

Rhythm and Self-perception — Performatively Disrupting the Self by Paying Attention to Attention

*Ritmo e auto-percepção —
Performativamente perturbando
o Eu prestando atenção à atenção*

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Abstract

The contemporary discussion about attention is often inextricably connected with moral judgments about how, and to what, we should pay attention — and with a recurrent vilification of media technologies. Through a shift from a critique of the economy of attention to the ecology of attention, and by considering the poststructuralist debate on the ontotechnology of humans, we show that there is a central concern with the loss of control over the self and an emphasis on differentiation, order, and systematicity. This can be understood as a preoccupation with the rhythm of attention, life, and mediation processes. Art, on the other hand, can

be thought of as a particular type of space, where experimentation with attention can happen beyond everyday assumptions and hegemonic understandings of how attention should manifest. By engaging with an existing artistic piece, *Bad Touch*, and building on it a series of technologically-driven feedback loop systems that are particularly sensitive to an embodied process of focusing on attention itself, we show how the voluntary loss of control — assisted by technology purportedly aimed at ensuring control — can better help us reflect on attention itself, and on how binary logics of dis/attention, un/control, or in/human fall flat within certain contexts; how the loss of rhythm can hold creative potency precisely because it can be derived from a wilful foregoing of instrumental control. We end by reflecting on what this illuminates in terms of the human/machine, body/mind, artist/artwork dichotomies, and how it can better help us value alterity as a precondition for sameness, and for attention as a system of valuing alterity.

Keywords

practice as research | biofeedback | technomediation | performance arts | ecologies of attention

Resumo

A discussão contemporânea sobre a atenção está frequentemente e intrinsecamente ligada a julgamentos morais sobre como e em relação ao quê devemos prestar atenção — e à vilificação recorrente das tecnologias de mediação. Através da passagem da crítica à economia da atenção, para um olhar sobre a ecologia da atenção, e considerando o debate pós-estruturalista sobre a ontotecnologia dos seres humanos, compreendemos a centralidade que a preocupação com a perda de controle sobre o Eu ocupa, bem como uma busca pela ênfase sobre a alteridade, ordem e sistematicidade. Isso pode ser visto como uma preocupação com o ritmo da atenção, da vida e dos processos de mediação. A arte, por outro lado, pode ser pensada como um tipo específico de espaço, onde a experimentação com a atenção pode ocorrer, para além dos pressupostos quotidianos e das compreensões hegemónicas sobre como a atenção se deve manifestar. Partindo de uma peça existente, *Bad Touch*, e construindo sobre ela uma série de sistemas de *feedback* tecnologicamente orientados que são particularmente sensíveis a um processo corporal de foco na própria atenção, demonstramos como a perda voluntária de controle — assistida por tecnologias supostamente destinadas a garantir o controle — pode apoiar a nossa reflexão sobre a própria atenção, e sobre como as lógicas binárias em torno de des/atenção, des/control e des/humanidade falham em certos contextos; como a perda de ritmo pode ter potencial criativo precisamente porque pode ser derivada de uma recusa deliberada face ao controlo instrumental. Por fim, procuramos refletir sobre o que este trabalho artístico clarifica, no que toca às dicotomias humano/máquina, corpo/mente, artista/obra de arte, e como isso pode reconfigurar o valor da alteridade, encarando-a como uma condição prévia para a mesmidade, e a atenção como um sistema de valorização da alteridade.

Palavras-chave

prática como investigação | biofeedback | tecnomediação | artes performativas | ecologias da atenção

Introduction

In contemporary artistic and performative practices, attention is no longer understood as a static cognitive resource, but rather as a dynamic and distributed ecological phenomenon (Citton 2017). Attention is not fixed; it can be felt as fully absorbing our immediate sensory experience at one moment, and seem like it drifts away the next. Driven by signals from the body, technology, and the surrounding environment, it is a process made of flows, shifts, and transformation. This paper explores how such attentional dynamics emerge in a live, heartbeat-driven performance.

This paper is based on our experimental performance project, *The (heart)Beat*, which explores how technology, acting as a supplement to the body, intervenes in a heartbeat-driven interactive music performance and shapes the performer's awareness of their own attention. We examine how the inherent instability of the performance triggers attentional shifts, redirecting the performer's focus from the predetermined musical structure toward an awareness of their own bodily states and internal rhythms. In our exploration, we used Casey Cangelosi's *Bad Touch*, a piece characterised by strong rhythm and a body-centred focus, to explore its interaction with real-time bio-feedback visualisation. Besides the visual dramaturgy associated with the pre-recorded music, the heartbeat rhythm runs throughout the piece and is continuously visualised, producing partially uncontrollable graphical effects that emerge from the performer's physiological state.

Coming from a Practice as Research approach (Nelson 2022), our experiment also explores how the intervention of sensors and other digital technologies may influence performers' attention and bodily experiences. Therefore, the central question of this study is: how does technology become part of the performers' attention and bodily experience of performing? And also, how can artistic practice be mobilised to produce new insights about the role of media technologies in today's sociopolitical landscape?

Performing arts have long since made use of computers, sensors, code and other emerging technologies, often adapting corporate products aimed at the general consumer, with varying levels of critical self-awareness towards that same technology and corporate culture (Birringer 2008; Goto 1999). Our contribution adds to this ongoing dialogue not only through its practical articulation of technology, but also through our reflection on it, and its relevance is renewed in light of recent discussions around so-called 'Artificial Intelligence' (AI).

