for MT are fulfilled. In the next section, the possibility that moderate levels of togetherness motivate players to find ways to strengthen the connections between them is explored.

It is proposed here that MT is an individual rather than group-level phenomenon. This is in contrast to the group level phenomenon of group flow. Players approach musical interactions with different expressive goals and different expectations about how the collaboration should work. The same performance might therefore satisfy some players more so than others, leading to different experiences of success and reward. Players might also differ in how readily they interpret the behaviour of others, and how accurately they determine the ensemble to experience or not a shared affective state. Empathy abilities might play a role here in addition to the role they play in supporting prediction and synchronization (Stupacher *et al.*, 2022).

In the study of singers and pianists discussed above, we paired participants with duo partners and recorded their performances of two pieces of classical Lied repertoire. Immediately after performing, they used a slider to make continuous ratings of their MT experiences while watching the audio-video recordings of their performances. This rating task was done independently by each participant. A full analysis of the similarity of partners' ratings, and how ratings related to aspects of the performances, is forthcoming (Bishop *et al.*, unpublished report), but to summarize, we found overlap but also substantial differences in how participants rated their MT experiences. Examples of ratings from two duos, one with high similarity between singer and pianist and one with low similarity, are given in Figure 2. The limited similarity that we found is in line with the hypothesis that MT is experienced at the individual rather than group level.

Real-time effects of musical togetherness on performance

In the literature, some theoretical frameworks have been proposed to explain how ensembles maintain coordination. Keller (2014) identified three cognitive mechanisms—attention, anticipation, and adaptation—that collectively enable ensemble players to coordinate their musical output, not only in timing, but in intensity, intonation, articulation, and timbre as well. He described these cognitive mechanisms as constrained by factors such as players' knowledge and expressive goals, and domain-general skills like empathy, personality, and intelligence. The Interpersonal Musical Entrainment model proposed by (Clayton *et al.*, 2020) centers around these mechanisms as well, but also emphasizes the role of social and cultural factors, which influence expressive choices relating to musical structure and the musical roles of different performers.

Glowinski *et al.* (2016) proposed a model to explain resilience in music ensembles, that is, their ability to recover from mistakes and disruptions. The model specifies three factors that affect an ensemble's performance in the event of a disruption: the magnitude of the disruption, the level of cognitive effort on the part of the musicians (ranging from "habit" to "goal directed"), and the level of coordination within the ensemble (ranging from "self-centered" to "fully coordinated"). The ensemble must be able to anticipate, monitor, respond and learn from

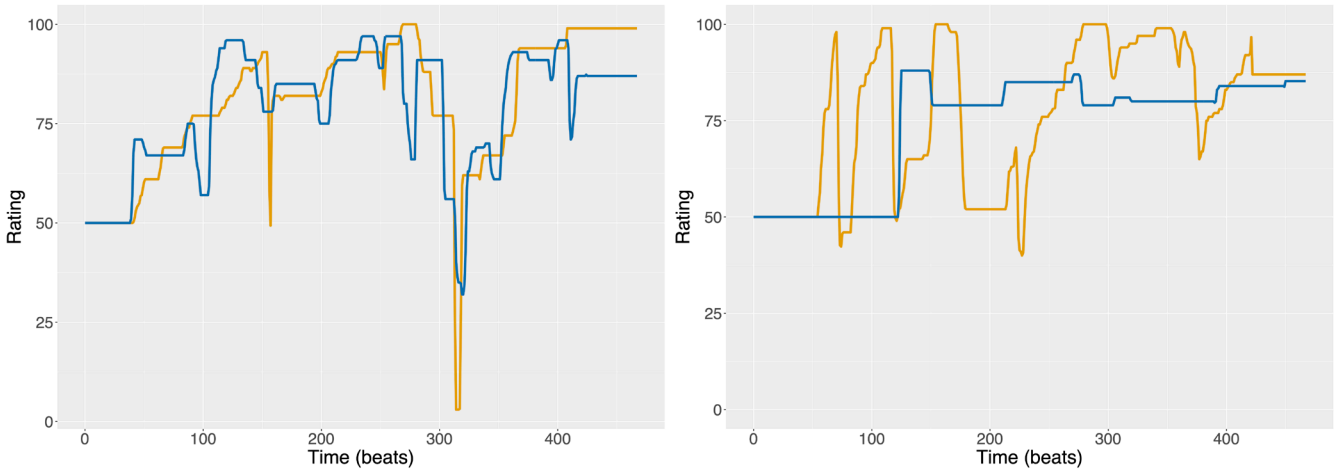

Figure 2. Ratings of musical togetherness given by members of two singer-pianist duos for their performances of Automne, by Gabriel Fauré. Ratings from the singers are in orange, and ratings from the pianists are in blue. The duo on the left showed greater similarity in their ratings of togetherness than did the duo on the right.

disruptions for an ensemble to regulate their performance successfully.

These models cover the key components that underlie people's abilities to establish and maintain coordination despite variability in one another's performance, changing musical structures and expressive goals, and unexpected disruptions. One might argue, however, that coordination is not the goal of ensemble playing, but rather a means to a rewarding shared aesthetic experience. Therefore, it might be useful to extend these models to account for how the experience of musical interaction shapes ensemble dynamics.

Drawing on extensive interviews with members of a community choir, Stephens (2021) proposed a model to explain how musicians use feelings related to aesthetic experience to guide their attention and behaviour during ensemble playing. The model posits that the aesthetic experiences of fragmentation and wholeness are adaptive subprocesses that are active during musical interaction. Ensemble members engage in "aesthetic orienting", which involves re-directing attention more towards wholeness, when they feel negative emotions associated with fragmentation. This idea of aesthetic orienting maps onto the "response" phase in the resilience model of Glowinski *et al.* (2016). Stephens (2021) makes the point that "ebbs and flows" in musicians' feelings of MT over time are inevitable, particularly for longer pieces or concerts, where it can be difficult for individuals to maintain their attention and engagement continuously.

In line with the model by Stephens (2021), a key hypothesis of the current framework is that the sense of MT contributes to shaping musical interaction in real-time. In Figure 1, this hypothesis is indicated by arrows feeding back from the rewarding state of social connection and pleasure into the first and second levels of the model. Feedback to these levels is posited to prompt three types of response: i) a null response, leading to maintenance of interaction strategies that are judged as adequate; ii) a change geared towards compensating or correcting for weakening MT; and iii) a change geared towards seeking further rewards when MT is already high.

Empirical studies suggest that experienced ensemble players take action when they feel weakly together or perceive that their coordination is threatened, in line with response (ii) above. For example, duo musicians were found to synchronize less precisely and watch each other more while playing an (unmetered) passage with irregular timing than during passages where timing was more regular (Bishop *et al.*, 2019a). Thus, they adopted a strategy of monitoring each other visually when coordination and togetherness were threatened. A recent study with an artistic swimming group showed that moments of weak togetherness preceded corrective actions that brought the group back into alignment (Gesbert *et al.*, 2022).

