



# Troubling Terrains of Diffractive *Re*-readings: Performing Transdisciplinary Re-matterings of Music, Mathematics and Visual Art Materiality

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In this chapter we offer a diffractive re-reading which can be considered a type of *transdisciplinary creativity* that radically re-situates, and indeed deconstructs, forms of new knowing, re-seeing and re-doing, that extend the interconnectedness of artistic practice and artistic research. We encounter the material and discursive simultaneously through co-creative diffractive *re*-readings, drawing on Donna Haraway (1997, 2016) and Karen Barad’s (2007, 2014, 2015, 2019) writings of diffraction as optical metaphor, method and practice that pays attention to the “relations of difference and how they matter” (Barad 2007, p. 1) We engage with speculative musings on acts of jazz performance by Miles Davis as he diffracts the same musical material for different potentialities. We also muse on

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the productive promise of co-creative diffractive re-readings of Math-ArtWorks by young South Africans (Burnard et al., 2020), challenging the subject–object divide of mathematics and visual art. As researchers, we work on multiple levels through re-readings of these musical and mathematical art materials as mutually constituted through multiple, diffracted re-encounters and come to re-see the blurring, embodiment and intersection of artistic practice and research as a performative methodology. In this chapter, we put to work French philosopher Catherine Malabou’s concept of ‘plasticity’, which she describes as referring to “the spontaneous organisation of fragments” (Malabou, 2010, p. 7).<sup>1</sup> This spontaneity of networks, collaborations and elements helps us rethink the relationality of different disciplines as boundary crossings, and what this means for transgressing disciplinary boundaries and the capacity of those boundaries to take and give new forms or collaborations with the non-dichotomous doings of artist *and* researcher. We also interrogate the lines of intersection between the terrains of artistic *practice-as-research*. This space of possibilities clears the path for changes that are not abstracted from the disciplinary world, but immanent in it. Using diffraction as a de-territorialising process which deliberately creates spontaneous ‘meetings’ across and between forms, we conclude with a rhizomatic form which illustrates how entwined diffractive re-readings can bring about new performative creativities.

## FIRST TERRAIN: TROUBLING DUALISMS OF ARTISTIC PRACTICE AND ARTISTIC RESEARCH

If artists focus on the ontological supposition of ‘becoming’ (Braidotti, 2019), how is this captured diffractively in artistic research?<sup>2</sup> Artistic practices produce particular worlding material performances that incorporate embodied movements and produce particular intensities of “making with” (Haraway, 2016, p. 58, further theorised in Murriss & Bozalek, 2019).<sup>3</sup> The artist’s identity drives artistic practices of becoming/embodiment art(s) that constitute and are constituted by a diffractive creation process. What then do artists and researchers do that connects and materialises as artistic? Artistic researchers offer theorisations of artistic engagements with places, people, histories and practices that invite explorations of complex affects. Artists, according to Hickey-Moody et al. (2016, p. 217), connect these roles to the diffractive motion of dance, which “allows pasts to fold back into presents in unexpected ways, bodies

... to become other than who they have been, and corporeal forms [to change] physically and emotionally”. It is this plasticity of ‘form’, the movement of “dancing into the unknown” (Barbour 2018, p. 79) involving the reshaping, remoulding and resetting of materials, ideas and self (as expressed through and with the body), that allows the spontaneity of ‘meetings’—a multiplicity of engagements—and creates the momentum of artistic practices. This onto-epistemological ‘becoming’ with the moments and momentum of artistic doings, as evidenced in the physicality of performing music, painting or drawing, or making-with materials or language, involves the openness and ‘response-ability’ (Haraway, 2016) of a ‘body-mind’ (Murriss, 2016) to what is forming. This view of ‘form’—not as a container made by pre-existing, pre-determined constraints abstracted from self—is significantly different from many research forms (as structures, material organisers and ontological ways of being ‘researcher’) that we, as lecturers in Higher Education, encounter in our work (see Weaver & Snaza, 2017; Lather & St. Pierre, 2013). So how *should/can we shake this dualism* between artistic practice and artistic research? How do we create spaces to perform spontaneous engagements within Higher Education, troubling existing, methodologically ‘fixed’ forms, and come to see the actualisation of artistic practice as a meeting-point of multiplicities in artistic research?

In this chapter we feature a research assemblage of music, mathematics and visual art materiality. These disciplines are often linked to separate discourses/narratives in formal education across all sectors, from Higher and Further Education to Early Years, where they are traditionally experienced as siloed or territorialised as distinct disciplinary subjects. The primacy of disciplinary knowledge is argued to continue two features: ‘generalisability’ and ‘universalisability’ (McPhail & Rata, 2019). In this chapter we put to work a *transdisciplinary re-seeing* of artistic practice and research to dismantle these dominant discourses (and myths). Employing diffractive analysis as a form of ‘re-reading’, creates the conditions for a pluralistic, multidirectional “propagating outward” (Barad, 2007, p. 76) beyond/across/within disciplinary boundaries. Barad is particularly interested in how disciplinary boundaries are (re)made within transdisciplinary research apparatus. With this focus, we move towards a recasting of disciplinary knowledge and show the salience of transdisciplinary dialogue between mathematics and art, where practices and knowledges *merge* through diffractive re-readings.

Like artistic research, artistic practice offers a combination of past and future in the present moment, along with new understandings of how, when and where we are “making-with” each other and the world rather than merely creating representations of “reality” (Barad, 2007, p. 139). Using diffractive analysis, we seek to de-couple the specific language of a discipline from its original context to open up new possibilities for making-with disciplines. Transdisciplinarity de-territorialises creative practices, producing a new type of transdisciplinary creativity, and generates new ways in which making-with becomes an experiential, exploratory, generative activity. Disciplines can thus be untangled to make new, posthumanist re-seeings of the potential for decentering the human and recognising the role of more-than-human elements, shifting our notions of materials from inert things waiting to be manipulated by human skill and control (Ingold, 2009) to active “ontological heterogeneous partners” (Haraway, 2016, p. 17) engaging with us in “material-discursive” practices of becoming-with and experiencing-with (Murriss, 2016, pp. 6–7).

