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The materiality of lines: The kinaesthetics of bodily movement uniting dance and prehistoric cave art

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We take two seemingly disparate practices as the foci for this work—dance and prehistoric cave art—in order to illuminate commonalities in embodied practices that reveal new theoretical insights. Whereas, dance clearly uses temporal traces of the body to shape space and create meaning, cave drawings have also begun to be explained and interpreted through kinesthetic and embodied metaphorical techniques. A key element that these fields have in common is the role of lines. The study of lines has become its own field of research, largely due to Ingold's foundational work on "linealogy". Considering the animate nature of lines and the kinesthetic response they have on the body, contemporary artistic practices can find parallels to the nature of ancient rock art if we recognize the similarity these fields share in the formation of and interpretation of meaning through movement and material engagement. Lines are a phenomenon that, when looked at as traces—memories of movement that once took place—become an organizing principle that brings distant fields like rock art and dance together. Thus, this article takes Tilley's suggestion that "a truly phenomenological study of imagery is grounded in the kinaesthetics of bodily movement" and applies it to three different artistic practices. Tilley proposes that an artifact may be ambiguous in its meaning because it relays a variety of information, which is often layered and contradictory. Here we see, in cognitive archeology, the idea that the articulation of ambiguous lines is an attempt to bring like-minded things (in the thoughts of the one drawing or dancing) together. The authors propose that the ambiguity of lines allows for a type of withness between the mind, body, and environment, allowing us to consider the mind as extended. Lastly, the nature of lines as extended mind motivate us to propose the term of "signature" in order to circumvent the dilemma of a static sign in regards to movement.

KEYWORDS

extended mind theory, rock art (painting), dance research, linealogy, lines as movement, ambiguity, signature

Introduction

Lines, as simple geometric forms, have the potential for complex, multimodal realizations. We can see this in terms of human experience with linear forms: in the various ways we encounter them, lines can be perceived visually or by touch, and can be ephemerally created by the body or generated more concretely with materials. In this essay, we examine three contemporary movement practices of line creation through the lens of ancient cave drawings. The intent with this comparison is to foster thought around the relationship between movement, line, and extended mind. First, we present a drawing activity where movement in cities is captured by simple drawn lines and consider how this could be compared to ancient humans drawing their surroundings on cave walls. Then we examine how arbitrarily drawn lines can, when perceived, be brought into kinesthetic and kinetic expressions by dancers. Lastly, we look at a practice where dancers translate the lines of landscapes and architecture into their body.

A key element that these (and many other) movement practices have in common is the role of lines. The study of lines has become its own field of research, largely due to Ingold's (2007; 2015) foundational work on "linealogy". Considering the animate nature of lines (the way they can be traced through movement) and the kinesthetic response they have on the body, contemporary dance practices can glean felt knowledge from perceived lines in space, lines of others' bodies (traces and designs), and imagined lines with felt meaning. These can find parallels to the nature of ancient rock art if we recognize the similarity these fields share in the formation of, and interpretation of, meaning through movement. Lines are a phenomenon that, when looked at as traces—memories of movement that once took place (Leyton, 1992, p. 79)—become an organizing principle that brings distant fields like rock art and dance together. Thus, instead of approaching lines through abstract proposals like those of Deleuze and Guattari (1988), where a "body without organs" is desired, this article will engage with material culture studies—resourcing the analysis of lines from ancient cave drawings/rock art and the phenomenology involved.

Malafouris (2004) and Renfrew (2004) together developed Material Engagement Theory (henceforth, MET) with the intention to contribute to the theory of extended mind (as per, for example, Clark and Chalmers, 1998; Malafouris and Renfrew, 2010) and propose that cognition is discovered through the body's engagement with materials. Going a step further than embodied or embedded cognition, MET argues for a serious look at the workings between body, mind, and the material world because "once the conventional demarcations of skin and skull are removed it appears that conventional cognitive science loses the analytical purity of its object of study" (Malafouris, 2013, p. 228). In additional to MET, the kinesthetic approach to analyzing rock art from Christopher Tilley will play a key role in this article's exploration of lines. Traditionally, rock art, encompassing colored cave drawings (Figure 1) and rock carvings (Figure 2) made with incisions (types referred to interchangeably within this essay), has fundamentally been approached with the question of "what does it mean?" (Tilley, 2016, ch. 1, par. 6). Typically, the drawings consist of items such as animals like deer, horse, rhinoceros, fish; objects like boats and tools; geometric shapes; and occasionally human figures. Tilley suggests that to interpret rock art, we should not analyze it like words on canvas. Instead, "a truly phenomenological study of imagery is grounded in the kinaesthetics of bodily movement. It explores the manner in which imagery impacts on and through the body and is understood through the medium of the relationship of the body to the phenomenal world within which it is enveloped" (Tilley, 2016, ch. 1, par. 12).