Strong experiences of togetherness seem to encourage creative risk-taking, in line with response (iii) above. Based on observational studies of a jazz sextet and a string quartet, Seddon and Biasutti (2009) identified three modes of communication: instruction, where information is given unidirectionally; cooperation, where communication is multi-directional and coordination is achieved; and collaboration, where empathetic attunement allows for greater creativity and spontaneity. Their findings suggest that performers are more likely to take creative risks when they do not have to invest effort in maintaining coordination. In an interview, jazz musician Harold Ousley said, "The musicians I played with this Thursday hooked up so well, it just gave me a cushion for my own solos. They made it possible for me to put myself in a state of mind where I didn't block my ideas and was able to feel that freedom that we all strive for" (Berliner, 1994, p. 389).

Golvet *et al.* (2021) found that improvising musicians were more likely to engage in dissenting (noncooperative or non-interactive) behaviour when their partner was physically present and familiar. A follow-up study showed that musical excerpts featuring dissensus were rated as more creative than excerpts featuring cooperative playing (Wolf *et al.*, 2023). Thus, physical presence and familiarity seemed to support improvisors' creative risk-taking. In a non-musical study, participants played the Mirror Game (coordinating improvised hand movements), then rated how much they liked their partner (Ravreby *et al.*, 2022). Partners who liked each other tended to be more creative in their movements, and movement synchronization and complexity predicted liking better than synchronization alone.

In sum, it seems that the less effortful coordination becomes, the more players are able to invest resources in the creative aspects of their performance. They demonstrate confidence in the strength of their coordination, and trust in their partners' abilities to respond, to the extent that they are willing to act in a way that could either destabilize the interaction or yield highly rewarding results. Importantly, by interacting creatively, performers may strengthen their feelings of togetherness even further.

Conclusions

This paper has defined musical togetherness as a dimension of experience arising from the act of playing music with other people, associated with rewarding feelings of social connection and pleasure, and supported by interpersonal alignment of body systems and shared affective responses. A framework has been proposed that outlines the conditions that are hypothesized to motivate social engagement and a resulting sense of MT in musical interaction. These conditions are co-determined by environmental constraints and the knowledge and interaction strategies that participants choose to use, noting that the same environmental features might be more constraining for some people than others.

It is important to clarify the scope of this framework. Currently, the framework broadly outlines the processes that are involved in gaining social rewards from musical interaction. This is not to say that interactions that do not fit within this framework cannot also be enjoyable. Referring again to Small's (1998) concept of musicking, there are many forms of active music participation, and they can be rewarding in different

ways. Singing along with one's favourite (non-responsive) music tracks is evidently enjoyable, as evidenced by the number of people who like to do it, but this enjoyment is not social in the way that MT experiences are.

It should also be clarified that this framework is not assumed to apply only to people with musical training or extensive informal experience, although most of the relevant research focuses on formally trained and experienced musicians. It is presumed that "simple" music structures can afford intense MT experiences just as "complex" structures can, so musical skill and musical complexity have not been included as components of the framework. That being said, very simple music does not offer performers much opportunity to express themselves, so there is likely a minimum threshold that they need in order to establish any expressive exchange (a basic criteria for MT experiences; see "Awareness of one or more interaction partners"). Furthermore, musical novices might also struggle to make use of the communication channels that are available to them, for example, by offering a signal that is a poor reflection of their musical intentions (*e.g.*, singing out of tune) and/or not adequately attending to their partner(s) (*e.g.*, not listening due to preoccupation with technical demands). Overall, MT experiences should be accessible to musical novices, but they may have more difficulty achieving them than experienced musicians do.

A third point to clarify is the role of synchrony in MT. While much of the literature on musical coordination focuses on behavioural synchrony, which does indeed play an important role in many forms of music, there are other types of temporal relationships that can have musical significance as well. Examples include microtiming with slight offsets between voices, out-of-phase relationships (*e.g.*, as in *Piano Phase*, by Steve Reich), polyrhythms, and turn-taking. The types of bodily alignment that support MT are variable both in the form of temporal relationship that they take and their precision.

This framework has been proposed with several aims in mind. First, it was intended to provide structure for a construct that has been referred to mostly casually in the literature yet seems to relate to reliable patterns of effects. Second, the framework addresses a gap in the literature on the social benefits of rhythmic synchronization, by explaining how social connections develop in real-time during the course of interaction. Third, some of the things that musicians do when they are performing together cannot be explained as part of a strategy to maintain coordination, for example, watching one another when it is not necessary to do so, or introducing unexpected new ideas. Some of these behaviours could be explained in terms of togetherness—watching one another communicates attention and social intent, and taking creative risks communicates trust in one's co-performers. Therefore, an MT framework could offer a way to explain some patterns of behaviour that do not seem to support coordination directly. Finally, from a practical standpoint, it is important to know what the conditions are that promote or discourage MT so that these can be taken into account when mediation technologies for musical interaction are developed and opportunities for music participation are designed.

This framework is novel, and there are still many open questions and hypotheses to test. Among the most critical trajectories for further study would be testing the generalizability of the framework across different musical traditions and types of interaction. In particular, with recent developments in social robotics and music technology, the possible forms that musical interaction can take are expanding. It would be valuable to use these new interactive systems to test some of the hypotheses and assumptions of the MT framework. Another valuable trajectory would involve further study of the role of conflict and dissensus in MT, with the aim of untangling the conditions that allow these modes of interaction to support versus disrupt MT experiences. Finally, mixed-methods studies that bring together phenomenological, behavioural, and physiological measures are needed in order to understand how the experiences of music-makers shape the process of music-making.

Data availability

The data for this article consists of bibliographic references, which are included in the References section.

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Open Peer Review

Current Peer Review Status: ✔ ✔ ? ? ?

Version 1

Reviewer Report 19 June 2024

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This is a useful paper that gives a theoretical explanation of feelings of musical togetherness that may strengthen and weaken during a group music performance, the factors that make it happen and feed into the experience of musical togetherness, and its influence back onto the musical performance. There are some shifts and inconsistencies in the paper that need to be clarified. There are some gaps in the explanation that are promised to be addressed but are not yet clearly addressed. And there is some further acknowledgment necessary for closely related existing contributions. I also have a number of points that require addressing that relate to specific sections of the paper.