This paper begins with a brief overview of how the concept of attention has evolved in the context of communication studies, to then integrate it in an artistic framework. Next, it explores how the body is inseparable from technology, and how artistic practices can help us reflect on that connection, starting from the embodied perception of the authors' own bodies in their own musical experiences. Then, it explains how integrating the performers' biosignals in the artistic creative process can highlight how performance arts form their own contextual ecologies of attention. In the section that

follows, we explain how these ideas came together in our reinterpretation of Cangelosi's percussion piece, *Bad Touch*, how, in this process, technology helped attend to our attention in unexpected ways, and what theoretical considerations about ethics, values, and nonduality we can derive from that.

Attention and mediation

Media studies have long focused on different ways in which attention is mobilised, co-opted, transformed, and more. Some of the earliest studies on the role of mainstream, or mass, media have precisely to do with the political and social impacts that come from engaging with media; and their attempt to understand their *influence* (Esteves 2009).

However, at the centre of these studies and debates often sits a somewhat techno-determinist approach to how we interact with media, fuelling old and new media panics about loss of culture, intelligence, mental ability and more (McRobbie and Thornton 1995). More so, these media panics are not only visible in mainstream discourse, but also in academic publications.

The recent rise in profile of large language generative models (LLMs) has made this debate all the more salient when it comes to artistic studies. As Lev Manovich and Emanuele Arielli (2025) duly note, framing artistic endeavour as a quintessentially human characteristic or skill seems increasingly difficult to do. On the other side of the artistic process (i.e., the audience), the loss of focus and ability to concentrate, or the capturing of our psyche and brains, are common leitmotifs.

As Dylan White (2024) remarks, behind such debates is a whole different issue — namely, agency, self-determination, and ultimately, *control*. However, such dichotomies often fail to attend to the material realities of how attention operates, what it is, or how multifaceted and non-deterministic it presents itself. Ironically enough, the critique of capitalist “attention economies” tends to assume, and thus validate, an intrinsically economist ontology of attention.

Etymologically, the word comes from the Latin “*attendere*”, meaning ‘to stretch towards’. Such an origin can help us understand why Citton (2017) says that “attention” is a doing — it is an action or process, rather than an object that can be accumulated, spent, hoarded or traded. It is also a process that requires a dislocation of self towards something else, and thus an orientation, but does not require a specific type of (metaphorical) orientator.

While it is outside the scope of this paper to give a full account of the different theories or empirical research on attention — as well as the ensuing critiques — we wish to emphasise several important characteristics here: the interpersonal, historical, situational, and embodied nature of attention.

As White (2024, 10) wrote, “what we attend to will affect our values and subsequent self-control decisions [...] [and just] as what we attend to will shape our values,

[...] our values similarly shape what we choose to attend to”. Attention is never neutral nor non-contextual and, since values impact the choices that shape our attention, and those values are historically and interpersonally (re)produced and contested, no full account of attention can be fully centred on any individual subject. Furthermore, because values are also deployed in different ways at different times, there is no possible way in which we can develop objectivist descriptions of how attention will operate in a given — abstract, theoretical — context, for a hypothesised subject.

Regardless, the experiencing of attention is often done individually (e.g., ‘I feel that my attention was grabbed’, or ‘I feel like I want to pay attention to something’) and, in fact, just like there is no way of thinking through attention by isolating subjectivity, there is also no way of doing it by abstracting the subject away. Rather than framing this, as is often done, as a case of quasi-economic depleting resources that the subject undergoes, we instead align with White in that “trade-offs among expected reward, cognitive effort, incentive structures, and values dictate where and when we *choose* to attend and exert self-control” (2024, 15, italics in original).

Arts as a laboratory of attention

Part of those trade-offs relate to how we *feel*, both when paying attention and when not — since *not* paying attention is something that can happen volitionally, rather than just being the result of the *failure* of something to make us extend ourselves in its direction; this is particularly evident when it comes to wilful ignorance (Posey 2021; Jones et al. 2023; Williams 2021; Abondio 2024). This means that, as Citton (2017) argues, drawing on Aspe, we should pay attention to the resonances present in attention.

We can understand resonance as an “affective dynamic”, as Paasonen (2011) calls it. Appropriately, Paasonen also uses “attention” to address how certain contents seem to have a bodily impact on us, and how that in turn shifts what we choose to attend, in ways that are “intimately connected with the technological horizons of possibility — that is, different media technologies afford and enable some activities and not others” (2011, 258). Resonance is not about sameness or identity:

To resonate with one another, objects and people do not need to be similar, but they need to relate and connect to one another. Resonance encompasses the emotional and cognitive as well as the sensory and affective, and it points to the considerable effort involved in separating the two (Paasonen 2011, 16).

Such an analysis, then, foregrounds the importance of situating — historically, technically, culturally, situationally, materially, physically — any given attentional dynamic, and the pitfalls and potentials that can there and then manifest, as well as which ones actually do and do not. As we note further on, one of the most important ways of paying

attention — of being in an affective dynamic with others — is empathy. Empathy has been centrally addressed in the context of artistic thinking since the early 19th century, as a way to understand how a subject can perceive something as being beautiful (Clohesy 2013, 11); and later was seen as a prerequisite for the development of morality itself, standing at the centre of the connection between Self and Other (Clohesy 2013, 17). However, the *ability* to have empathy does not suffice: for the Other to be seen as worthy of empathy, it must first be recognized as an Other in a way that does not result in ontic injustice (Jenkins 2023, 24) — thus requiring that the Self pays proper moral attention to it, and that the *conditions* for the enacting of that attention exist in the first place.

The importance of considering the context in which we *do* attention is why Citton (2017) shifts from considering an economy of attention to an *ecology* of attention, and thus to a multilayered non-deterministic and non-binary approach to how some people (do not) stretch towards something. After all, the concept of ecology arose precisely to address the “interdependency between [an] organism and its environment” (Pasquinelli 2026, 5).