As proposed by Klein (2010), scientific research and artistic research should not be distinguished as mutually exclusive categories because they both seek new knowledge. Artistic research is itself the method whereby artistic creation and

FIGURE 1
Cave drawing from Lascaux II paintings, Lascaux, France.

FIGURE 2
Rock carving from Gobustan National Park near Baku, Azerbaijan.

theoretical reflection are inextricably linked (Klein, 2018, p. 78). Artistic research blends theory-informed practice and practice-informed theory, often drawing on theoretical paradigms from diverse fields of study. In the practices that follow, we will discuss the possibilities for how lines, as phenomena with multimodal potential, can blur the demarcations of what is mental, corporeal, and material within artistic practices. In doing so, we propose that lines, as concepts, take on a materiality of their own.

Drawing landscapes

The first practice[1] to compare alongside cave drawings involves drawings consisting of lines of motion. The traces of lines that are "created by movement are not perceived or perceivable but are, through and through, imaginatively constituted phenomena. The patterns emerge in the form of imagined trajectories that a moving body draws in the process of moving" (Sheets-Johnstone, 2016, p. 116). In this practice, the first author (the drawer) uses any writing utensil, a material to draw on, usually a simple piece of paper, and finds a location to observe. Over the time frame of 5–10 min, the drawer translates any line of movement imaginatively perceived into a line on the paper. When it comes to imagery created by drawing, Ingold proposes that "the pencil is not an image-based technology, nor is the drawing an image. It is the trace of an observational gesture that follows what is going on" (Ingold, 2010, p. 310). The paper stands for the visual field of the drawer and starts to accumulate lines whereby no distinction is made between what is being translated—a passerby, car, bird, or bicycle—all items appear simply as a line. They take on no other distinguishing element (see Figures 3, 4). In this way, the traces only show their spatio-temporal-energetic nature (Sheets-Johnstone, 2016, p. 117), to use Sheets-Johnstone's language, or the possible *vitality affects* (dynamic qualities of experience) of the original movements, to use a term from Stern (1985, p. 54). The difference may reside in the quality of the line, thus the spatio-temporal-energetic gesture that translates the seen line into a kinetic and material form. Ingold proposes that in the act of drawing, a pencil "does not hover but carries on its way from where the hand is now positioned, responding only to the present conditions in its vicinity rather than to any imagined future state" (Ingold, 2010, p. 301). In this practice, the hand responds to the present perception the drawer has of the landscape.

Leyton, in his book *The Structure of Paintings*, credits Picasso for discovering that "sight is a creative act", and continues himself that "Sight is an active exploration and manipulation of objects" (Leyton, 2006, p. 152). In the practice described above, the drawer is visually engaged with the landscape bringing seen movement into traces on the paper through the use of the tool in real time. Anthropologist and archeologist Tilley aligns himself with Merleau-Ponty and they both state that touch and vision "involve the same sets of embodied relations between the subject and the world" (Tilley, 2016, ch. 1, sec: The Fleshy Image: Merleau-Ponty, par. 8). Tilley states: "we look at things in the world and become fused with them. We become part of them and they become part of us" (Tilley, 2016, ch. 1, par. 10). Paterson agrees and in his book *The Sense of Touch* gives us an example stating that, when looking for something lost, "eyes and hands explore and we realize that vision and touch are equally prehensile and kinaesthetic" (Paterson, 2007, p. 30). Paterson also directs our attention to the investigations within disability research, particularly Gabriel Farrell's book *The Story of Blindness*. In the chapter "Fingers for Eyes", Farrell quotes blind teacher and psychologist Pierre Villey: "Sight is long-distance touch, with the sensation of color added. Touch is near sight minus the sensation of color, and with the sense of rugosity [texture] added. The two senses give us knowledge of the same order (in Farrell, 1956, p. 93). In this sense, vision is not passive, but connects us to what we see, and brings proximity to what is often regarded as distal.