Clarification 1 – the specific topic and research question of the paper
What is the phenomenon that this paper addresses? I think it is: 'experiences of musical togetherness' that musicians report and that may vary as a performance is developing. However, the introduction suggests it to be about: the rewards of group performances and about 'How do feelings of enjoyment, frustration, and social (dis)connection shape group performance as it unfolds?' as the abstract suggests. However 'rewards and shaping of group performance as it unfolds' do not seem the core of the topic, but rather extensions of it. I think it is first of all about defining the experience of musical togetherness and the factors contributing to it. For example, enjoyment and frustration are mentioned in the section on Embodied alignment: One source of emotional response relates to the challenges and unpredictability of joint action. Participants might feel excitement, anxiety, pleasure, and/or disappointment before, during, and after an interaction, as joint goals are negotiated and either achieved or not, whilst the section on Social connection and pleasure talks about links with aesthetic pleasure and the positive experience of musical togetherness. The bulk of the discussion is however about processes related to musical togetherness. Not much detail is provided explaining how emotions may be evoked, and the feedback into the performance process itself ('shape group performance') is mentioned as likely without much theorizing.
It would be good to clarify the topic of the paper or the main phenomenon that it addresses early on in the introduction. I think that can be usefully done using some of the quotes from musicians that are now introduced later in the paper (p8). Clarifying musical togetherness as an experience

that musicians talk about and that they find a meaningful concept to rate across the development of a musical performance. This would clarify the scope of the paper, and helps to clarify its boundaries. For example, there are many resources that have addressed social bonding effects of musical participation. This paper is about something more specific, namely the feelings of musical togetherness during music performance.

Clarification 2 – is musical togetherness necessarily social and how does it differentiate from social bonding?

This point is related to the above point about the clarification of the specific scope of the paper. The top level of the presented model (Figure 1) is social connection and pleasure. However, the paper does not engage much with existing literature on music, synchronization and social bonding, nor with existing literature on social dynamics in music making. Furthermore, is togetherness in musical terms automatically also perceived as social connectedness? Does it automatically translate or are there certain conditions for this to translate. How do other social factors influence the perceived social togetherness, or is this mostly bottom-up? This can be contextualized better and discussed in the discussion.

Clarification 3 – what type of article is it, what is the basis for its presentation, and what is the main contribution going forwards?

The article seems to me to be a position paper rather than a review paper. Its status as a position paper and the basis for the position taken in the paper could be explained better. For example, it can be explained that the author proposes this based on her extensive research and data collected in this domain for x number of years, and presents this as a proposal that is supported by the research evidence provided in the article. To make an impact, I think the article would be strengthened if specific predictions and hypotheses are formulated. What is the main contribution and shift in knowledge and understanding that is offered by the model? What does the model predict, and how can it be falsified or developed? What are the limitations of the presented evidence, what is relatively well established and where are remaining uncertainties? The concluding section addresses some generic themes. This needs to be sharpened.

Clarification 4 – what is the relevance of synchronization versus other means of being together?

It is not clear to me what the role is of ‘entrainment’ and synchronization versus other forms of being together. Is synchronization a strong form of generating musical togetherness but not essential or is it essential? Same question for entrainment. Could being together mean complementary action that create a coherent whole? This seems possible within the framework. However, most examples relate to synchronization, and the conclusion also talks about the framework addressing a gap on the social benefits of synchronization, suggesting rhythmic synchronization is central after all. This can be further clarified (it comes across as shifting in position in the article).

Specific comments

Abstract – these questions do not seem central to the paper:
What factors come together to maximize rewarding group playing

experiences? How do feelings of enjoyment, frustration, and social (dis)connection shape group performance as it unfolds?

Abstract – are the 'conditions' prerequisites or factors contributing to the experience? It comes across as prerequisites, but that seems stronger than argued in the paper and the figure and also than what evidence would suggest. What if the conditions are not met?
In:
It is argued that three conditions must be fulfilled for togetherness experiences to occur.

Abstract – do you mean 'or' or 'and' in:
a sense of we-agency, or the feeling of shared contribution to the collective musical output.

Abstract - what is different between successful interaction and the musical togetherness as conceived here? It sounds the same, which would make the argument circular.
The social and emotional rewards that are associated with musical togetherness are strengthened through a shared positive emotional response to successful interaction.

Abstract – does musical togetherness shape group performance? Or is it influencing or providing feedback? The sense in which it shapes group performance is not clear from the paper.

Abstract – Is the implicit assumption that an ultimate motivation of ensemble performance is to create a sense of (social) togetherness? What is the evidence for that and also should there be some caution around this? Can the motivation be aesthetic rather than social for example? In:
by motivating group members to interact in ways that lead them to feel more together.

P3.Introduction
Statement: 'musical participation has demonstrated benefits for well-being'.
Comment: I would say that this article (Williamson & Bonshor) does not necessarily demonstrate benefits for well-being. Rather participants self-report benefits on well-being.

Statements: On the academic side, musicians' subjective experiences of playing with others should be considered as a dynamic factor that can shape their performance in real-time.
Comment: why 'should be'? This is not new is it?

Introduction general comment:
what is the aim of the paper, and what is its framing? How was this framework developed and for what purpose?

Comment: Is this the main proposal of the paper? The discussion of 'musical togetherness, which shapes their performance…. and they collectively aim to communicate through their playing' seems not to get a lot of attention in the paper, and there is also not a lot of evidence presented in the paper to support it. Evidence mostly relates to the three layers presented in Figure 1. For example how is musical togetherness communicated?
Statement: This paper proposes that members of music ensembles experience musical togetherness (MT), which shapes their behavior during performance and forms a key aspect of what they collectively aim to communicate through their playing.

Under 'what is musical togetherness'?

Statement: MT can be defined as feelings of social connection and pleasure
Comment: can be or is defined? Also, why is it defined as social connection and pleasure? Why not as musical connection? And from that pleasure and social connection may be derived, but it is not itself pleasure and social connection?

Statement: They distinguish situations where people might not have the sense of engaging in social interaction with
co-performers at all (e.g., accompanying a recording), from situations where there is some potential for MT experiences.
Comment: This comment is a reflection on the need for social interaction, which returns in the discussion of the factors in layer

1. I wonder whether the picture of social vs non-social is too black and white, and whether music that is pre-recorded can indeed be felt as deprived of social engagement. For example, research has also argued that in certain situations music serves as social surrogate? Participants can be made to believe that a computer that taps along with them is a fellow participant, but that is an artificial situation, so less relevant. The main thing to consider is whether there is a bias in this starting point towards synchronized live performance? What about the practice of recording one track over another in the making of popular music? Also, the interaction between a DJ playing electronic dance music and the audience dancing? You could acknowledge such potential variations more, and also clarify what the context is that your model or framework is conceived in, and how it may be adjusted for different situations depending on the expectations of the performers? Rather than making it necessarily universal?

Statement: you refer to 4E cognition.
Comment: This needs a reference. Also, in your discussion, you do not actually engage with all 4 E's (embodied, embedded, extended, enactive). Not with extended for example.