This chapter takes up the feminist new materialist concepts of *diffractation* and *diffractive analysis* as way of enquiring into the *ontologies of difference* and *relationality* that underscore the interconnectedness of practice and research that scholars routinely work with, particularly when trans(disciplinary) mattering involves musical enunciations and gestural composition, in which the physicality and kinesis of playing are central to the sonic result.<sup>4</sup> What this means is that repetitions of pitches (i.e., motives and phrase of a melody) are **mutated into rhizomatic diffusions**. These diffusions of doing/theorising/conceptualising become sites for contesting disciplinary boundaries or exclusions (Sandford, 2015). They are a “generative and productive way of knowing—and mattering—that are more multiple, complex, and discontinuous than the master/dominant discourses of White, Western, colonial patriarchy” (Taylor et al., 2020, p. 5), and therefore, in both practice and research, are generative sites at which to “become in-tune-with” (Taylor et al., 2020, p. 5) in order to re-see, re-hear and re-sound these pitch patterns and passages in relation to aspects of the world that can be classified as human and nonhuman (musical instruments, objects, spaces, silence, technology).

By employing a new materialist lens, we show how a transdisciplinary diffractive re-reading of music, mathematics and art materiality becomes a reading of doing diffraction differently. As mentioned in the opening paragraph, this chapter offers a re-reading that can be considered a

type of *transdisciplinary creativity*. Why? Because we radically re-situate, and indeed deconstruct, forms of new knowing, re-seeing and re-doing, through an extension of the interconnectedness of artistic practice and artistic research.

The data theorised in this research assemblage is drawn from the findings from two separate projects; each addresses ‘transdisciplinarity’ but navigates the postqualitative, new materialist, posthumanist terrain differently. One explores the salience of silence in music performance practices (Burnard et al., 2021) and the other how mathematics and art produce transdisciplinary practices (Burnard et al., 2020).

In the first project, we challenged that which we thought we had already rethought. Silence is more than the absence of sound, content or meaning (de Visscher, 2014): silences can mark the beginning and end of musical phrases, disrupt and enhance musical flow, and be tangible presences. Composers and performers have an acute, often intuitive awareness of this relationship, and there is evidence from music psychology that as listeners, we perceive musical notes in relation to the silences that shape them (Margulis, 2007). In the intra-action between performers, and between performers and audiences, silence also has social significance, and its value is affected by where a performance takes place. Composers write in silences to guide how performers should play, and performers use them to great effect, sometimes creating a distinct authorial voice. Yet the relation between sound and silence in music performance is under-researched and under-theorised. To understand its complexity, we addressed the productive differences between performance and composition in both physical and virtual presences, investigating the role(s) silence plays for composers, performers and listeners. The study (Burnard et al., 2021) explored the multi-dimensional nature of musical silence, drawing attention to the role it plays in establishing an authorial voice. What interests us now is understanding how the relation between silence and sound can affect intensities of differing temporality, spatiality and texture and how it impacts the audience’s perception and the sensing of its relational activity in music performance. Applying a diffractive analysis of silence in relation to sound could provide performers with greater support to find their authorial voice and embrace the sound world with a holistic attentiveness to our entanglement with nonhuman things.

The second project pays attention to the entanglement and blurring of the boundaries and connections between mathematics and art, and attempts to understand the authoring of transdisciplinary creativity and

describe the normative and affective impressions this leaves upon creators and spectators (learners and teachers). For example, Leonardo da Vinci's celebrated drawing of 'Water Falling Upon Water' (Fig. 1) is not a realistic snapshot of a jet of water but an attempt to "elaborate on several types of turbulence caused by the impact of the jet" (Capra, 2007, p. 195; see also Capra, 2005, 2002). It is the form of water—its changeable, diffractive dynamic shape—and the shifting boundaries of perception that provide the focus of da Vinci's drawings, which are never realistic renderings of a single instance, but a synthesis of repeated observations through which he attempts to craft a theoretical model.

Karen Barad describes the physical phenomenon of diffraction: "the disturbances in the water caused by each stone propagate outward and overlap with each other, producing a pattern between the overlapping wave components" (2007, pp. 76–7). Diffraction, therefore, is predicated on motion, where everything is constantly intra-acting with everything it entangles itself with. Barad continues: "The waves are said to interfere with each other, and the pattern created is called an interference or diffraction pattern" (2007, pp. 76–7). To pay attention to the patterns that are created and how they have come about, whether through interferences between wave patterns or amplification of waves as they come together to create a larger wave, is to 'trace' differences made as a result of this constant, diffractive 'pushing outwards'. This process of paying attention to plural encounters and resulting patterns involves processes of re-reading, as one reading is insufficient to be dynamically *with* the diffractive process. Diffractively *re-reading* a music and maths art case *with* each other creates different types of motion (of both artist/researcher/text/ideas and materials) allowing the relational, the embodied and the material to surface and make-with the texts.



Fig. 1 Images for Leonardo da Vinci's Drawing 'Water Falling Upon Water'

As mentioned earlier, perception, in art as well as in science and mathematics, is different from ‘reception’ (as in the process of registering stimuli from an external reality). Perception is very much an active shifting of our own attention to the world, as in the original Latin ‘ab-tension’ (to draw something or somebody towards). The awakening of creative intelligence is what enables science to understand both the world and the human nature from which that science was first generated; human creativity is thus central to putting forth new sensory orders and structures that form new perceptions. An aesthetic engagement, in this regard, is the act of making sense of the sensorial relationship being established with and in the world (Bergmann, 2018).