For Citton (2017), artistic practices can act as valorisation laboratories: times and spaces where our values (and their subsequent trade-offs) are different from those we deploy in our everyday lives, and especially in the context of hyper-accelerated capitalism. In this way, then — and since valorisation is the centre of moral intersubjectivity — these laboratories can open up space for embodied, reflexive empathy in and through the arts.

Not only, as he notes, there is a particularly strong resonance in watching and/or performing live — the possibility of failure, disappointment, and success creating uncertainty about what the experience will be until it already was — but that resonance is also enmeshed in other people’s experience of being there with us; what Citton (2017) calls “meta-attentional engagement”. The audience present at an event is there with each other, and never only with the artist(s) or work(s) presented. Likewise, in live performance contexts, those who are performing are doing so in the presence of others, and may feel more (or less) in resonance with them, which then impacts how they attend to what they are doing.

Taken together, our approach breaks up facile dichotomies — namely between subject and object (“attention should be thought of as an interface: it is what links a subject to the object it has selected in something external to it [and so] it is irrelevant to wonder if it should be situated on one side rather than the other” (Citton 2017, 174–75)), or the derived author/work, performer/audience, watched/watching, immediate/mediated dualities. Therefore, as we later explore in more depth, our laboratory is set up to draw attention *to* attention, recursively, and to thus deploy technical control systems to *choose* to relinquish control over the exact manifestation of the aesthetic product being presented, in ways that integrate the resonance of the audience over the performer while denying both the audience and the performer the ability to control how that resonance manifests.

Integrating Technology

According to Sloterdijk's ([1993] 2024, [2004] 2016, [2001] 2017; Pavanini and Lemmens 2023) philosophy of technology, there is no — and never has been any — divide between human and technology. Anthropogenesis is anthropotechnical. It is precisely the feedback effect of our technical practices that creates us. Our drive towards mutual protection, pampering and safeguarding — what he calls luxuriation — shapes our environment, which, in turn, shapes us. Our biological evolution is then a consequence of this technological deployment, not its cause. On a similar note, Bruce Mazlish (1995) talks about how discontinuities were produced as strategies for creating anthropocentric superiority (the one between human and machine is one such discontinuity), but those discontinuities keep being undone, leading him to talk about humans and machines as “co-produced”.

That is not to say that there is no tension between people's subjective experiences and technology, or between technology and the environment — Heidegger (1999) famously distinguishes different forms of technology precisely by thinking through the ways in which these three things connect. As with anything else, there are always ambivalences.

The current discourse around so-called AI illustrates this well: since its recent widespread accessibility, it has become commonplace to perceive it as a convenient and powerful tool to be used in their work and day-to-day life. Yet, even disregarding ethical considerations, it is undeniable that the massive data centres required to run it are already straining local water supplies and power grids and heavily polluting the communities surrounding them, disproportionately affecting marginalised people, and impacting their health (Smith 2026), thus directing and influencing their bodies and behaviours.

Relying on an LLM to find information quicker is different, but no less technologically mediated than going to a library to look things up in physical books. Technology, according to Pavanini and Lemmens' (2023, 18) reading of Sloterdijk, is “an interstitial and irreducible third within the traditional dichotomy between spirit, mind or form, on the one hand, and matter, body or substance, on the other” (see also Sloterdijk ([2001] 2017, [2004] 2016)). More recently, Matteo Pasquinelli (2026) has argued that LLMs sit at the confluence of two historic conceptual mergers — that of bodies and machines, and that of language and machines — resulting in the attempt to automate “the relational structures historically produced by human cooperation” (p. 9), thus endangering our ability and potential for empathy — not via distraction, but rather via an embodied *unlearning* of empathy and connection, and a disregarding of the ethical, aesthetic, and epistemic confluences between technology and embodiment.

To reiterate, our embodied existence cannot be described as purely biological. We constantly supplement ourselves with technology. Leder (1995, 20) calls this cyclical process “incorporation”, describing how it (trans)forms bodies: “a skill is finally and fully learned when something that once was extrinsic [...] now comes to pervade my

own corporality”. Once a musician learns their instrument, it mostly disappears into their perception and becomes as much a part of them as their hands. However, as White notes, there is no contradiction between this seeming automatism and attention and control: “automaticity is a form of control [...] dual-process accounts which distinguish voluntary, intentional control from automatic, reflexive behaviour are untenable” (White 2024, 10). That automaticity only comes from the choice of attempting to master the instrument, not in spite of or besides it.

Bodies are also socially and politically defined. It is only in contrast with the Other that one can become fully aware of their own body and construct their self-image. Self-understanding is, in part, shaped by the collection of experiences of others gazing upon us, perceiving and judging us in certain ways. In fact, and in connection to our previous point about empathy and the Other, alterity is a precondition for the self to exist (Ricoeur 2015). Through empathy, the process of mutual incorporation can take place (Leder 1995). Empathy deploys difference, and this articulation can be felt as dangerous:

an empathic experience of difference, in giving us a *lived* sense that our lives represent only one way of being in the world, and by giving us a *lived* sense of the violence we commit to Difference in order to sustain the unity of our identities, has profound ethical implications (Clohesy 2013, 25; italics in the original).

Deploying attention to these processes of empathy can then be a mindful, ethical approach to engaging with alterity in an embodied way.

Two jazz musicians at a jam session supplement each other through communication, through intentionally placing their attention on the other’s body language and sounds they produce, mutually opening to new musical possibilities. Likewise, an audience is invited to pay attention to what is happening on stage, to share a common experience with the people in the seats next to them, and they can perceive things they otherwise could not. Their perspective is enriched. As Citton puts it, “the intensity of a live performance does not only come from this live temporality, but also from the sharing of the same space which puts spectators in the localised presence of the performers” (Citton 2017, 101).

This bidirectional incorporation means that the performers themselves are, in turn, often aware of the audience’s dedicated attention. There is a feedback loop between them, which is why performing for a live audience tends to be a wholly different experience to the lone practice of collective rehearsing.