When we acknowledge that sight is a way to as-if touch material, our eyes have the capacity to take on similar engagement as our hands do. Therefore, as the drawer's eyes engage with the different movement qualities, what is seen can be translated without difficulty back into movement by our hands and left within the lines drawn. When looking at the function of the pencil drawing in this exercise, we can consider Malafouris' (2013, p. 154) suggestion that tools function as enactive cognitive prostheses. In extended mind theories (e.g., Clark and Chalmers, 1998; Gallagher, 2013), there is no demarcation for where the mind clearly stops[2]—but the engagement of cognition extends into the action and material and in this case extended into the lines and markings left. Malafouris proposes that "early markings and lines do not externalize anything but the very process of externalization" and that he "will approach mark making not as a passive representational object but as an active prosthetic perceptual means of making sense. That is, marks will be treated as enactive projections" (Malafouris, 2013, p. 180).

By considering sight as a prosthetic tool that connects us to our surroundings, the lines of motion we see in this activity allow perception to be an important component for extended mind. Here we can draw upon the notion of mental scanning, as characterized by the cognitive linguist Ronald W. Langacker. Describing it as "tracing a mental path" (Langacker,

1 Borgdorff's definition of practice in the arts: "Art practice—both the art object and the creative process—embodies situated, tacit knowledge that can be revealed and articulated by means of experimentation and interpretation" (Borgdorff, 2007, p. 14).

2 This proposal mirrors the Blind Man's Stick hypothesis where Bateson (1972/1987, p. 324) asks,"where does the blind man's self begin? At the tip of the stick? At the handle of the stick? Or as some point halfway up the stick?"

2008, p. 82), he notes, "It is by means of scanning—through space in the case of objects, and through time for events—that their constitutive patches or states are integrated to create the seamless conception of their spatial or temporal extensionality" (Langacker, 2008, p. 109–110). Additionally, as proposed by MET, the pencil can be seen as a tool extending cognition into action. But even more radically, MET proclaims that we can see the lines left as externalization of sense-making and perception. Mentally scanned, imagined traces, when rendered visually, translated into drawn lines, made through gestures with a tool, capture the qualitative movement between perception, objects, and materials.

From disability studies, art, cognitive linguistics, and anthropology, a variety of fields speak of externalization through different forms of mental, visual, or physical movement as lines. The ability to easily integrate scanning as touching and drawing as perceiving in this practice, exemplifying an extended mind, can be explained by the words of Sheets-Johnstone: "The quality of our movement in drawing extends into the quality of the lines drawn, just as the quality of our movement in everyday life extends into the character of our doings" (Sheets-Johnstone, 2016, p. 117). The lines we make engage the quality of our character with our surroundings.

In Figure 3, one may try to decipher which lines would be coins being tossed vs. taxis driving by, based on the spatio-temporal-energetic nature of those objects in relation to gravity and context. The size of one's own body, when viewing this image afterwards, creates a kinesthetic response in relation to the imagined movement. In Figure 4, the three types of moving objects remain indistinct due to the similarity of their drawn qualities—straight lines clustered in the same location. In both drawings, the background landscape that these moving elements operate in remains undrawn, but greatly influences the objects' movement and the drawer's perception during the creation. The negative space on the paper (what was not drawn upon) suggests by means of absence what could be there; inanimate parts of the landscape: buildings, streets, city squares. The lines that overlap also convey a passing of time, something which can be seen as providing a visual instantiation of a particular type of mental scanning that Langacker calls "summary scanning". He points out (Langacker, 2008, p. 83), "As we scan through a complex scene, successively attending to various facets of it, the elements apprehended at each stage are summed, or superimposed. In this way a detailed conception is progressively built up, becoming active and available as a simultaneously accessible whole for a certain span of processing time." Indeed, the drawing, by reifying this scanning, provides a material product that allows for temporally unlimited and shared accessibility to it.