Artistic creativity, because it is not subject to purposive, language-bound rationality, can give access to aesthetic experience and to much of the systemic wisdom re-linking us with our context. Similarly, scientists’ work is rooted in the individual’s own sensorial experience of the world, and such embodied experience is at the heart of the ideas, imagery and conceptions formulating their thinking (Gosetti-Ferencei, 2018). Hence, visual and aural images, kinaesthetic sensibility and sensorial elements play into the repertoire of both scientific and artistic creativities (Gosetti-Ferencei, 2018) to constitute a complete ‘feel’ for and ‘becoming’ part of the systems under study. Thinking and knowing in the arts and sciences embrace the unconscious and recursive processes upon which all scientific and transdisciplinary creativities are embedded in the natural world (Bateson, 2000).

What follows are diffractive re-readings of Miles Davis’s ‘making-with’ music, and of ‘making-with’ mathematical artworks explored as conceptual vehicles to produce new knowledge. By paying attention to the encounter and the resultant patterns and difference making, we develop a diffractive methodology that is situated, experiential, material, affective and dictated by dimensions of each discipline.<sup>5</sup> The ontological understanding of subjectivity is an endless process of becoming. As with Fig. 2, our analyses are never final renderings of a single instance, but a synthesis of repeated observations through which artists/authors attempt to craft a theoretical model. We see this in artist Trisha McCrae’s sensemaking of her perceptual encounters with da Vinci’s drawings, where she recognises the “vital materiality” or “material vibrancy” (Bennett, 2010, p. xiii) that runs through and across bodies, both human and nonhuman, and emerges as transdisciplinary renderings (Fig. 2).



**Fig. 2** Trisha McCrae’s creative exchange with da Vinci, bringing to life the constant rhythms and movement that provide new insights into activating transdisciplinary renderings

The blurring of boundaries is seen not only in da Vinci’s multiple drawings featuring spiral patterning, but also in his effective use of the technique of *sfumato*, which challenged the view of early modern philosophers of aesthetics that favoured ‘disinterested observation’ as a means of making sense of perceptual encounters with the world. Da Vinci’s focus on representing what something “may appear like to the human eye” (Capra, 2005, p. 19) goes in the opposite direction, recognising and rebelliously embodying how interconnected sensing and acting are. Another such example is Cooke (2020), who explores teaching as an improvisatory act with music student-teachers, diffractively analysing sequences of improvised music and re-reading the production of sound and entanglement of bodies with materials *as* “theoretically and materially consequential” (Gershon, 2013, p. 258). In doing this, the sounds themselves and how they are made are ‘troubled’ (Haraway, 2016), which in turn ‘troubles’ previously held concepts and understandings of relationships with the discipline, teaching and materials.



A new materialist understanding of music (and sound studies) is also offered by Finnish researcher Taru Leppänen at the University of Turku, in a study of the musicianship of a Deaf Finnish rap artist who uses international sign language and a performer/collaborator who sings in English. Through an analysis of the materialities and their affective interplay (e.g., human bodies and sound waves mediated by air/technologies), as well as Deleuze's views concerning the processes of relating to and creating in connection with Deaf cultures, beyond the territory of human hearing, Leppänen (2014), diffractively analyses the vibratory materialities of making-with sound. In another project, Leppänen and Tianien (2018) explored how materiality—or materialities—matter a great deal in trans ways of being or becoming and the unfolding of trans selves. In particular, she engaged with Derian Seesjärvi, a classically trained singer, by asking how his artistry and music-cultural field of classical singing prompt insights into the co-formations of body, voice and sex/gender in trans ways of being. In this study she asked: How can new materialist ideas embrace the emergent, instead of passive or predictable, character of matter, and the intra-action/intra-active occurring of materialities and other phenomena?<sup>6</sup> Other examples of diffractive analyses in music research focus on the field of gay and lesbian musicology. In *Queering the Pitch*, Cusick thinks with an “assemblage of notes that constitute the less private parts of an interior conversation among the several selves I am” (Cusick, 1999, p. 69) to expose the territorialisation of gender, bodies, musics, acts of making and the institutions which constitute musicology. At the centre of Cusick's diffractive readings are calls for an ontologically different way of engaging with music, most notably the statement that “I try to treat [music] analytically as I would be treated: as a subject who may have things to say that are totally different from what listeners expect to hear” (2006, p. 76).

Similarly, Hickey-Moody et al. (2016), exploring an interdisciplinary university course involving expressive physical movement, utilise a diffractive reading of dance as a way of resisting “the hierarchisation of one type of meaning over another” (p. 217). In doing so they illuminate the inseparability of students' bodies from their environment, exploring how diffractively reading across and between different media and boundaries creates spaces for theorising, creating and producing as a simultaneous practice. In another study, Hickey-Moody (2020) explores how primary-school children make art, using diffraction as a way of thinking that “draws attention to the agency of the nonhuman, the ways that the

materials used to make art can change thinking and change relationships between people ... building more than human relationships” (p. 731) and troubling practice-as-research. Insights from these studies show the relevance of new materialist approaches to performance practices of music.

## SECOND TERRAIN: TRANSDISCIPLINARY DIFFRACTIVE RE-READINGS THAT KEEP TROUBLING PRACTICE-AS-RESEARCH

The *dividing line that differentiates practice and research* arises from different epistemological assumptions about what knowledge is, how it is produced and what it means for it to be expressed. As Nelson (2006) argues, it was only in the Enlightenment that knowledge was specifically equated to rational-scientific forms of knowing. While the application of practical knowledge became an important part of research over a century ago, the continued presence of a positivist framework dominated by cognitive and human forms of knowledge kept artistic practices involving the body, affect, making and innovating demarcated from research. Since the 2000s, *practice-as-research* has both raised the profile of artistic/research practices (Bayley, 2017, 2018) and highlighted continuing disagreements and tensions about the purpose, role and place of arts research (Schwartz, 2011, p. xxvii). At its core, practice-as-research “entangles the complex processes involved with the making of art/performance with the making of critically robust knowledge ... by thinking-through different modes of practice, including the embodied, the multiple, the experiential and the affective” (Bayley, 2017, p. 11).