Embodied alignment: does this relate specifically to synchronization or also to other forms of alignment? Does it need to be embodied? Can it be alignment in sounds? Or is that also intended as part of embodied alignment? Do you mean by this not necessarily alignment in thoughts?

Statement: The contribution that each level makes to MT experiences is explained, and relevant research is
explored.
Comment: is 'explored' the best word? How do you explore other people's research? Better to use 'discuss'.

P4.figure 1. What about aesthetic outcomes, where do these fall within the model?

Basic criteria: 3 conditions must be met.
What is the evidence that they need to be met? Is not it more a matter of degree? In your later explanations of research findings, it also comes across as a matter of degree rather than black / white yes or no.

Statement: To be present and perceive one another's presence, interaction partners must be able to express
themselves and perceive others' expressions (Gaggioli et al., 2015).

Comment: so people do not necessarily have to see each other or be present in the same room? This can be clearer and more explicit.

Statement: In contrast, performance with a non-adaptive partner (e.g., a virtual partner or recording of a
human performance) does not allow for bidirectional communication, and as such, arguably offers little or no potential for
MT experiences.
what about playing along with a pre-recorded backing track – like in a multitrack studio recording where things are sometimes recorded subsequently? This is not giving a sense of musical togetherness, even if it is a joint product?

Statement: It is also possible for an adaptive virtual musical partner to be perceived as non-intentional, precluding a sense of social presence.
Comment: you might need to first explain that an adaptive virtual musical partner is sometimes perceived as human? Given the 'also possible'? Otherwise, this comes across as selective reporting.

P5. Collaborative live coding.
Comment: Add a reference? E.g. to Together in cyberspace: collaborative live coding of music, (Trimmers et al.,2021)(Ref-1)

Statement: For partners to be perceived as responsive, they should produce expressions that are complementary to the player's own in timing and content.
Comment: is 'complementary' the right word?

Anecdotal evidence suggests that a virtual duet partner who is unreliably adaptive (sometimes adapting less than it should, sometimes adapting too much, for example by playing unreasonably fast or slow for the musical style) is perceived as untrustworthy and distracting
Comment: Why is this anecdotal? [may be the right term, ignore my comment if appropriate].

Statement: suggesting that social status influences how partner responsivity is evaluated
Comment: is this social status or rather whether it is goal-directed? Presumably the experimenter has a particular goal in mind?

Embodied alignment. First sentence – you talk about different modalities including sound.
Comment: sound is not strictly speaking embodied. Clarify what is meant by embodied, or your use of the term.

Statement: 'use same bowing'
Comment: you could contextualize these kind of remarks by clarifying 'if part of the aesthetic objectives'. Since shared bowing used to not be a particular goal and may in certain contexts still not be common.

P6.statement: Embodied alignment is hypothesized to be supported by Realtime multi-directional information flow between players.
Comment: here you seem to refer to aspects of Layer 1, rather than new things. Clarify.

Statement: at the higher-order level f expressive goals.

Comment: f should be for

Joint agency section.
Statement: Joint agency arises in joint action settings, where people act together to accomplish a shared goal
Comment: can arise rather than arises?

P7.Participants might feel excitement, anxiety, pleasure, and/or disappointment before, during, and after an interaction, as
joint goals are negotiated and either achieved or not.
Comment: link to emotions should be further supported and developed. Also, is not this part of the next section / level?

why vitality in particular? Why not indeed a shared state (conceptual, affective,) or intention (character)?

Statement: Both human behaviors and inanimate phenomena (e.g., sounded music) display vitality. For example, human motion can convey a sense of forcefulness or gentleness, and so can a passage of music. For both motion and music, these qualities emerge from a combination of low-level features relating to timing, amplitude, and articulation. Vitality attunement occurs when individuals are aligned in the forms of vitality that are displayed through their behavior. Since vitality is a dynamic attribute of behavior (or events), alignment in vitality involves alignment over time of the body systems that shape the behavior.
Comment: this section on vitality – needs some further references. Not clear where the information is from that is explained. Stern wrote about this originally?

P8. You refer to other related research in: Several studies have used interviews to investigate the rewards and challenges of ensemble playing, in the context of professional, student, or community groups. The results are sometimes broader than what is strictly relevant here, with participants commenting on factors such as musical development and sense of community (Taylor et al., 2011), conflict resolution and maintaining relationships (Lim, 2014), and obstacles to participation such as health problems and other commitments (Pitts et al., 2015).
Comment: some research is more closely relevant to what you are talking about for example: social dynamics within ensembles and how these develop over time and are experienced as part of a performance and rehearsal. There is research on rehearsal dynamics that you are not considering. Relevant references: (Seibert, 2021)(Ref-2), (Saunders, 2021)(Ref-3)
Furthermore, you consider how social connectedness and pleasure may feed back into shaping the performance, but not how other elements of the social context may influence social connectedness and performance. This can be better acknowledged and contextualized.
References e.g.(Moy,2021)(Ref-4), (Camlin.,2021)(Ref-5), (Su et al.,2021) (Ref-6)These references are from (Trimmers et al.,2021)(Ref-1) but there are also more extensive journal publications for some of these.

Quotes about MT suggest role of aesthetics – not just alignment and getting it right, but the whole becoming bigger than the sum of the parts.

These findings support the idea that people can draw “aesthetic pleasure” from moving together, and

that close alignment of body motion supports experiences of togetherness.
Comment: connection to pleasure only, or also other emotions? And, is synchronization in body motion in the end the central topic?

P9.Players might also differ in how readily they interpret the behavior of others, and how accurately they determine the
ensemble to experience or not a shared affective state. Empathy abilities might play a role here in addition to the role they
play in supporting prediction and synchronization
Comment: and and their evaluation and assessment of the situation? Does that also play a role?

In the study of singers and pianists discussed above
Give reference – there are so many studies referred to above.

P10.Statement: They made it possible for me to put myself in a state of mind where I didn't block my ideas and was able to feel that freedom that we all strive for"
Comment: Acknowledge the role of safety and trust in ensemble performance? (including reference)

General comment: it is not entirely clear where the explanation of the model ends, and a discussion starts from the section headings. I assume it is from 'Peak experiences and group flow'. This can be better signposted.

If social aspects are so important for MT, clarify this by calling it SMT?

P11. That being said, very simple music does not offer performers much opportunity to express themselves, so there is likely a minimum threshold that they need in order to establish any expressive exchange (a basic criteria for MT experiences;
Comment: 'express themselves' is not part of the model, so why are you referring to that?

Non-musicians are also less critical than musicians. How is that included in shaping the experience?

Statement: The types of bodily alignment that support MT are variable both in the form of temporal relationship that they take and their precision.
Comment Refer to changing expectations, e.g. (Terepin et al.,2021) (Ref-7)
Second, the framework addresses a gap in the literature on the social benefits of rhythmic synchronization.
Comment: this is too generally phrased (social benefits), and also is it indeed purely about rhythmic synchronization?