In this artistic practice, we can see how lines blur the demarcations of the mental, corporeal, and material through the body's ability to move them between modes of the traced, the visualized, and the imagined. Sight, when approached as a tactile act in combination with drawing, bring vision and movement

FIGURE 3
Sé Alfama, Lisbon: Trams, Tuk Tuk, taxis, people, coins, motorcycles, birds. Drawn by: Michael O'Connor.

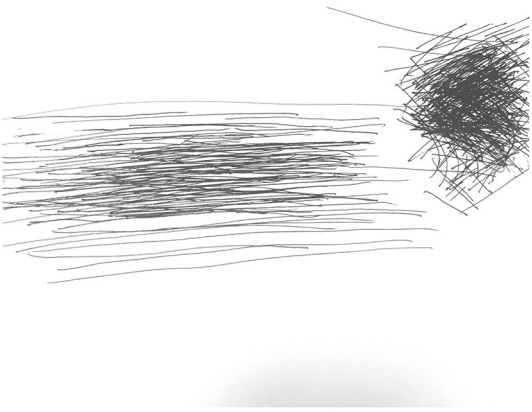

FIGURE 4
Amsterdam: Walkers, Bikers, Cars. Drawn by: Michael O'Connor.

together as perceptual tools creating a feeling of fusing the body with the environment. For Ingold, the ocular itineration of joining tactile with the visual is where vision resides and is the practice of what he calls *togethering* (Ingold, 2010, p. 308). When drawing the imagined traces from movement, the vitality of the objects and subjects is felt by the drawer through the material engagement of line making. Additionally, the completed drawings themselves offer a viewer a kinesthetic engagement through the possibility of sensing their spatio-temporal-energetic nature.

Components of cognitive archeology

The line making practices discussed here seek to share the same approach as MET—in that marks from creative gestures are continuations of thinking in time and space (Malafouris, 2021, p. 114). This commonality is where we find

resonance with these studies, and as artistic research, seek to draw upon theoretical notions from seemingly diverse fields. However, researchers of ancient mark making (the perceived or felt difference of lines on or in a surface) (Malafouris, 2021, p. 95–96) draw upon other scientific fields of study as well. The field of cognitive archeology defines lines, and marks in general, according to certain criteria in order to determine their significance and to distinguish their relevance as forms of material engagement. Cognitive archeology can be defined as "an approach to studying human cognitive evolution that applies theories and concepts developed in the cognitive sciences to archaeological remains of the prehistoric past" (Coolidge and Wynn, 2016, p. 386). Four general criteria for identifying instances of mark making in archeology are: antiquity, artificiality, intentionality/deliberateness, and symbolism (Malafouris, 2013, p. 184). Within a contemporary artistic research practice, antiquity would be irrelevant, as the distinction between contemporary marks and ancient marks is already known. Likewise, artificiality is not a relevant distinction here because all lines created here are made by the artist. Whether imagined, seen or made with the body, there is no confusion where the line comes from—they are a phenomenon brought into a present body.

The third and fourth criteria, however—that a mark is deliberate and symbolizes something demonstrative of human thought processes—are important for this discussion. Deliberateness is seen in the practices because the lines are actively translated between different domains: from imagined to drawn, drawn to kinetic, and perceived to kinetic. Lastly, the criterion of symbolism is concerned with the point that the mark is attached to meaning. In the previous and upcoming practices, what can be interpreted as the meaning of the lines resides in their spatio-temporal-energetic form, which stems from the materials being translated. Therefore, these two criteria from cognitive archeology are also applicable to use to look for traces of cognition in material engagement, *via* the marks and lines left behind in the artistic practices. Combining these two criteria, we will call this deliberate sense-making. Here we build on Sheets-Johnstone's notion of kinetic sense-making, which she defines as "making meaning through movement and making sense of movement" (Sheets-Johnstone, 1999, p. 170).

Let us imagine a dance floor is covered in sand (or see Figure 5, for an example with a natural sand "floor") and a dancer starts moving in the space, creating strokes and traced lines behind any of their movements that touch the floor. The traces in the sand constitute an embodied, enacted thought process left by the dancer through movement. While feeling the texture of the sand under their feet, the sand informs and influences how the person moves. Knowing the texture of sand, the dancer can be precise or careless; both qualities creating either defined or vague lines left behind. The interaction of the dancer's thinking through the body while being with the sand as material is rather easy to see. The marks left behind do not represent anything specific, but constitute the *thinking while doing*. Likewise, as material engagement theory wants to posit, a person holding a tool or a drawing apparatus is doing the same thinking by doing. It is this shift away from representation that is relevant here, or as Malafouris explains; "Marks made with a pen on paper are not an ongoing external record of the contents of mental states; they are an extension of those states. Cognition and action arise together" (Malafouris, 2013, p. 74). Ingold defines drawing as a tool of observation in that it "combines observation and description in a single gestural movement" (Ingold, 2010, p. 303). Lines become the material from which we can perceive a type of deliberate sense-making.