The above can better help us understand how the body is an *assemblage*¹, as understood by Deleuze and Guattari (2007). As Currier explains, “assemblages are functional

¹ We use here the English term, but we would also like to note that this translation is somewhat misleading. The original term, “*agencement*”, clearly points out that there are processes of subjectification and identification central to this coming together of disparate elements, and that we can, yet again, see a concern with agency and wilful action (Nail, 2017).

conglomerations of elements but, importantly, the component elements are not taken to be unified, stable or self-identical entities or objects” (Currier 2003, 325). Bodies are constantly constructed and negotiated in their supposed naturalness (Cardoso and Scarcelli 2021).

As two out of three of us are musicians ourselves, we turn to our artistic practice to make sense of these concepts. Some we knew in an embodied, implicit way well before we tried to put them into words, or found authors and their theories to explain them. Some, we only recognised after theory gave us a structured framework to analyse our own experiences. We realised, mostly in a non-reflexive way, that when playing musical instruments, in a so-called “flow state” (Mark 2023), the perception we had of our own bodies somehow included the instruments themselves. We knew that drawing the line between human and machine wasn’t such a straightforward affair, as Turing (1950) himself demonstrated by creating a hypothetical situation where humans could very well fail to be recognised as humans.

Methodology

We follow here the basic principles of Practice as Research (Nelson 2022) and its epistemic stance, and mark ourselves as constructivist, inasmuch as we focus on how elements like ‘attention’, ‘experience’ and ‘perception’ are construed in ways that do not fit the nature/nurture or mind/body dichotomies (Huffer 2009). Thus, we draw on a wide range of influences that highlight how knowledge-making is a situated (Haraway 1988) and embodied (Butler 1993) process, and consider that it is by focusing on those elements that we can better attain strong objectivity (Harding 2015). We also note that such an epistemic stance needs to be explicitly political (Alcoff 1993), especially considering how art is political in itself (Benjamin [1936] 2010).

Our methodological approach is intimately enmeshed with our techno-artistic practice. It is through it that we found ways to explore our research questions. We believe that fluidity is a necessary part of any creative endeavour, and one which can deeply enrich academic research as well. Following the principles of Practice as Research, we set out to “*attend differently*” (Nelson 2022, 38) (paying attention to our attention) to our artistic practice through an academic lens, self-critically and self-reflexively, focusing on experiential modes of knowing, and employing a multi-modal enquiry process.

For reasons of theoretical coherence, here too we see knowing as a sociotechnical process — which is why we draw on the concept of “*poiesis*”, understood as everything that encompasses an artistic process capable of “open(nig) up new territories of being” (Whitehead 2003, 3) for both artist and recipient. Thus it becomes a research method in and of itself: “practical *poiesis* becomes for the artist a means of knowing when and how to incline or induce the self-presencing of things, things let be of their own innermost need” (Whitehead 2003, 11).

Here too, empathy is what allows this faithfulness to come into fruition. It is by attending to how the “gift of art” (Whitehead 2003, 11) can be deeply moving that we can analyse the “essential solidarity and common ground” (Agamben 1999, 102) in, and between, artists and observers. Furthermore, this assemblage (Deleuze and Guattari 2007) of artists-artwork-receiver highlights the embodiedness of poiesis, since it is also an experience of “bidirectional incorporation” (Leder 1995, 88), where someone simultaneously feels the body of the artwork as part of their own materiality, and their own body as part of the artwork’s materiality. This approach is well suited to address our research questions since, on the one hand, it keeps the focus on the embodied experience of the artist/performer, allowing us to explore how technology affects it. On the other hand, because it illustrates how experiencing the gift of art can foster empathy and appeal to the common ground between people, it helps us understand how and why our insights remain relevant to look at the role of technology in today’s socio-political stage.

By utilising digital technologies, namely sensors, software to manipulate and generate graphics in real time based on the sensor data and audio recording devices, we sought to visually further externalise the corporeal, biological process that is the heart-beat in a way that explicitly attempts to value it and, through that, orient attention to it. Not only the performers’, but also that of the audience. Thus, this technological mediation becomes part of the ecological context in which attention can be mobilised, in the context of this performance. Biofeedback becomes central to the creative and artistic process, and can be used to reflect on the experiences of embodiment that arise in this context; a form of work similar to what Citton calls an “attentional performance [...] the production of a joint co-presential attention to the work, an attention which is itself raised to the level of artistic activity” (Citton 2017, 153).

The careful documentation of the performance, namely in its video recording, extended the creative process past the moment of its capture, allowing for space to include Daniel Cardoso’s feedback and artistic sensibility in the video editing phase. Furthermore, the option of playing it back at will allows for deeper self-reflection not only by Yi Huang and Gabriela Marramaque, but especially in the joint author discussions, where Daniel Cardoso’s more specifically academic contribution was particularly fruitful. Finally, we applied a very pragmatic poiesis to the end, approaching the academic writing itself with the same fluidity we dedicated to the rest of the creative process, aware it too became part of the ecological system of attention we set out to explore.

Biofeedback, Attention, and Bodily Awareness in Interactive Performance

Biofeedback refers to the use of technological systems to monitor physiological signals — such as heart rate, respiration, or muscle activity — and translate² them into perceptible forms of feedback, supporting users' awareness and self-regulation of bodily states, particularly within contemporary interactive and musical interfaces (Yu et al. 2018). When physiological signals are integrated into interactive systems, they are indeed translated into feedback that is perceived differently than what the participants are used to, effectively externalising part of their own embodied experience. This allows for a space where participants' physiological states influence system outputs. In turn, the system's feedback affects participants' attention and mental state, forming a continuous feedback loop in which attention is repeatedly redirected between bodily signals and system responses (Kaushal 2019).