Final paragraph:
end with specifying hypotheses to be tested and the specific research questions that are generated by the framework, including for each layer and relationships between layers. This is too generic.

Final comment: is it a framework or a model? To me it comes across more as a model than a framework. I think a framework would be more flexible in its application, while this is quite a

specific model of contributing factors to musical togetherness.

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Is the topic of the essay discussed accurately in the context of the current literature?
Yes

Is the work clearly and cogently presented?
Yes

Is the argument persuasive and supported by appropriate evidence?
Partly

Does the essay contribute to the cultural, historical, social understanding of the field?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: ensemble performance, emotion, expression

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 11 June 2024

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Lauren Stewart
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This is a welcome review that emphasizes a new angle on the topic of musical interaction - namely the pleasure of social connection that can emerge from joint music making. The author explains

how concepts of agency, synchronization, attunement and flow all play a role in bringing about togetherness in musical interaction. The final paragraph mentions the need to test some of the hypotheses and assumptions of the framework. I would welcome something more explicit about this: what are the main testable hypotheses of the framework and how would the author go about measuring these. In addition, it would be good to point the reader towards relevant methodologies for 'capturing' musical togetherness (or indeed in discussing the need for new, implicit methods for doing so).

Is the topic of the essay discussed accurately in the context of the current literature?
Yes

Is the work clearly and cogently presented?
Yes

Is the argument persuasive and supported by appropriate evidence?
Yes

Does the essay contribute to the cultural, historical, social understanding of the field?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: music cognition, cognitive neuroscience of music

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 08 June 2024

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Julien Laroche
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In the present paper, the author offers a synthesis of literature and a framework that accounts for the phenomenon of musical togetherness (MT). In particular, she concentrates on the conditions that bring forth the experience of MT and the way these factors interact with each other, which is the main point and merit of this paper. The topic of joint-musicking in general has been getting increasing attention lately, and the perspective offered here is solid and it brings an additional degree of formalization to the current literature. The paper is well written and structured and should be accepted, in my view, with revisions that I estimate to be rather minor, although my

report contains many comments and interrogations. One reason for these multiple remarks is that the text is catchy and interesting enough to trigger numerous reflections. Plus, a number of the comments I had in mind while doing a first reading got addressed later in the text, underlining the quality of the proposition. I decided to let some of them in the final report to let the author get a glimpse into how the text reads from a fresh perspective. Finally, I should emphasize that the present report is not meant to make the author think that she should respond or even agree to all of them in the text, or cite all the references I suggest, and certainly not at the risk of de-structuring a well constructed and smooth proposal. They are to be seen as springboards to foster further reflections and refinements: I feel the potential for a great proposition, but I also feel that the paper can benefit from some improvements.

To start with the main, overall model, I find that that the figure illustrating the conceptual proposition could be improved. For instance, the dependance between the proposed conditions of MT could be emphasized. I was wondering also why what is termed embodied alignment does not fee back into aspects such as the perception of responsivity and liveness. Finally, I think that one of the main strengths of the proposition is the way MT, through social connection and pleasure, feeds back into its own pre-conditions. This aspect could be clearer in both the figure (with more emphasized arrows perhaps) and the text. In the abstract for example: « Musical togetherness is hypothesized to contribute to shaping group performance in real-time by motivating group members to interact in ways that lead them to feel more together ». This argument becomes clearer in the text, but at first, it sounds simply circular (MT motivates MT, in short). This gets progressively clearer. on Page 1 : « it serves as a form of positive reinforcement, guiding players to behave in ways that make them feel more strongly connected ». My understanding that previous experience of MT and their rewarding quality encourage performers to guide their behavior in the pursuit of such feeling when the interact again with others. Guidance of behavior in the light of phenomenal experience and past feelings is a strong point that could be better highlighted and made more explicit.

It is also not entirely clear to me, by reading, why embodied alignment and joint agency have a different status than the 3 announced pre-conditions of MT. Is it because the 3 conditions are thought as individual happenings, and the other two are relational in nature ? Yet, mutual perception is mentioned, suggesting that pre-conditions are relational in nature as well. In the abstract, we read: « Togetherness experiences are further supported by alignment between group members in body rhythms and a sense of we-agency, or the feeling of shared contribution to the collective musical output. », so it is not sure if those are 4th and 5th conditions that enables MT, or if they rather are to be thought as enhancers or modulators of the effects of the 3 conditions introduced before. Note also that in the abstract, the difference between conditions 2 and 3 (mutual perception of liveness vs of responsivity) is slightly unclear, as responsivity could be thought of as a cue of liveness. It becomes clearer afterwards but the difference could clarified in the abstract.

An other interesting way in which the proposition is framed is that instead of simply taking for granted that playing music together or coordinating activities lead to positive subjective (and intersubjective) outcomes, the authors looks for the conditions under which this can happen, pointing out that playing together might also simply go wrong for a number of reasons. Careful, then, when giving the definition of MT as « feelings of social connection and pleasure that result from being and acting together during musical interaction » that sounds unconditional (emphasized by « being » : isn’t being together a subjective feeling itself, one that goes beyond

mere physical co-presence ?).

As pointed out by the author, togetherness in general is rarely defined and clearly operationalized. But since the text aims at offering a definition in a particular modality (the musical one), perhaps a hint (or perhaps a source) on what togetherness is in general could precede the presentation of that definition. Does it mean that similar processes in non-musical domain operate similarly and give rise to similar experiences in the non-musical realm ? Or are the qualities of MT experiences somewhat modality-specific ?

The author mentions the feeling varying from weak to strong. Does it actually go from « 0 to 1 » ? Or should it be described/conceptualized as going from -1 to 1 ? that is, not from weak or absent to strong togetherness, but rather from the very opposite of togetherness (disconnection or something alike) to actual togetherness? I feel the author goes in that latter sense later on, but the way it is expressed vary. Maybe you can stabilize the proposition a bit more in that regard.

When comparing mutual interaction to the accompaniment of a recording: I'm personally very sympathetic with the idea that reciprocity is a core aspect that fosters or even enables togetherness but reading the text I found myself having doubts after all. For instance, when thinking of musicians exchanging tracks they co-create, playing over each other in a delayed mode of coordination, where some sort of interactivity, proximity, dissensus, sharing of feelings, intentions toward others etc.. can be felt.
The author says that this situation is not « social in the same way » in the conclusion, but maybe what the phenomenological differences are should be expressed more clearly. Otherwise this is an observer-dependant statement, which contradicts the fact that togetherness here is presented as an (individual) experience rather than an observable feature (although some of its enabling conditions have observable correlates).
The author also mentions singing along a non responsive track. It made me wonder: is MT the same or different when it occurs between performers and audience ? The feelings of connection can be really strong and impacts the musical interaction and the participation of all parties. If it is different, what are the specificities ? Page 4, paragraph 2 of the second column, the claim is reiterated that the lack of bi-directionality prevents feelings of togetherness, but, to me, it is still not entirely clear why (especially as it is later claimed that the feeling is pretty individual in nature). Perspectives between co-performers sometimes differ to the point that a player does not feel the mutual responsiveness despite the interaction being in real-time, while the other does feel it. So, is mutuality important as an objective feature of the situation, or is it the feeling of mutuality that matters ?