FIGURE 5
Video still from dance film *Between Foam and Origami* by Michael O'Connor. A circle is seen drawn in the wet sand from the dancer's foot before it quickly disappears in the tide. Camera: Lukas Georgiou.

Turning back to cognitive archeologists, one question they look at is focused not on what the incisions in caves and rocks mean, but "what did the activity of mark making do for the ancient mind" (Malafouris, 2013, p. 190). The lines show the maker's cognitive template, thus in that way, mark-making action and thinking are the same. Malafouris points out that studies in scribbling[3] have received little attention in archaeological research and suggests this crossover of different fields could support each other (Malafouris, 2013, p. 193). Like studies from (Stamatopoulou, 2011, p. 166), that show scribbling actions stimulate further actions and subsequently contain and express meaning, improvised dance is also a type of trace making, but involves "scribbling" in the air, which stimulates further actions and likewise expresses meaning. In the next practice, we will examine doodled lines on paper (a kind of pictorial extension of scribbling) and their transfer to kinetic traces made by the body. This translation of drawn lines into

3 It is no coincidence that etymological connections can be traced for the word *scribble* and words in several Indo-European language for "writing" (e.g., Latin *scribere*, German *schreiben*) to the Proto-Indo-European root **skribh-*, meaning 'to cut', as in to carve marks into a surface (Online Etymological Dictionary, n.d.).

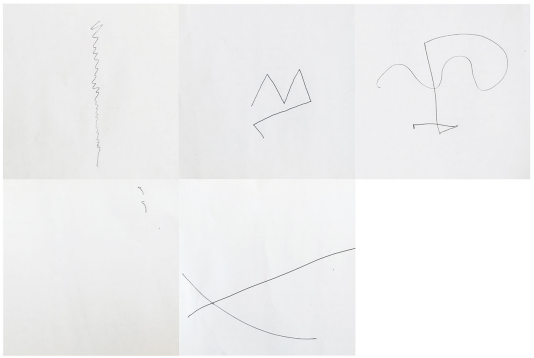

FIGURE 6
Doodles 1–5, Trial #2.

movement reveals dancers' ability to find and make meaning out of what seems to be meaningless forms.

Dance doodles

In this next practice, arbitrarily drawn lines are used to create performed lines of movement by dancers. Each of five dancers were asked to draw one doodle on a separate piece of paper. The term *doodle* was used to invite the drawing of a small line that did not take up the whole page. Each dancer then privately chose an order for the five drawings. For each doodle, they translated the line drawing into their body as movement. Then they created a movement sequence that came from that order. One at a time, the dancers performed their dance of five doodles as one connected action. The other four dancers watching tried to guess the order of the doodles for that performer.

In this practice, the watchers are not neutral. They are the drawers of the doodles, and even more, they are familiar with the doodles in that they too have chosen an order and put the lines into their own body. They each have a drawn relationship to one of the doodles, and a kinesthetic translation into action for all five doodles themselves. While watching the others dance, they were in fact not looking at the drawings while guessing an order. As they had translated the numbered doodles into a sequence of actions for themselves, they could use memory and self-movement translations to recognize the other dancers' actions, rather than referencing the drawings to compare. In the first run through, the correct orders guessed were inconsistent. Those who thought they knew the correct order of the dancer's line movements were not necessarily correct. Those who thought their guesses were partially accurate actually guessed perfectly. What can be noted in the first time is that the dancers were asked to just draw a line without knowing what would follow (what the experiment was). By calling it a "doodle" this may have been why some of the drawings in the first try out were similar, as people drew what they had thought by definition a doodle was. Many of the lines looked rather similar, which would make it difficult to differentiate between them. In the second trial (see Figure 6), repeating the exercise, the dancers already know what the experiment was. Even without seeing what others drew, or agreeing to make larger distinctions, the variety between the drawings was more diverse. Additionally, three of the drawings could be said to convey simpler proposals allowing for greater readability. Participants used more recognizable features in their drawings, like angles or curves, meeting points or symmetry. In addition, the second trial had the advantage that the participants had more practice in reading movements within this abstract exercise. They also had the insight to create more recognizable translations, knowing others will be guessing them.