Artists reflect on, evaluate, open up to and engage with ‘making’ and ‘making-with’ as a spatialised, sensory-material embodiment. As Nowotny (2011) argues, “art cannot escape ... the lure of uncertainty, which is an inherent component of ... research and of innovation alike” (p. xxv). Sometimes researchers use theorists to think through and across terrains of uncertainty. They invite us to be open to uncertainties of diffractive *re*-readings when performing the transdisciplinary re-matterings of discipline-boundaries.

Sometimes researchers without extensive artistic practice experience also engage with artistic research. From a position in another field of artistic research, an artist-academic might discover that practice offers new perspectives on their field(s) of interest which can only be gained through

engagement with/in these different worlds. Understanding what counts as artistic research in relation to artistic practice necessitates recognising a human/nonhuman entangled phenomenon. This helps us move away from siloed discourses and the colonising binary logic which essentialises and falsely separates research and practice, science and arts, matter and meaning, human and nonhuman.

This chapter gives a flavour of how re-reading diffractively can play a part in the multidirectional human/nonhuman entangled phenomenon of co-constituted knowledge production, and the specificity of *thinking-with* and *making-with*, where material entanglements matter.

So, what are our points of departure for diffractive doings?

1. Artists, like learners, are me-searchers (Edward, 2018) *entangled with affect*, which is generative and inseparable from ‘doing’ when “a diffractive [re-]reading of data involves an installing of ourselves that attempts to make sense of the blurring and viscous interactions” (Jackson & Mazzei, 2012, p. 131) between practice and research.
2. Artists, like learners, are me-searchers engaged in diffractive practice-as-research encounters with complex, dynamic entanglements of *bodies, minds, matters and environments in creative relationships full of potential*. The posthumanist new materialist terrain re-configures things through the notion of diffraction as *a movement of interference* creating patterns which produce new forms of motion, blurring boundaries between practice and research. So here we ask, how does *diffractive re-reading* allow us to think-with the blurring of artistic and research practices and pay attention to generative patterns created by the diffractive re-readings?
3. Artists, like learners, are me-searchers attending to *spacetime-mattering* (Barad, 2007), where “space, time and matter are intractively produced in the ongoing differential articulation of the world” (p. 234). The new materialist (and posthumanist) terrain offers a speculum through which we can capture the complexity of ongoing processes of subject formation and boundary-pushing. If *diffractive analysis* enables subtler and more complex analyses of powers and discourses, which start by questioning who ‘we’ might be and what else is going on here, then we also ask, what does a diffractive reading do in changing relationships and removing hierarchies between different music performance practices and mathematics and art practices?

4. Artists, like learners, are me-searchers involved in being *attuned to moments of unlearning/getting lost/being led*. A flattened onto-epistemology (Barad, 2007) asks questions about power and control, whereby materials, environments and bodies are equally ‘vocal’ within an entanglement. As artists/researchers, being able to listen with the whole body—what Lipari (2010) calls attuning as a “listening being” (p. 348)—involves relinquishing control.

All of these ‘doings’ for artists as researchers create different types of movement, producing multiple lines of inquiry that disrupt the linearity of a singular trajectory and ‘trouble’ epistemic, transactional notions of research or artistic product. Through these movements, spontaneous transdisciplinary ‘meetings’ occur, similar to the interference patterns created by diffractive processes, which require us to be in a state of existential improvisation. They require attentiveness to differences made (Barad, 2007) and openness to form as both taken and given (Malabou, 2012). It is here that we see a cogency between plasticity (Malabou, 2012), improvisational response-ability (Haraway, 2016) and the processes of diffractive re-reading. Paying attention to how diffraction as a metaphor, method and practice creates “relations of difference” (Barad, 2007, p. 71), we pay attention to how these differences matter through engaging in a re-reading of MathArtWorks and music performance practices. We engage in a diffractive methodology through which we allow ourselves to entangle with affect, encounter difference, pay attention to spacetime materialities, get lost and be led, by elaborating the details of one discipline (in one case, the salience of silence in music and in the other the meeting of mathematics and visual art) through another, being attuned to differences and their effects in knowledge-making practices. Here multiple re-readings are required for more creative insights and new knowledge creation, where the researcher as the knowing subject is decentred.

### DIFFRACTIVELY RE-READING MUSIC PERFORMANCE PRACTICES

In this section we perform re-readings of Miles Davis’s music performance practice. These re-readings were enacted as diffractive analyses while listening to sound files and watching videos of performances. Our

questions concern how these re-readings are produced, what we ask of the artist and what we ask of ourselves as researchers. This re-reading comes in two forms:

- **Exploring how Davis himself diffractively re-read the musical material (as me-searcher)**, and thus how it relays different potentialities in the ongoing material co-constitution between performers and performance. Different attunements lead to multiple performances as different ways of “thinking with” (Haraway, 2016, p. 5) the whole body, a trumpet, other beings, sound and silence, embodying and enacting “an ongoing responsiveness to the entanglements of self and other, here and now, now and then” (Taylor, 2016, p. 15). This means that Davis performed the same melody very differently each time.
- **Exploring how we (as me-searchers/researchers) diffractively re-read his performances** with literatures from posthumanism (Murriss, 2021) and about other musics (see de Visscher, 2014), the doings and knowings of the body, and how interrelationality is set in motion (Taylor, 2016) to find difference.