Relatedly, reading the text, I thus started to wonder if the feeling of reciprocity goes along with the reciprocity of feelings, in the authors' mind. Togetherness can be one-sided and co-interactors can have very different perspective on their interaction (in music, see for instance, Pras, A., et.al., (2017) (Ref 4). What about their performance do free jazz improvisers agree upon? A case study. Frontiers in psychology, 8, 263067 SPIRO N.et.al., 2021 (Ref 5). The author has, later on, a strong opinion on this issue, namely that MT is an individual, subjective experience. Past empirical observations and subjective report corroborate this position, at least regarding the fact that perspective on that matter can radically differ between 2 people interacting with each other. but in the text, this notion is unveiled abruptly and was, for me at least, unanticipated. I felt a bit lost at that point: the author insists on the fact that real-time mutuality of the interaction is a core ingredient for MT to manifest, and that situations where interaction is not in real-time lack the

social aspect that grounds MT. But then it is proposed to be an individual, or individually felt phenomenon. I don't say, or think that it is contradictory, I actually relate to the suggestion, but it might confuse the reader: it feels « unannounced » and the individual / social cut might be either too abrupt or not defined well enough. It makes us wonder : what in the mutuality of interaction is so important if it ends up being a subjective feeling ? I'll come back to that but I'm not sure the text explain that in the most convincing manner.

The notions of embodied alignement and joint agency are central to the second layer of the proposed model. Therefore, they require way more precise definitions. Embodied, alignement, and joint agency are terms whose definitions in the literature are as fuzzy as those of togetherness.
More generally, the author should be careful with the accumulation of under-defined jargon borrowed from 4E frameworks and with the temptation of taking their meaning (and conceptual appropriateness) for granted, which might not be the case from the perspective of some readers (who might even be unfamiliar with the associated technical vocabulary). There is a possibility to do even better justice to these frameworks by formulating things outside of their vocabulary habits.
Embodied for exemple is used to mean so many different things that it lost its meaning.
Here, if it only means « alignement of movement », there should be a better term.
Embodiment, in the original understanding provided by Varela et al. (« the embodied mind »), is not a thing that belong solely to the observable, physical domain: it relates to how experiences are subjectively enacted. In that sense, I find the use of the term a bit problematic or perhaps simply unnecessary here.
Agency needs a substantial definition too here, because when presenting those terms, the author seems to talk about the sense of agency, not agency itself. So, on the other hand, joint agency is not just a subjective / experiential quality, but it is also an observable state of affairs. In that sense, joint agency and whatever is embodied alignment are unsurprisingly mutually influential because what they mean partially overlap in some regards.
End of page 4, discussing liveness, I felt again a need for a precise definition of alignement. Are we talking about synchronicity (as a state, measurable as a temporal distance) ? Or the way the respective timing of co-performers relate to each other (not necessarily aiming at pure synchronicity, but at the establishment of patterns of relation). I'm guess the author is thinking of the latter, but this should be made clearer (this sort of remark can be responded with a short reformulation or clarification, I'm definitely not asking for a whole chapter of philosophy)

Would there be more felt liveness with an agent that would perfectly predict our fluctuations and perfectly synchronize with us ? I suspect, reading other parts in the text, that the author does not advocate for such a linear relationship (e.g., when mentioning contrast and conflict as adaptive ways). Therefore a better definition of alignement would help too, otherwise risks of contradiction could emerge. This is done page 5, but it feels a bit late considering that the notion is discussed before. But there too I wonder if the provided definition truly aligns with the author's vision since it seems to project that more alignement is more similarity or synchronicity. Is it, in music, the optimal form of alignment (given, for example, the importance of micro-timing in the discourse of people such as Vijay Iyer 2002 (Ref 10) or in Keil's (1987) (Ref 6)

Page 5, on the interpretation of the Demos et al., 2017 paper: it might not be the result of social status per se but of the understanding that as, an experimenter, the unresponsiveness has a function that is coherent with the underlying intentions of the experiment (perceivable as playful

constraints or even as a game by the participant)

Page 5 on the neural part of alignement: the results of the following paper could be interesting for the author to read and perhaps mention: Lender, A., et.al., 2023 (Ref 11)Page 5: "Coordination in body sway or head motion is an emergent process that strengthens when players see one another »
I'm not sure in what ways this should be formally considered as « emergent » (from what and how ?) but you might just need need that expression here.

Page 6: citing Noy et al., 2015, perhaps you could mention something about togetherness since it is at the heart of their paper.

Page 6: reading this part I again felt that more interpersonally body coordination equals more togetherness. I'm not sure if it really is what the author thinks, as suggested in other places of the text (e.g., the later discussion on overly responsive partners). Shouldn't the feeling of being able and allowed to act somewhat independently convey a stronger sense of togetherness than the requirement to strictly align with another at the expanse of one's autonomy and expressivity ? Are we looking for a sweet spot or the edge of a spectrum of alignement ? If it is a sweet spot that should be sought for, what does it tell us about the pre-conditions of MT and the proposed concept of alignment ?

Regarding earlier remarks on alignment, and the acknowledgement of the importance of complementarity mentioned by the author herself, discussing this paper could be important in the section on joint agency : Zhou, Z.et.al.,(2023) (Ref 7).
Also, the cited Loehr 2022 review paper could be used to better define the sort of we-agency that is targeted in the present paper: see Loehr's distinction between united and shared agency. Is togetherness more one or the other ? Temporal alignment might lead more to we-agency feeling, but togetherness might reside more in shared agency ? That would make togetherness more dependent on relational processes, rather than aligned states, which might make more sense regarding (non-military) music. Given that the author later on moves toward the proposition that togetherness is an individual feeling, I think that the notion of shared agency lets more room for a definition of togetherness where individual autonomy remains, while the sense of self seems to dissolve during united agency (although, I agree, this does not entail that the same feeling is shared across individuals).
In other words, togetherness would relate more to the active regulation of the relation between performers behaviors than their alignment stricto sensu (something well captured by the enactive notion of participatory sense-making framework : De Jaegher, H.et.al., (2007)(Ref 8). Schiavio, A.,et.al.,(2017) (Ref 9).