What stands out however, is not how precisely the dancers were able to match the movement to the drawing, but more interestingly, the different approaches that each dancer used to translate the same lines, and the knowledge they had of other dancers' attempts to read the movements, even while their own translation was distinctly different. For example, in a discussion afterwards they stated they could recognize that their two jumps were another dancer's two claps. In this case, it should be noted it is not just the number of elements that is the same, but the similar sonar, rhythmic, temporal, and percussive aspects involved when feet hit the ground or hands clap together. This is an example of what Sheets-Johnstone means by making meaning through movement and it highlights the deliberate sense-making components that this practice shares with mark making in archeology. The doodles hold meaning in their spatio-temporal-energetic form that can be reproduced and understood in a variety of ways.

Trial #2
Doodle one: A tight wavy line running vertically.
Doodle two: Two angles of the same size with an open bottom and an additional angle.
Doodle three: A circular wavy line that turns back in on itself before making a vertical drop with a horizontal bottom.
Doodle four: Two small vertical dashes.
Doodle five: Two lines crossing like an asymmetrical X.

In the second trial, three of the dancers took the same approach to translating the first drawing of the wavy vertical line, rendering that by vibrating their body while standing in place. For the fifth drawing, one dancer ran across the diagonal of the space, ran backwards and then turned to a different corner and ran diagonally across the space again. The cross of the X was a point in the middle of the space and her body translated the X as a pathway through the room. The second dancer crawled across the floor in a straight line and then retreated back on the same line. The X was not made, but symmetry and straightness was translated. The position of the X on the paper also resembled

the position in the studio space, from the audience's perspective, on the lower left side. Another translation approach from a different dancer depicted the two lines crossing by looking over each of her shoulders. This translation used eye sight as an imagined line through space and the X was crossed where her body stood. Lastly, the final dancer translated the two crossed lines by swinging each one of his arms from a raised position down and behind him. The crossing point was his hands held together from the starting position.

Tilley outlines the process of textual interpretation as follows: "A person wishing to understand a text places him or herself immediately in a dialogic situation involving a question and answer process" (Tilley, 2015, p. 117). In the translation process in the present practice, when a dancer sees lines that they have to interpret, though it is not a text of words, they need to fall into the same dialogical question and answer situation [which we will consider below using Shotter's (2010) term, "withness"]. They have to decide what parts of the lines speak to them, what spacing, what contours— what information can they translate into movement.

In the case of our study, the lines are not symbolic or representation—they are purely abstract. Therefore, the watchers, as trained dancers, have to interpret what possible array of choices a colleague may be pulling from in order to make a conclusion about what action would pair with the drawing. By being able to recognize how the dancer was translating the line into their body, the watchers can make guesses for the order. In order to guess, they need to pull from the spatio-temporal-energetic qualities made by traces, designs and imagined lines. The nature of this experiment requires the observers to be flexible with the unfinished and ambiguous nature of the line. One doodle that was two dashes on the paper was translated as hand gestures. Rather than a symbolic approach where these lines would mean hands, the lines have an open-endedness to them, that allows a dancer to translate in a variety of ways. This requires the dancer and watcher to engage in a dialogical relationship with the intertwining meaning that the lines hold. The dancer did not translate that doodle the same way into their own body, but can recognize what another dancer was thinking with their translation, due to the effort involved, and temporal and qualitative similarities.[4] In addition, certain features like symmetry or quantity, are recognizable, for example when the two lines are translated as two jumps, or two claps. The task of translating drawn dashes into a jumping action, or an auditory action from two hands coming together, should not be underestimated. "Simple line drawings can give visible shape to patterns of forces or other structural qualities" (Arnheim, 1969, p. 135). This argues in favor of considering lines from a multimodal perspective, considering their ability to materialize as sound or actions, with timing and dynamic information that is translated with and through the body.