What are the ways of knowing-doing in music performance practices that affect and move us through perceptible and imperceptible relations that involve making-with materials, techniques, other humans and nonhumans, and thinking-feeling responses? What if silence is more than the absence of sound, content or meaning (de Visscher, 2014)? We sense how silence marks the beginning and end of musical phrases. We feel its diffractive line as it disrupts sound. It can be a channel for intra-active performance opportunities between performers, and between performers and audiences. How is this troubling terrain amplified by a diffractive re-reading? What is learned by being attentive and attuned to the affective intensities and interferences between performers, the nonhuman and the embodied experience of listening to live music? How can the binary logic of sound and silence, which privileges sound over silence, be troubled? What does a transdisciplinary diffraction bring to this understanding?

‘Round Midnight’ is a 32-bar ballad composed by Thelonious Monk in 1943. Davis learnt the tune from Monk in 1945 and made his first studio recording of it in 1953. It became a staple of his concert repertoire until 1969 and was closely associated with him following his performance of it

at the 1955 Newport Jazz Festival, which led to a recording contract with Columbia Records. We used this recording as a benchmark to compare and contextualise two live performances recorded during Davis's 1967 European tour, on 31 October in Stockholm, Sweden and 6 November in Paris, France. What if we become attuned to Davis's diffractive play of in two studio recordings?

*Example 1: Studio Recording, 10 September 1956, the Consensus Classic*

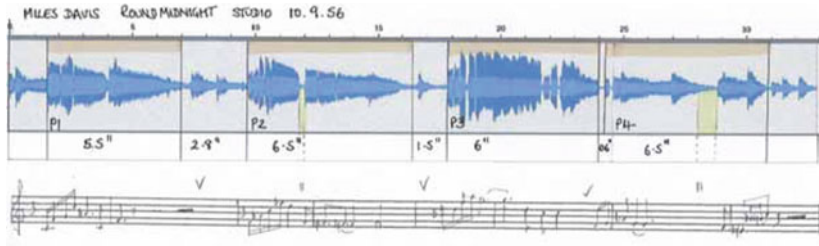
As the title track of Davis's first LP for Columbia Records, this version is probably the one that his audiences were most familiar with. The performance was played at a consistent tempo of 67 bpm throughout, and Davis adapted Monk's original tune, omitting (i.e., silencing) some notes of the original composition. This was a diffractive practice involving the omission of four notes at the end of the first phrase (P1). He also explored intra-actively through material-discursive experimentation, simplifying the chromatic pattern at the end of the second phrase (P2). This was a significant characteristic of Davis's authorial voice: he pushed beyond the normative boundaries of what we have come to know as a 'body' and how bodies move, act and react to silence, as well as exploring the profound effect of temporal expansion and contraction.

These ideas are made explicit in Davis's performances of a Studio (1956) and Live Recording (1967), which brought into high relief in material discourses forces at play between silence and sound.

Miles Davis 'Round Midnight' Studio Recording, 10 September 1956: <https://www.youtube.com/watch?v=GIgLt7LAZF0>

Miles Davis 'Round Midnight' Live Recording, 31 October 1967: <https://www.youtube.com/watch?v=JpFS4O6VmVU>

Here we see the extent and significance of the forces at play in the salience of performed silence in relation to sound. The main melody comprises eight bars divided into four phrases (P1–P4). Davis's diffracted use of silence is brought into high relief in the material-discursive forces at play with/in silences and sound. It occurs in multiple ways. First, by leaving out notes at the end of the phrases Davis accentuated the silence between the phrases, and second, in P2 and P4 he inserted small silences within each phrase. The rhythm section (piano, bass and drums) accompanied his statement of the theme. Why this diffraction is significant in relation to



**Fig. 3** Transcription and Audacity file of ‘Round Midnight’ studio recording, 10 September 1956, showing ‘time-images’ at play

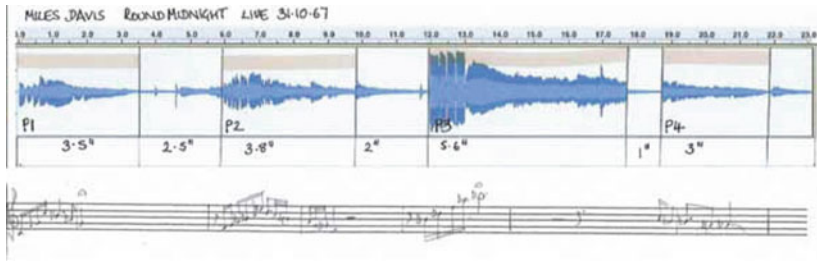
the other ‘various ways’ silence was (and can be) troubled is attributable to moments of temporal expansion and contraction, in which different phrases of the music suggest different rates of temporal unfolding and the decay of the life of a sounded note or sonic tone. Silences can be performed as spaces that translate into rhizomatic diffusions: in other words, Davis’s diffracted use of silence is what brought into high relief the dominant discursive and material forces at play within silences, which are made explicit by the play with/in/between silence and sound and the temporal gestures conveyed through the body. These offer an indication of why it is significant in Davis’s play in the form of pulsed and non-pulsed times, and in the variety of temporal states that the interplay of silence and sound allows.

We have included a visual representation of the audio waveforms and hand-drawn transcriptions (Fig. 3) because, as re-readings of the musical material, they diffractively trace lines of articulation as lines of flight (Deleuze & Guattari, 2014)—as explorations of the relationality of sound and silence.

### *Example 2: Live Recording, 31 October 1967, Stockholm, Sweden*

By the time Davis came to give his live concerts the personnel in his band had changed, as had some of the materiality of his performance practice in concerts. His performance aesthetic set new standards, making innovations that remain fundamental to small-group improvisation today.