In both clinical settings and music performance research, biofeedback is commonly used to support emotional regulation, reduce performance anxiety, and help performers maintain a more stable and regulated attentional state (Borges et al. 2023). In music performance research, heart rate variability (HRV) biofeedback has been shown to help performers maintain bodily balance while recalibrating their sense of rhythm, while also enhancing their awareness of breathing and heartbeat fluctuations (Thurber et al. 2010).

In the context of artistic and interactive performance, the role of biofeedback extends beyond a mere self-regulation tool, gradually becoming a creative medium in which participants' physiological states directly shape the generation and perceptual experience of the work (Ortiz et al. 2011). By externalising internal physiological signals into auditory or visual feedback, the performer's bodily state becomes an integral part of the performance, rendering bodily processes perceptible within the performance itself. While this integration enables performers to perceive their bodily conditions more clearly, their engagement with the system and the environment can lead to dynamic, continuously shifting experiences of bodily awareness and attention.

As described earlier, in our experimental performance, heart rate signals were captured in real time and translated into visual feedback. Using a contact microphone attached to the performer's body with an elastic necklace, we amplified subtle internal rhythms that are normally difficult to notice. By turning these physiological signals into

2 While it is outside the scope of this paper to go in depth into translation theory, we would still like to clarify that, following Susan Bassnett (2005, 86–87) and her mobilization of feminist and postcolonial theory within translation studies, our use of 'translate' does not deal with "equivalence, premised on binary oppositions between source and target" — which she equates with a traditionalist approach to translation —, but rather a "plurivocal site" where "Otherness [...] is rather seen as a component element in the field of negotiation [of meaning]", characterized by "boundarylessness, of movement in-between and across as a metaphor for contemporary world transactions". Any process of translation is a process of transformation, creating both familiarity and estrangement, literally transforming (i.e., changing the form of) things in ways that allow for more ways of engaging with them.

visible feedback, the performer could more easily sense changes in her bodily state during the performance and adjust her movements and timing accordingly, while also experiencing firsthand how bodily sensations and musical structures influence each other. Such bodily engagement resonates with Coelho's (2017) discussion of attention practices (in the original, "práticas de atenção"), where embodied practice allows performers to perceive subtle internal rhythms, make moment-to-moment decisions, and respond to the dynamics of a performance environment. By engaging bodily awareness in this way, performers experience how attention, perception, and movement continuously interact in choreographic practice.

Building on this, we selected a rhythmically strong, body-centred piece, which caused performers' attention to continually shift between the fixed musical rhythm, heart rate feedback, and bodily sensations, producing an open and dynamically unstable attentional state. This fluctuation resonates with theoretical perspectives in Claire Bishop's *Disordered Attention* (2024), where attention in contemporary art and performance is described as mutable, variable, and shaped by mediated and immersive conditions. Notably, because the heartbeat feedback was amplified so strongly, the performer sometimes unconsciously followed it too closely, which disrupted the original musical rhythm. In contrast, in versions without biofeedback, performances were rhythmically more stable and precise.

Furthermore, in interactive music performance, biofeedback not only provides performers with real-time perception of their internal bodily rhythms but also influences their attention. This externalisation of these typically unnoticeable bodily rhythms reflects the ecological and distributed nature of attention, where focus emerges from interactions among body, technology, and environment (Citton 2017). It also aligns with Citton's (2018) discussion of attention in mediated and technological environments, illustrating how virtualised feedback can influence attentional distribution.

In our performance, however, biofeedback was not introduced to improve self-regulation. Instead, it brought normally unnoticed bodily processes into the foreground of Yi Huang's experience. The heightened awareness of heartbeat, breathing, and muscular tension continually redirected attention away from the musical structure and back toward her body. This did not make the performance more stable. Instead, it revealed attention as something embodied, relational, and constantly changing.

In the next section, we explain the last point of contact in this cyclic process — the original piece, and why and how we mobilised its characteristics in the context of our work.

Bad Touch by Casey Cangelosi

Casey Cangelosi is an American percussionist, composer, and educator. His work focuses on rhythm and bodily awareness, often combining music, movement, and performance in ways that highlight the performer's physical presence, a concept explored in performance studies literature as the phenomenal body through which performers

engage and affect audiences (Fischer-Lichte 2024). Unlike traditional percussion pieces that primarily focus on sound or pitch, Cangelosi's compositions treat the body and its interaction with space as an integral part of the musical structure. His work explores how performers align rhythm within a fixed temporal framework through body awareness and controlled movement, making attention, bodily perception, and musical timing central elements of the performance.

One of his notable works, *Bad Touch* (2013), illustrates this approach well. Commissioned by the Thai percussionist Paopun Mu Amnatham, the piece is written for a solo performer with playback, meaning all sounds come from pre-recorded audio rather than live instruments. The work is divided into several distinct sections, each requiring the performer to precisely coordinate movements with the recorded track and maintain tight synchronisation within the fixed timing of the piece. The physical materials needed are minimal — handheld LED lights, a lamp, an extension cable with a foot switch, and a single drumstick — but the performance relies heavily on careful coordination between movement, light, and audio. In our rendition, we replaced both the LEDs and lamp with a video projection, and the manipulation of it was given to the second performer, Gabriela Marramaque, the one responsible for the technical operation. Performances are typically presented in dim or nearly dark spaces, which enhances the visual impact of the light effects and makes the relationship between movement and rhythm more apparent. Each movement directly corresponds to the audio, shifting the focus of rhythm from instruments to the performer's body itself, providing a clear, hands-on context for studying rhythm perception and bodily experience.