Tilley's (2016, ch. 1, sec: From Sensory Experience to a Kinaesthetic Perspective of Rock Art, par. 9) definition of kinesthetic is relevant here: "the study of the active effects of imagery in relation to the human body, its balance, effort, postures, and gestures". In a previous study, a short movement was performed and the dancer as well as the watcher then drew a doodle translating what was felt or seen into a drawn line. In this reversed practice (O'Connor, 2023), whether felt or seen by multiple people, all of the drawn doodles had some similarities. This suggests commonalities in what traces are imagined as movement when watched and a general ability for people to translate those into drawn "gestures". Considering this reverse practice reveals a type of empathic ability to see similar imagined lines from kinetic movement, and the ability to translate those into drawings, it is not surprising that the ability to guess a doodle's translation into movement is also possible. "Meaning is derived from and through the flesh, not a cognitive precipitate of the mind without a body, or a body without organs" (Tilley, 2008, ch. 1, par. 12). Thus, if we follow the view that Lakoff and Johnson (1999) characterize as "embodied scientific realism", we can point out that the people in both practices have the same body and its capabilities that they can draw upon for reference when they are imagining lines, and translations of lines to actions. Turning back to Sheets-Johnstone, she explains this is possible because we are aware of the shapes of our bodies through joint angularity created through imagined lines, as well as imagined lines that appear as traces, e.g., when we reach for a book—"What are imaginatively constituted in all instances are *lines*" (Sheets-Johnstone, 2016, p. 116).

Studying the translations that are possible from line drawings to embodied movements and back again illustrates the same approach Tilley proposes for analyzing rock art: "The body both limits and constrains, and enables us to perceive and react to imagery in specific embodied ways" (Tilley, 2016, ch. 1, par. 8). Ingold explains that "following materials and copying gestures both call for observation" (Ingold, 2010, p. 308). He states that these activities require "an intimate coupling of the movement of the observer's attention with currents of activity in the environment" (Ingold, 2010, p. 308). He argues that one does not observe passively from a distance, but instead one participates within the process of the production of drawn lines, and when watching graphic lines, one is "reunited" with the "inked traces" (Ingold, 2010, p. 308).

4 Mirror neuron studies in monkeys have looked at and debated the ability one has to understand the actions of others from inside, even when one has not done or cannot do the action themselves (Rizzolatti and Sinigaglia, 2010, p. 260). These studies have also proposed that understanding the "motor behaviour of others might require a mechanism different from mirroring" (Rizzolatti and Sinigaglia, 2010). Differences in recognizing others' motor actions versus motor intentions also opens up questions about which mechanisms in the brain are required. If these doodle practices require more than mirroring mechanisms, no neurophysiological data can explain how the 'mentalizing network' might work" (Rizzolatti and Sinigaglia, 2010, p. 271).

Moved by materials: Tracing contours in space

In the last practice discussed here, lines, body and materials take on a different composition. Compared to the first exercise where traces of movement were perceived (and imagined) in space and translated into a drawn line, or the second exercise where drawn lines were brought into traced lines of the body, in this practice, lines already existing in architecture or landscapes are only traced and brought into movement of the dancers' bodies. Whereas, in the first practice, we could discuss whether the drawn lines have some symbolic status, as they leave a perceived trace that stays after the initial action has happened in the environment, and in the second practice we could equate some desire to seek symbolism with the fact that, in the practice, viewers were searching for iconic features between the drawings and the performed interpretations, the third practice here bypasses the question of sign or symbol in the creation of lines. Lines perceived in landscapes or architectural components are brought into the body of the dancer by tracing the lines with parts of their body. Tracing used here is similar to the tracing mode of presentation used in gesture studies where the shape or path of an object is drawn as if tracing its contour (Müller, 2014, p. 1691). The lines created by tracing the perceived lines do not stand for anything other than "captures" of the mental and/or visual scanning involved, but aligning with the proposal of MET, they aim to substantiate the material and concept the body is engaging with. In a way, this practice is similar to the first, but the lines here are visually perceived instead of imagined from movement traces, and the tracing happens without a pen and paper. The similarity of this practice to the second practice is that the dancer is also bringing visible lines into their body as movement, but the tracing practice does not require interpretation, but aims for copying the contours of the lines as tracing actions.