In this example of ‘Round Midnight’, Davis seemed to intentionally play the theme out of tempo, very freely and accompanied only by pianist Herbie Hancock, whose subtle and remarkable improvisations filled the



**Fig. 4** Transcription and Audacity file of ‘Round Midnight’ live recording, 31 October 1967 showing ‘time-images’ at play

spaces, or silences, between the phrases by moving together/apart in intra-action. The temporal flow was diffracted—that is, there was a co-constituted movement of shifting spatiotemporalities that is visible in the transcription and sound file (Fig. 4). Shifting patterns and intra-actions of the sound–silence nexus were reordered in a line of flight through the actualisation of silence itself.

Davis’s body was inscribed with an intense, motionless suspension. The affective movement of silence—the lines of flight that moved away from dominant norms that govern how we normally hear signature tunes—was sounded through thought taking the plunge to cut apart silence with sound. He seemed to be inviting us to think-with, rather than about, the material encounter of space and time sounded, to open a space for the audience to navigate the movement of change and possibility. The performance was not static; rather, tunes and tunings attuned to exploring new configurations of the phrases of the melody. The bass and drums were tacet, waiting to come in when the theme had been played. Davis made the most of the gaps between the phrases, taking his time over the statement of the theme. On the one hand, there was a further simplification of the tune, which is particularly noticeable in P3 and P4. On the other, he embellished P3. The “infinite multiplicity” of silence and entangled relationalities that do not appear to be proximate in space and time constitute a force (Barad, 2007, p. 74) that is a re-working or ‘un/doing’ of the past (original version of the tune), and that invites us to appreciate that these entanglements (configurings) of sound and silence are relational. This creates the perception that Davis was taking his time in playing the tune; the silences suggest an openness and freedom that are emphasised



by his minimal exposition of the theme. This queering of the stability of spacetime coordinates and openness to “infinite multiplicity” (Deleuze & Guattari, 2014, p. 296) presume a spatial scale where every moment ‘in’ time is “an infinite multiplicity ... broken apart in different directions” (Barad, 2014, p. 169). This sense of holding back—of playing the bare minimum of notes, exploring the silences—contributed to Davis’s aura as a performer.

*Example 3: Live Recording, 6 November 1967, Paris, France*

The third example, performed six days later, shows how the overall architecture and approach to the tune were adhered to differently again. The silences between the phrases established the sense that Davis was taking his time, reflecting on every note. The introduction of a small silence in P1 broke the phrase up and contributed to the improvisatory feel of Davis’s playing. This addition suggests that every night the performance was different. Maybe Davis, in each re-working (performance), invited (or exemplified) a diffractive reading of ideas through another, leading to more generative ‘inventive provocations’. Yet it also disrupts what it means to be a musician, or a collective and collaboration between musicians and audiences, with memories moving together ‘in’ space and ‘through’ time. In this third example, we are reminded that the past, present and future are always threaded through one another.

For Davis, diffracting his performance practice meant working with *silence acting as an embodied partner*. Silence became a material practice of the performing/sounding body ‘making-with’ what was happening in the moment of improvising, which generated what was new, surprising and unpredictable. This is most explicitly seen in Davis’s physical movements, where he seemed to mobilise silence as an opening-up of possibilities for other ways of (un)knowing, (un)learning and (un)doing a very well-known tune. Davis was not confined by the parameters established by the composition, the ‘given form’ (Malabou, 2012), but rather enabled by messing with the contours of this well-known (pre-existing) melody. He was ‘doing’ something that cut across practice/research—diffractively re-reading the material in relation to the in-the-moment possibilities, ‘making-with’ the plasticity of the forms.

Davis diffracted silence as a partner who occupied space and time (spatiotemporality). The diffraction of silence interrupted *temporal flow*,

allowing different, generative types of movement, attention and uncertainty. This was Davis diffractively re-reading and creating anticipation and tension within his music, which activated modalities of thought, rhythms and affects from inside the act—what Taylor (2016) calls ‘thinkings-in-the-act’ which “set practice in motion, so that practice becomes interference, always diffractive, multiple, uneasy and intense” (p. 19). This process of temporal flow, interruption and subsequent difference is diffractive play with the materiality of music. The embodiment of temporal possibilities and of diffractive experiments in temporality and coexistence within a given passage of diffracted rhythmic impulses (i.e., the relationality of silence and sound) that it acknowledges offer insights into diffractive pathways in performances of the musical fabric of temporality in music.

### THIRD TERRAIN: DIFFRACTIVELY RE-READING TRANSDISCIPLINARY UNDERSTANDING OF MATHEMATICAL ART

In this section, we re-read and diffractively re-read two MathArtWorks—student-artists’ disciplinary readings of mathematics/art—from a sample of 200 (Burnard et al., 2020; Fenyvesi et al., 2019), attuned to how they themselves are entangled with becoming-with subject/knowledge.

*Annika’s statement: In my drawing I have chosen to use numberlines as numbers can go on till infinity and our hair grows continuously, non-stop, this is a comparison between the two. The numberlines as hair is representing the roots of our lives as we cannot go one day without counting or using numbers to represent or solve anything. I have drawn a little demonic girl and as you can see the numbers close to her head are small numbers, but as they go on, the numbers increase continuously and there is no end. This represents the knowledge we obtain in our everyday lives, subjects and Maths. I’ve used black and white because those colours are drab and my interest in Maths before was boring. The little bit of red shows my slow interest in Maths. To me Maths is like a demon slowly stealing my soul, like I’m becoming addicted to it and starting to enjoy it.*

Is this (Fig. 5) a self-portrait? Is Annika taking what she finds inventive and making-with patterns of thinking in their materiality of mathematics and art as predicated on her view of herself? Whether it is or not, she

gives a performative account of the relationality of these disciplines when set in motion together. Her narrative gives us access to an inner world: the meeting with and ‘othering’ of the demonic girl and growing self-relation to maths multiply in acts of ‘a demon slowly stealing my soul’, where thinkings-in-the act set in motion her own ‘becoming addicted’. Most markedly, the image appears to have been excavated from the wider materiality of Japanese manga/anime, crossing over boundaries of space-time, culture, physical location and economics: what Barad refers to as the move towards ‘performative alternatives’, enabling a “performative understanding of discursive practices” beyond representationalism (2003, p. 802).