Page 7: I didn't know the Forlè 2021 paper but I guess the Vitality concept comes from Daniel Stern no ? If yes, it could be good to mention and cite it briefly

Page 8, Himberg et al. study: even more striking in that study is the fact that the correlation between tempo similarity and social connectedness applied also to members of separate / competing groups ! Which backs up the authors' claim even more strongly, although this is a correlational result so the direction of causality is unclear.

Page 9 column1 paragraph 3: 'MT is an individual phenomenon'

There is some tension between that claim and the overall claim that interactivity is central in MT. I don't say contradiction though, and I don't disagree, but a clearer explanation / articulation of how this can be a non-shared subjective feeling while its sources and cues are at the interactional level might be needed. Why is mutuality so important if it is an individual phenomenon, and if it is an individual phenomenon, why wouldn't playing against a pre-recorded prevent from experiencing MT ? The condition of responsivity is an element of response yes, and the distinction with group-level flow is understood, but can we say that MT is a strictly individual phenomenon when it stems from a process that is entirely embedded into the dynamics of interaction ? A piece of the explanatory mechanism seems to be missing, or could be better described. Should it be discussed somewhere when and why MT can be sometimes shared but not necessarily ?

Page 9: Piano/singer ratings: very good example that MT as a feeling can be either shared or not, which also makes the claim that it is an individual phenomenon too strong. On the second example, the timescales at which participants are rating their feelings of MT might simply differ, explaining part of the difference by differences in attentional and rating strategies (but I admit they really look quite different).

Page 10: « abilities to establish and maintain coordination »
I would add « establish, maintain and re-establish coordination ». This might sound like a verbal detail, but it is not. The tension I feel between making « embodied alignement » central and the rightful mention of complementarity, conflict resolution etc.. appeals to a more dialectical process, and perhaps MT is linked to the succession of such contrasted phases. sometimes, it is the process of mutually recovering from de-synchronized phases of interaction that strengthen the interpersonal musical connection:
Laroche, J., & Kaddouch, I. (2014) (Ref 1)
The author expresses that well shortly after, so, making me think that the following paper on agency might be more in line with the author's underlying thoughts, and could help to better explain the emergence of feelings of MT than more mainstream conceptualizations of agency:
Buhrmann, T.,et.al.,(2017) (Ref 2).

Page 10: « experienced ensemble players take action when they feel weakly together or perceive that their coordination is threatened »
I like how the author proposes that musicians use their felt experience (of MT) to guide their interaction / to motivate certain actions that recursively aim at MT. The way MT feeds back into its pre-conditions is clear here, and the wording here could inspire a clarification of that point earlier in the text (see earlier comments about feelings of circularity in the argument, and the suggestion that the author should better clarify and emphasize this, which is one of the strong points of the paper) .

Page 10 and conclusions: I don't have specific guidelines here but overall, I felt that the structure at the end could be improved (with not much effort but with a more explicit plan of where things are going here).

The studies at the end of the part that precedes conclusion (Golvet et al. Wolf et al. and Ravreby & al.) go further than the interpretation given by Seddon and Basutti: the lack of embodied alignement might be source of creativity. In fact, in the Ravreby studies, and in the mirror game tasks in general, people tend to sacrifice their synchrony at times just to improve their collective creation and renew their coordinated pattern.

This becomes interesting to discuss more thoroughly: in the case of the improvisers of these 3 studies, do they seek for stronger togetherness through « embodied dis-alignment » ? If yes, this is challenging for the proposed framework, which would need to take more into account the dialectic between coordination and de-coordination, alignment and dissensus. The fact that musicians need a certain level of complexity to feel MT (stated page 11) is a clue of the importance of the processes that go beyond « embodied alignment » (or that a more general definition of this terms required, one that does welcome micro-timing as a way of actually coordinating, for instance).

The length of this report is commensurate to the interest aroused by the submitted draft and is meant to help the author get a fresh perspective and a few challenges to help her improve the proposition. To sum up, the three main points of this report concern 1) the clarification of the main concepts (e.g., in particular related to alignment and agency, and the feedback loop between the phenomenon of MT and its pre-conditions) 2) the tension between the claim that it is an individual phenomenon and the centrality of interactive, relational processes 3) the tension between the emphasis put on alignment and the acknowledgment that aspects such as complementarity, dissensus and others are also strong factors.

Side note: this paper just came out during the reviewing process and could be of interest to the author as well:
Faraco, A., et.al.,(2024) (Ref 3).

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Full Text

Is the topic of the essay discussed accurately in the context of the current literature?
Yes

Is the work clearly and cogently presented?
Partly

Is the argument persuasive and supported by appropriate evidence?
Partly

Does the essay contribute to the cultural, historical, social understanding of the field?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: music psychology, joint action, improvisation studies, individual and collective agency

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 31 May 2024

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In this review I recognize the considerable strengths of this essay, two areas for further development, and a broader critique on the body of research this work exists within.

Building on current research on interaction in music, this essay proposes a framework for understanding musical togetherness (MT). This framework is structured in a logical manner and supported by a host of secondary research. In short, Bishop argues that there exist a set of necessary conditions for MT, a set of criteria built upon those conditions that consequentially strengthen MT, and a set of outcomes as a result of MT which may prompt a positive feedback loop. Bishop's proposal is supported through a comprehensive overview of existing research. This is an excellent model of how a literature review may be structured in support of an author's argument. The summaries of this research are concise and well-paced.

I would suggest this specific work be refined in two ways:
First, there is scope to more thoroughly provide background on the term 'musical togetherness'. Providing conflicting examples of its use in existing research would clarify the degree of its ambiguity and, consequently, the need for a more rigorous definition. More transparency in the need for a common definition—the impetus for this research!—would be more in line with the wealth of secondary sources drawn upon in this essay.
Second, there is space for more critique of existing research to be included. Such critique may have been made opaque by dint of the way the argument has been edited; i.e. research that has been flawed may have been left on the cutting room floor rather than mentioned and then disregarded. As with the previous point, more transparency in this would have improved the rigour of the work.

From a broader perspective, this work succumbs to a common shortcoming of research on the psychology of musical interaction: it is almost exclusively limited to classical music and jazz (or improvisation framed within these genres). These traditions of musicking fall within what Thomas Turino (2008) classifies as presentational performance. Within classical music traditions (and arguably within jazz that emulates many of the presentation aspects of art music if not the degree of performer autonomy), the line between performing and non-performing participants is clearly demarcated. As I have written in relation to chamber music, 'audiences may observe performers enact intimate relationships and listen to intimate sonic relationships between musical parts, but they are, by and large, external to these relationships' (McCaleb 2022, p. 33)(ref-1). Live performance within popular music traditions, on the other hand, exists within a space which encourages (and is contingent upon) more active engagement from all participants. Musical togetherness thus becomes more complex as it involves not only the playing but also the non-playing participants. Turino writes 'when [participatory] performance is going well, differences among participants melt away as attention is focused on the seamlessness of sound and motion. At such moments, moving together and sounding together in a group creates a direct sense of *being* together and of deeply felt similarity, and hence identity, among participants' (2008, p. 43)(Turino ., 2008)(ref-2). Thus, the behaviors, motivations, and experiences of musicians in participatory traditions are arguably more significantly impacted by their audiences than musicians in presentational traditions are.