We chose *Bad Touch* for our experiment because it places rhythm, bodily awareness, and attention at the centre, making shifts in attention easier to observe and directly relevant to the performance outcome. Unlike traditional percussion performances, which use physical instruments to produce rhythm through the sound they make, this piece generates rhythm through the performer's bodily movements, which are precisely synchronised to a pre-recorded playback track. Without directly producing sound live, the performer's sense of timing, movement precision, and internal rhythm become essential for realising the work, which also makes attention more visible.

In our experiment, we added real-time heartbeat biofeedback visualisation to the original piece. By highlighting the heartbeat in this way, Yi Huang and Gabriela Marramaque could both perceive changes in the internal rhythm of Yi Huang, the percussionist. This intervention introduced a new kind of tension, making small deviations between bodily rhythm and musical timing more noticeable, as we later explore.

Because the original piece already integrates movement, music, and performance, this addition did not disrupt its core concept. It provided instead another way to explore the performer's awareness of their own body and sense of rhythm. In this sense, for us, *Bad Touch* is not only a musical work, but also a framework for experimentation, allowing attention to be observed and studied as an ecological, distributed, and dynamically unfolding process.

The Performance

The technical apparatus necessary for this performance is setup as follows: a computer runs Reaper, a Digital Audio Workstation (DAW)³ with the plugin VS2, (an add-on program compatible with any DAW, that is an audio-reactive graphics generator) compatible with MIDI (Musical Instrument Digital Interface, a communication protocol for electronic instruments and programs), which allows it to be seamlessly integrated with typical electronic music set-ups. In this case, this allowed us to connect the MIDI controller AKAI MPD 232, to allow for tactile manipulation. An audio interface, a third-generation Focusrite Scarlet Solo, receives the signal from the contact microphone serving as the heartbeat sensor which, in turn, is then fed to VS2, generating graphics that react to each heartbeat.

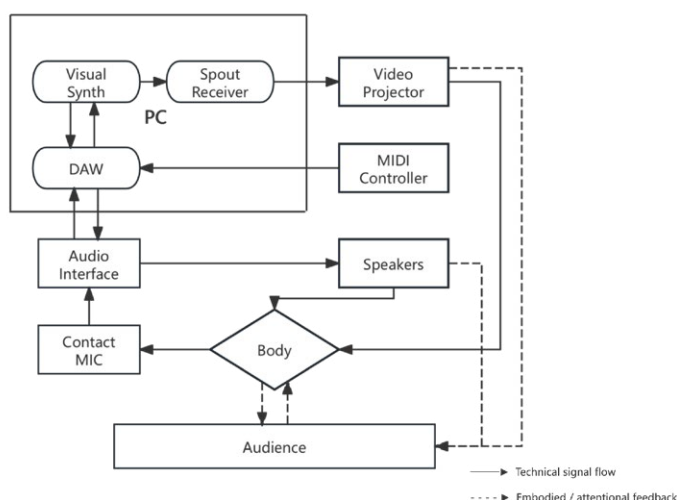


Image 1

Diagram illustrating the technical implementation and respective embodied/attentional feedback relationships.

© Image by Gabriela Marramaque, Daniel Cardoso and Yi Huang, 2026.

³ A DAW is a type of software program that allows users to record, edit, process and further manipulate digital audio files. Since the 2000's it has become the most common way to record and produce music, both in professional studios, and in so-called 'bedroom' studios.

A separate track is used to both reproduce the instrumental piece and feed it to VS2 for further interactive video manipulation. The MIDI controller is set up to allow for the manipulation of some of VS2's parameters during the performance. The contact microphone is run through a Direct Injection box (DI box)⁴ to better avoid noise contamination. The processing chain applied to the heartbeat in the DAW ensures the signal that is sent to VS2 is going to produce the desired effect on the video generation, namely, equalization to highlight the frequencies that better represent the signal, and compression, to ensure audio signal peaks that are loud and even enough. VS2 outputs the video stream at 1080×1920 resolution using Spout (a real-time video routing system for Windows), which is sent to a dedicated receiver, allowing for the graphics to be projected with minimal latency.

The performance was recorded with two cameras, in multiple takes, and later edited in Da Vinci Resolve, producing a video which documents our final results.

Two of the authors, Yi Huang, as the percussionist, and Gabriela Marramaque, responsible for the technical operation, were also the performers.

Yi Huang's body, connected to the sensor, served as the core of the performance. The use of biological signals did not function merely as an auxiliary element; they actively shaped attention and rhythmic perception. *Bad Touch* is characterized by a pronounced rhythm and strong physical engagement, making it particularly suitable for real-time visualization of heartbeat data. Its intense rhythm heightens performers' sensitivity to changes in their movements and on the beat, so that even slight disruptions — such as shifts in attention or fluctuations in heartbeat — can immediately alter the flow of the performance.

The following observations are grounded in Yi Huang's embodied experience during the performance, and in the reflections that emerged while revisiting the video documentation after the performance with the other two authors. Yi Huang's heartbeat was captured in real time and the graphics that help visualize it were projected onto the back of the stage. Although Yi Huang did not directly view the projection, the sensations it amplified still influenced the performance. The physical sensation provoked by the elastic necklace used to hold the microphone further drew performer Yi Huang's attention to her heartbeat. As the performance unfolded, Yi Huang became increasingly aware of other normally unnoticed bodily sensations, such as breathing, swallowing, and muscular tension, all of which began to compete with the musical structure for attention. The awareness that even the slightest movement would be accidentally picked up by the microphone, adding noise to the heartbeat signal, served to further amplify the sensation of instability, making every movement and breath acutely vivid. This conscious awareness became a driving force, shaping how the performer moved and, interestingly, actually disturbing her internal sense of rhythm and motor coordination.

⁴ A device that takes a high-impedance signal and makes it compatible with low-impedance inputs.