Annika seeks to communicate the complex and sophisticated mathematical concepts of infinity and number sequencing, revealing a remarkable metaphoric quality and abstraction of ideas and of self (pre- and post-MathArt self, manga self, South African self, student self, math-artist self). The numberlines in the form of flowing hair create ‘unending’ visual registers, and the symbolism of the monotone image with its focus on one eye, hair related to ‘roots of our lives’ and the concept of infinity are diffracted visual codes (unending numberlines, stitched lips, red eye). But why red? Is it indicative of a growing passion, a self-demonisation, or both? The use of grey related to drabness, contrasting with one red



**Fig. 5** ‘Soul Number’ by Annika, female, aged 15, in Grade 10 at a fee-paying public school where the school community is from low to average socioeconomic background

eye, suggests a symbolic self-reference to Annika's developing relationship with mathematics. Her monotone shading and use of black-and-white spaces are performative, diffractive and highly complex.

Implicit in Annika's title 'Soul Number' is another diffractive practice of multiple connotations: soul music emerging from black subcultures, mathematics in music, internalisation of maths. The head and the encompassing hair are framed by numbers. Within the descriptive material-discursive matter of the statement, we see a diffractive unfolding of Annika's mind regarding the nature of mathematics and her personal encounter (and entanglement) with it. Reflecting on the ubiquitous quality of mathematics, she considers how we 'cannot go one day without ... using numbers to represent or solve anything', but acknowledges that she has employed monotones as a metaphor for the 'drab' in mathematics, with the red eye wide awake in this artful expression. At first, such description and depiction of mathematics seem sinister, as she indicates the colouring of the eye signifies her interest, slowly growing to the point of possible addiction. Her embodiment of knowing offers insights into her pathways of intradisciplinary formations.

The material realities of "being-of-the-world", not 'being-in-the-world'" (Barad, 2007, p. 160) are reducible to neither one nor the multiple. As Barad writes, "Beyond the issue of how the body is positioned and situated in the world is the matter of how bodies are constituted along with the world, or rather as 'part' of the world" (Barad, 2007, p. 160). Again, the material enactment of mathematics and art meet as a (re)configuring of disciplines in a drawing by Euclid (see Fig. 6).

Euclid's statement: I made it clear that Mathematics could have both a positive and negative impact ... we experience Math daily as measurements of our clothing; which is why you will see the right side has measurements that are in centimetres ... Clothes require accurate calculations together with the fact that our bodies are asymmetrical; which is why you see that the left side does not look like the right side ... I share my reality of Mathematics... it is interesting and effective...it can prove to be stressful especially for stressed teenagers ... the slightly bowed head shows the negative impact. The hands which cover the face are an indication of frustration. The answers to the equations represent that there is always a solution. The equations appear at different places to show that there are different ways to get the answer. The two sides have different shading as indication to the positive (simple art, no shading) and negative (complicated side with



**Fig. 6** ‘The Stressed Vitruvian Man’ by Euclid, male, aged 16, in Grade 11 at a private school that facilitates learners from less privileged backgrounds and thus has a socioeconomically varied environment

shading) influence of the subject on me. I call it ‘The Stressed Vitruvian Man’. It’s a modern version of da Vinci’s Vitruvian Man.

Like Annika, Euclid focuses on himself—his hair, hands and body—and shares how he thinks of and experiences the consequences of mathematics education. It seems that his understanding of learning is based on an essentialist view where he is judged (and here, judges himself) in relation to his own mathematical development and progress, and status (or lack of it) as a mathematician. The monotony reflects different shades of black with strong cultural references. The bi-tonal hands are productive of difference that comes to matter, with cultural associations of anxiety, emotions and bodily reactions which connect and take action with/in his body. He communicates stress, solemnness and seriousness. Does this produce a view that normalises young people in accordance with dominant views on mathematical development?

Euclid seems not to separate mathematics from art, but to be thinking-with and -through the relational nature of mathematical concepts, expression and form. His art reveals that the human body is the seat of

mathematical knowledge, and that he is a knowledge producer—making-with mathematics and art. We connect with a young man and his creative educational experience of mathematics and art, which is inscribed on his body.

What do we hear in the commentary about the learner questioning and experiencing feelings, ideas, shifts in consciousness and imagining different realities? Could he be trying to suspend disbelief and work in fictional contexts using a range of mathematics devices, dilemmas and demands? Could this be an expression of deep understandings about the need to enact and embody mathematics learning, and about his making the familiar strange inside the art ‘work’? Euclid produces an account not only of the mutual production of thinking-with patterns but also of thinking-through mathematics and art, making new patterns of thought (superimpositions), deconstructing power-producing binaries (mind–body, mathematics–art) and showing how mathematics and visual art overlap and change in themselves as an intra-action of what they do and how they connect and co-constitute.

### POSTLUDE: PERFORMATIVE CO-CREATIVITY AS RHIZOMATIC

We began this chapter with a theoretical ‘first terrain’ and a more practical ‘second terrain’. Both challenged the research-practice distinction and explored different enactments of transdisciplinary creativity (new authorings that arise in the meeting of different territories). Much space was given to diffractive *re*-readings of the materiality of music, mathematics and visual art and the functioning of practice-as-research in materialising the intra-action between the material and discursive. In creating spaces for plural *re*-readings rather than a singular reading, the texts and our thinking-with them have interfered with each other, making the “effects of difference” (Barad, 2014, p. 172) more visible, and ‘troubling’ (Haraway, 2016) disciplines, discourses and practices. What our two case studies say about transdisciplinary practice-research is that diffractive *re*-readings are vital to creating new knowledge and “alternative visions of both the thinking subject, of his or her evolution on the planetary stage, and the actual structure of thinking” (Braidotti, 2013, p. 170).