Rigorous research on this distinction is contingent upon the clarity of terminology used within the literature. However, the phrase 'group music-making' (and the more generalized use of 'music') is commonly used within the unspoken context of Western art music. This generalization does not provide semantic space for discrimination between a broader range of musical practices, let alone different musical ontologies, phenomenologies, and epistemologies. Without adequate framing within classical music traditions (of which jazz has increasingly become subsumed within), research on the psychology of musical performance misrepresents its breadth.

I would like to stress that my concerns about scope are considerations for further development for this entire area of research. This essay never purported to include broader critique of types of musicking included within research on the psychology of musical performance. However, clarification as to the types of musicking under consideration would have both framed the work more appropriately and flagged up the need for comparable research inclusive of a wider range of musics.

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Is the topic of the essay discussed accurately in the context of the current literature?
Yes

Is the work clearly and cogently presented?
Yes

Is the argument persuasive and supported by appropriate evidence?
Yes

Does the essay contribute to the cultural, historical, social understanding of the field?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Musical ensemble interaction, pedagogy, and cultural context

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 22 May 2024

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Review of “Togetherness in musical interaction”, by Laura Bishop

In this paper, Laura Bishop aims at defining what constitutes musical togetherness and identifying the necessary conditions for such phenomenon to emerge. In doing so, she integrates the scattered empirical evidence published over the years (including significant findings from her own team, as she has been at the forefront of research on collective music making for several years now) into a coherent framework, meant to explain how the various component of musical togetherness relate with one another.
The resulting essay is remarkably clear, and provides an impressive synthesis of the current state of the art on the topic, drawing from the extent scientific literature published in music psychology, but also phenomenology or human-computer interaction. Of course, the main original contribution of the paper lies in the proposed framework. Overall, and in my eyes, it does a great job in accounting for musical togetherness, even though I have some minor points I would like to

discuss.

Musical togetherness (MT) is first defined as intrinsically pleasurable: feeling together when making music in a collective setting is a positive feeling; and second as a feeling of social connection: feeling together is feeling connected to others. This calls for two remarks: first, MT is presented as a component of musicians' *experiences*; second, defined as such, MT can be usefully distinguished from coordination (musicians' actions can be combined efficiently without necessarily giving rise to a feeling of MT). However, it is less clear how MT relates to aesthetic evaluation and aesthetic experience (issues related to creativity are mentioned at the end of the paper but aesthetic experience does not necessarily involve creative or original behaviors). On the one hand, one might wonder whether a positive aesthetic experience (i.e., the performers evaluating their ongoing performance as beautiful or expressive) is a pre-requisite for MT to emerge[1]. On the other hand, one might wonder whether MT itself is a constitutive component of the musicians' aesthetic experience, and if, following C. Thi Nguyen's analysis of games and other "arts of action" (Ref-4)(Nguyen, 2020), the very agential experiences of MT afforded by collective musical practices can be the object of the aesthetic attention of the performers themselves.
Within the basic criteria underlying MT, Laura Bishops mentions the awareness of intentional interaction partners/intentional others. I am wondering whether framing this criterion in intentional terms might be too strong. Later in the paper, Laura Bishop makes it clear that MT is related to individual experiences (i.e., two musicians playing together do not have necessarily the same experience regarding MT). An intriguing issue is thus whether experiences of MT could potentially emerge when interacting with a musical AI for example (such as the one provided by the SoMax2 software developed at Ircam, see Fiorini & Malt, 2023), and whether feelings of socio-musical connectedness might arise even if the status of such IA's intentionality remains unclear.
My third point is on the relation between joint agency and MT. Joint agency is itself highly multi-dimensional, with components such as the feeling of we-agency, the sense of agency for a joint outcome, or the phenomenology of integration. It would seem that once a sense of joint agency is clearly established on at least one of these dimensions, MT should follow. Or is MT only characterizing a subpart of the experiences we have when joint musical agency is achieved? And if so, why exactly?
Finally, at the end of the paper, Laura Bishop calls for the development of mixed methods to further investigate MT. I feel that this aspect could be developed in the paper, maybe by suggesting relevant ways to integrate qualitative and quantitative approaches. MT is often investigated through post-hoc self-reports (either verbal reports, or post-hoc annotations, as in one of the studies conducted by Laura Bishop's team), which is probably the most natural way to go when we need to account for musical experiences. But one might wonder if mono-dimensional annotation of MT (e.g., using a scale or slider) are really possible, given the multi-layered nature of the construct. Laura Bishop also mentions tracking physiological markings (e.g., cardiac synchrony) that have sometimes been taken to indicate experiences of shared absorptions, but it would be particularly interesting to test for the presence of such markings in musical settings in which togetherness might mainly depend on timbral/spectral relations rather than temporal relationships, as a way to assess whether they are in fact trivially dependent on rhythmic coordination or whether they can be taken as robust correlates of the specific phenomenology of musical togetherness. In any ways, some further methodological discussions would make the paper even stronger.
A particularly interesting feature of the framework suggested by Laura Bishop is how MT feeds back on the unfolding musical interactions, i.e., how monitoring one' own feeling of MT might impact your own musical and interactional behaviors. This is something I often observed in my

studies on collective improvisation. For example, a collective silence during a given performance might be experienced very differently by performers, either as a quasi-magical collective breathing or as a sign of disconnection, pushing the performers to quickly come up with a solution to overcome the resulting feeling of social awkwardness (see Canonne 2012; see also Wilson & MacDonald, 2012). Investigating in more detail how MT (and other aspects of the performers' experiences) regulate individual and collective behaviors during musical performances is certainly an important issue for future research on joint music making and Laura Bishop provides a first attempt at a typology that should prove useful for further studies.
[1] Note that musicians can certainly found a collective artistically valuable even in the absence of a feeling of togetherness. During my own fieldwork on collective improvisation, a musician once said to me about a performance she remembered vividly: "As soon as I made a sound that was a little too loud compared to what he [the cellist] was playing, it was like a switch, he stopped playing all of a sudden. Musically, it created a tension that was very interesting, but on the other hand, this was really unpleasant for me" (quoted in Canonne, 2014).

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Is the topic of the essay discussed accurately in the context of the current literature?

Yes

Is the work clearly and cogently presented?

Yes

Is the argument persuasive and supported by appropriate evidence?

Yes

Does the essay contribute to the cultural, historical, social understanding of the field?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Musicology

I confirm that I have read this submission and believe that I have an appropriate level of

expertise to confirm that it is of an acceptable scientific standard.