Rather than stabilizing the music, this biofeedback occasionally disrupted the rhythm: fluctuations in heartbeat pulled attention away from the music, subtly altering the perception of timing and flow.

Yi Huang later reflected that, at several moments during the performance, attention became almost equally divided between listening to the heartbeat and following the playback track, creating a tension between the body's internal rhythm and the external musical rhythm. Attention oscillated between the musical structure and the body's monitored rhythm, creating a highly sensitive yet somewhat uncontrolled state of mind. Yi Huang also later noted that this oscillation was experienced not as distraction, but as a continual negotiation between the intended musical actions and the body's persistent demand for attention. Thus, introducing biological signals did not give performers greater control over the rhythm; on the contrary, it added another layer of unpredictability.

By translating internal physiological signals into visual or auditory feedback, the performer could observe their own physiological responses. As these perceptions were amplified, performers became more attuned to the subtle interactions between their body and the music, positioning attention as a fluctuating and distributed process rather than a fixed focus. Upon revisiting the video documentation, Yi Huang realised that attention had never been directed toward a single object. Instead, it continuously shifted between the playback, bodily sensations, the imagined visualisation of the heartbeat, and the awareness of performing in front of the recording devices. Biofeedback thus created a continuous loop in which performers monitored their physiological signals, adjusted their actions accordingly, and observed how these adjustments influenced the overall musical output.

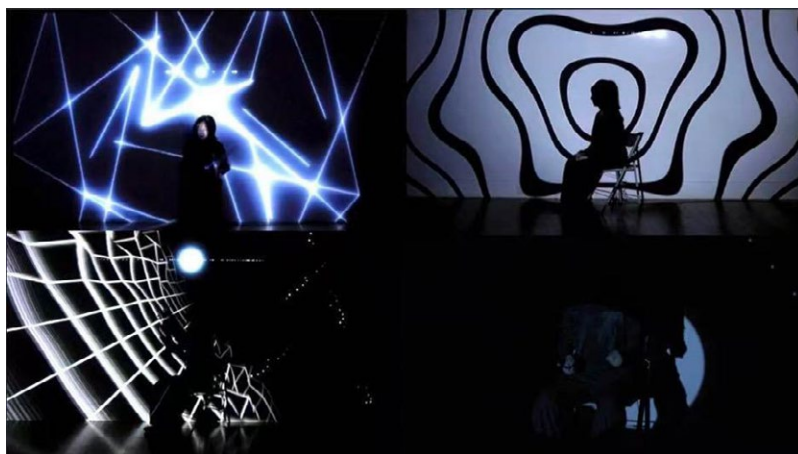


Image 2

Selected frames from the video documenting our performance of Bad Touch. © Image by Gabriela Marramaque and Yi Huang, 2026.

In addition, live technical operation also affected attention. During the performance, Gabriela Marramaque continuously monitored Yi Huang's heartbeat data and her movements on stage, and accompanied them by adjusting visual effects, transitions, changes in brightness, or zooming in and out. As a result, attention was not focused solely on Yi Huang's body: she had to concentrate on her own bodily movement and sense of rhythm, while the technical system translated both her heartbeat and the music itself into the real-time audio-reactive graphics that were being projected, and which Gabriela Marramaque further manipulated according to their own perception of the performance's rhythm, and to their own reactions to Yi Huang's movements. In this sense, and following Heidegger's (1999) and Sloterdijk's ([1993] 2024, [2004] 2016, [2001] 2017; Pavanini and Lemmens 2023) lead, we can see the technical system as a third agent (alongside Yi Huang and Gabriela Marramaque) in this process of co-creation. These three agents simultaneously influenced each other within (and, at times, beyond) pre-defined levels of unpredictability, responding and adapting in real time. This performance lives in its technomediatedness, technology becoming the interstitial third, mindfully and intentionally deployed to destabilise the ways in which Yi Huang and Gabriela Marramaque typically attend to their attention during artistic production.

While Yi Huang's role can be seen as corresponding to the commonsense definition of 'performer', Gabriela Marramaque's role is perhaps closer to that of a player in a jazz ensemble improvising alongside other musicians, seeking to co-construct a pleasant, engaging and interesting aesthetic experience. However, unlike with a jazz ensemble, Gabriela Marramaque was engaging with multimodal techniques which were partially outside of their control, with their own dynamics to which they had to respond; furthermore, those dynamics, and Gabriela Marramaque's response to them, could also retroact on Yi Huang, creating a situation of multiple potentially escalating situations of affective excess or depletion. If Yi Huang's attention was focused on how her own body interacted with the music and the scenic space, Gabriela Marramaque was focused on how the scenic space interacted with Yi Huang and the music — in a triangular relation where no one vertex was able to overdetermine the other two.

In fact, Yi Huang's attention was constantly jumping between the heartbeat, the music, and the (refracted) visual projections. This shifting focus was not a sign of distraction, but rather a form of attentional movement. As Citton (2017, 36) notes: "The peculiar work of attention consists in precisely this: paying enough attention — to still unnoticed details, to still overlooked nuances, to still unexpected implications." This, in turn, can also be seen as a powerful way of fostering empathy through the opening up of venues for resonance to be developed and attended to.

Bishop also points out that "the hybrid spectatorship of performance exhibitions does not represent a dilution of attention, but a return to an oscillating focus" (2024, 265). The performers' attention did not scatter; rather, it continuously shifted and reorganised across multiple channels of perception. Furthermore, the performers were, at once, performers *and* audience, not only of each other, but of the agentic presence of the *teknê* involved.