*Re*-reading diffractively has required us to do more than insert ourselves into the material production of the texts in terms of the performative practice making-with sound and silence, or mathematics and visual

art. We encountered a different, diffractive methodological performativity which enabled us to produce other, unexpected interference patterns. This relied on us engaging with and across practice/research / disciplinary/transdisciplinary/ arts/sciences to adopt what Malabou describes as a “mode of being collectively or individually, that has to constantly invent itself” (Hogstad & Malabou, 2021, p. 1051), finding differences as sites of production and re-thinking.

These differences, as described by Haraway (Haraway, 2016) and Barad (2007), are most clearly identified not in and of themselves, but as the *interference patterns* created (Barad, 2003, p. 803). Across this chapter, through multiple, iterative and transdisciplinary diffractions of the materials, we have made and traced such patterns of difference through sound and image. In the music case study, it was the re-reading of sound in relation to silence, with the patterning of the body exemplifying matters of practice—the transdisciplinary combining of acts and actions which allowed patterns of interference to surface around the materialised and embodied mattering of silence across the performances. In the MathArt-Works case study, the re-reading of the visual and linguistic statements across transdisciplinary and disciplinary literatures created patterns of interference. From these diffractive processes, and the patterning that resulted (see Fig. 7), we see not only interferences but also amplifications, where diffractive waves across two case studies overlap, combine and make some patterns louder. Such soundings (or amplifications) highlight particular blurrings of artistic practice-research differencing in action. These include: the response-ability to make-with and think-with in the moment; purposeful temporal/spatial or material interruption or interference to create different forms of making and thinking; encountering as of and with the whole body, where tensions and uncertainty are moments of potentiality; and a constant ‘pushing outwards’ to meet and explore the world, its bodies and materials (Figs. 8 and 9).

*Re-reading* as a performative methodology therefore creates spaces to perform, re-form, self-form and de-form through plastic processes of becoming-with all the senses. To re-see form in this way—not as a container, shape or contour, but as what Malabou describes as a “collaboration...of different elements: shape...context, corporality, speed, colour and sense” (Hogstad & Malabou, 2021, p. 1052)—means we can never isolate or separate materiality, meaning and self.







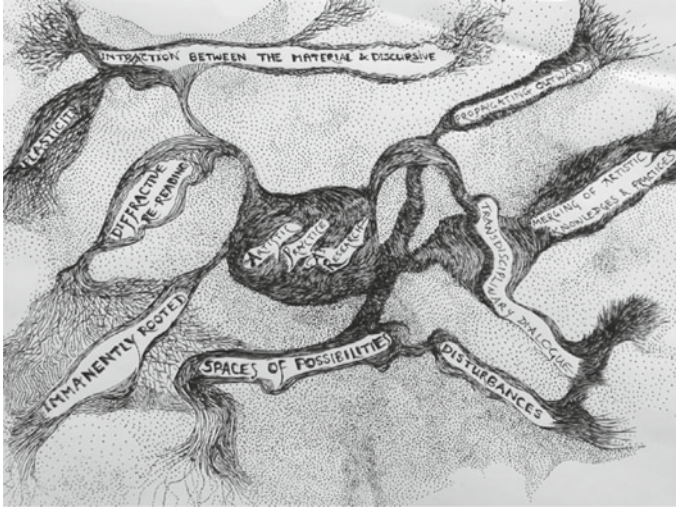


Fig. 9 Rhizomic renderings of diffracted themes designed and drawn by Julia Flutter #3

Entangling matter and materiality, particularly when the deterritorialisation enables active processes of differencing in transdisciplinary knowledge-making, *is* performative.

## NOTES

1. Catherine Malabou is one of France's leading philosophers. The guiding thread of her research is the concept of plasticity—both the capacity to “take form (as in the plasticity of clay) and to give form (as in the plastic arts and plastic surgery)” (Malabou, cited in Street 2014)—and the possibility of a plastic ontology.
2. Braidotti (2019) describes posthuman subjectivities as involving “a materialist process ontology based on immanence and becoming” (pp. 53–54). This ‘becoming’ is a “creative praxis of actualisation of the virtual” (p. 54).
3. ‘Worlding’ as used by Haraway (2016) is an embodied and enacted process—a way of being attentive to the world with the whole person, where we engage in relentless processes of ‘becoming with’ a world in which “natures, cultures, subjects and objects do not pre-exist their intertwined worldings” (p. 13). “*Making-with*” is a term coined by Donna Haraway (2016, p. 58) which recognises that nothing makes itself but is

in a constant state of ‘becoming’ with materials, environments, bodies and constructs.

4. ‘Musical enunciations’ is a term coined by Stoianova (1993), who considered the working of graphic scores works and gestural compositions as non-fixed objects in favour of process, play, experimentation, multiplicity and multi-directionality, with a disregard for effacing the compositional subject and object.
5. ‘Me-thodology’ is a relatively new term used by Edward (2018) to explore the fluidity between researcher (sense-maker), performer (sense-making) and author (sense-theorised) in practice-led projects.
6. ‘Intra-action’ is a Baradian term used to replace ‘interaction’, which necessitates pre-established bodies that then participate in action with each other. Intra-action understands agency as not an inherent property of an individual or human to be exercised, but a dynamic force in which all designated ‘things’ are constantly exchanging and diffracting, interacting, influencing and working inseparably (Barad, 2007).

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