From an artistic perspective, these shifts are not considered mistakes; rather, they are an integral part of the performance. As Coelho (2017) notes, in the context of choreographic practice and attention, performance does not rely on a stable rhythm or strict formal control; instead, it unfolds through constant correction, selection, and response. Attention moves across different levels of perception, allowing the performer to continually reposition themselves in relation to changes in rhythm, the environment, and relationships. The performance created a situation where attention was constantly interrupted, reshuffled, and refocused. The goal of the piece was not to make attention steady or to perfectly sync the body with technology; instead, it was to set up conditions where attention wobbles and shifts, reappearing in new ways.

Attention is not something a performer can fully control; rather, it is constantly pulled, guided, and reorganised at the nexus formed by the body, technology, the environment, and the attendant streams of information (Citton 2018). Movements cannot just be carried out according to a plan, they happen through constant adjustments, small experiments, and tiny shifts influenced by many factors. Attention does not stay fixed, it moves back and forth, side to side, and reshapes itself with a rhythm that cannot be fully predetermined but which was, nonetheless, chosen in its indeterminacy. The whole performance felt, then, especially to Yi Huang and Gabriela Marramaque, (and, in a different way, also to Daniel Cardoso), like a process of exploration, where bodies were guided and being guided along, rather than fully under the performer's control, and attention to attention (made concrete via the translation of a heartbeat into a synthetic image) was the loop that made the experience possible.

At the time of writing, we have not yet had the chance to present our reworking of *Bad Touch* to a broader live audience. Ultimately, because the result of this performance was its video recording, the camera was part of the audiencing process, which means the feedback loop between audience and artists previously alluded to still manifested itself, albeit in different ways, and with a temporal dimension to it.

In fact, the knowledge that the recording was being made, the pressure of having to complete the recording under a strict deadline, and more, were all elements that became part of the (ecological) context in which our attention was employed. The editing process for the video thus became yet another way to creatively deploy attention. Which shots to cut and which to keep, how long each one should last, how the colour grading should look were all decisions all three authors contributed to, borne of how, even through the same framing, each one would pay attention to the recording in different ways. Re-watching them/ourselves was also an opportunity to reflect together on the experience, where their/our attention kept being drawn towards, and in this dialogue, many of the ideas for this paper emerged, particularly in how much of the end result came from the unpredictability of technology, both intentional and not.

The multiplicity of roles the performers could occupy because of creating a video, as artists, as editors, as a/synchronous audience, as researchers, further calls into question the preconceived dualities around technology. The existence of this video also allowed for

the authors to more embodiedly reflect upon this experimental piece, their own attention drawn to different aspects of the images, allowing their perception to resonate constructively towards co-writing the present document. Daniel Cardoso's aesthetic sensibility, in the form of valuable feedback, came to shape the final video as well, allowing them a deeper involvement in the performance itself. The technological mediation was a fundamental part of how all these elements could be (re)articulated towards artistic creation and knowledge pursuit.

Conclusion

Through this performance, we explored the relationship between performer attention, technomediated embodiment, (loss of) control and empathetic resonance.

Against what previous research showed (Thurber et al. 2010), and in line with what authors like Citton (2017) and White (2024) note, biofeedback systems can create irregularities and loss of control, thus operating almost as non-cybernetic systems. While loss of agency is often rhetorically tied with lack of attention, and it with negative moral judgments (White 2024), we showed here that treating attention as a process means considering the whole of the elements that play into it, as well as how it links with sociohistorical and interpersonal valuing, ethical decisions, and (non-)resonant affects; how it allows for an opening up of selfhood and agency to alterity, and to the potency of failure (Halberstam 2011).

The tension between external musical time and internal physiological signals made external helped produce shifts in the orientation of attention (felt as distraction, loss of focus, or re-engagement), and to make them more noticeable, literally visible in timing and movement. In this situation, biofeedback does not make the performance more “stable”; instead, it amplifies subtle changes in bodily state, making variations in attention easier to perceive.

From the performers' perspective, the explicit enmeshing of technology within the artistic and performative process changes the experience of bodily control and self-determination, in ways that frustrate any possibility of an absolute control over attention *through* its orientation towards values of empathy and non-certainty. The visualisation of the heartbeat is not only a display of physiological data, but a process of perceiving time, movement, and bodily rhythm during the performance.

By drawing on and reshaping *Bad Touch*, we hope to have made clear how artistic practices can be mobilised as attentional laboratories (Citton 2017), well suited for reflecting on how body, technology, and attention interact. Through biofeedback, attention can be made more visibly understood as a distributed and embodied emergent process, where temporality is an inescapable determinant, as change over the course of the performance produces yet more change. This approach offers a unique, yet theoretically grounded, perspective on how attention shifts, disperses, and refocuses in live performance settings, and how such a reframing of attention can speak to matters of agency, empathy and alterity.

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Authors contributions Contribuições dos autores

Conceptualisation: GM, YH, DC; Methodology: GM, YH, DC; Formal analysis: GM, YH, DC; Investigation: GM, YH; Resources: GM, YH; Data Curation: GM, DC; Writing: GM, DC, YH; Reviewing: DC, GM, YH; Visualisation: YH, GM; Supervision: DC; Project administration: GM, YH. All others: not applicable.

Data availability statement Declaração de disponibilidade de dados

Biosensor data is non-anonymous in this instance, and therefore cannot be shared. Programming configurations and code generated for this project are protected by IP and copyright legislation and cannot be made available without a prior justified request, to be evaluated on a per-case basis. The video of the performance will be made available after publication via the first author's YouTube channel: https://www.youtube.com/@Queer_Gabe. It can also be made available upon request, via email.

AI tools Ferramentas de IA

LLMs were used to help with syntactic and grammatical accuracy in English. No content was wholly or partially reproduced from any LLM output, nor were they used for the conceptual, theoretical, or structural development of this article or any of its components.

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Filmography Filmografia

Bad Touch. Casey Cangelosi. Commissioned by Paopun Mu Amnatham, 2013. 8:45 mins.

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