As MET hypothesizes, prehistoric humans, using their own kinesthetic sense, engaged with materials to substantiate concepts of deer, boats, and fish etc. in the process of creating cave art. We could say that the drawer was also *moved* by these objects (in both literal and figurative senses), and through movement, united their own gesture with materials to create lines on cave walls, allowing their expression to be surrogates for their emotional and mental activities.

Malafouris (2008) uses the potter and clay as another example to understand how material, action, and cognition work together. Malafouris acknowledges the potter's sensorimotor attunement to the clay's affordances by means of visual-haptic engagement, with "affordances" here referring to what Gibson defines as an action possibility formed by the relationship between any property of the physical environment and an organism (Gibson, 1979, p. 127). The dance practiced in the current study proposes the same material engagement is happening through lines but without tactile engagement. The dancers themselves engage with materials, but instead of holding materials in their hands to create lines, the lines of material are already embedded in the walls, architecture and even other dancer's bodies around them. The dancers are not touching the buildings or materials they see, but they allow the affordances and perceived vitality affects created by the lines to literally move them, through traces and responses (see Figures 7–9). When we remember that vision itself can be considered a type of touch and connection, and that the architectural lines are brought into gestures through an act of tracing, this coupling of action and perception could be also considered a type of material engagement.

Instead of a person using a gesture to place a line on the wall in the act of drawing a horse or deer, a dancer traces the lines they see already in the environment. In both instances, the human engages with the lines, bringing forth or activating the conceptual elements the lines hold. When scanning the environment for lines during the practice, it is the different kinds of lines, textures, and vitality affects associated

FIGURE 7
Sophia Obermeyer tracing lines in architecture as a dance practice. Photo: Niels Weijer.

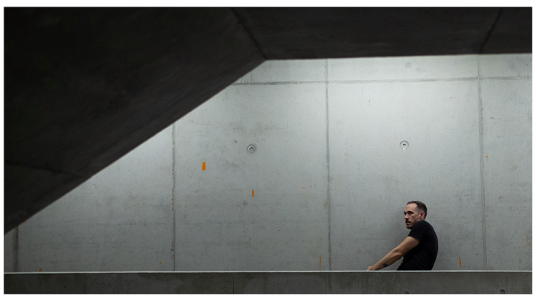

FIGURE 8
Michael O'Connor tracing lines in architecture as a dance practice. Photo: Niels Weijer.

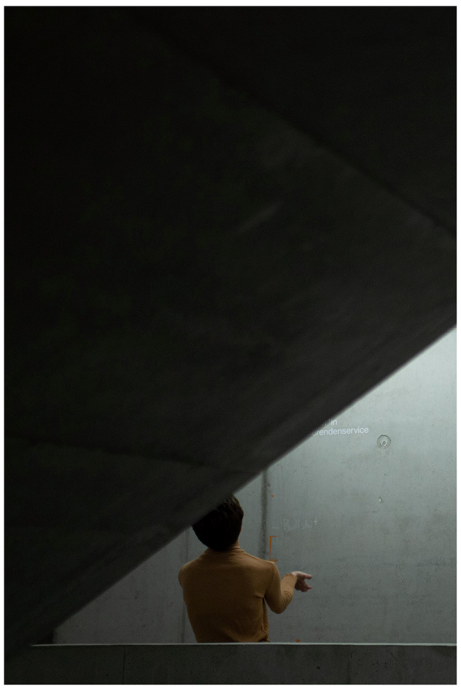

FIGURE 9
Samuel Feldhandler tracing lines in architecture as a dance practice. Photo: Niels Weijer.

with those lines, that then bring movements into the dancer's body. The gestures and movement express what the dancer is perceiving, using lines to foster movement and substantiate their own subjectivity through the engagement of material and lines. The improvisation the dancers create is based on their individual perception. How and what they see in the space takes on different forms in their body. By bringing the lines of space into themselves, they substantiate—in other words: bring meaning to—the intertwinement of action, perception, material and body. The meaning that is involved here is the kind Johnson's describes as concerning "the character and significance of a person's interactions with their environments" (Johnson, 2007, p. 10). Embodied meaning for Johnson is about ongoing experiences and how things relate and connect to other things. In Figures 7–9, each dancer reveals their own perception of the same architecture by means of different interactions with the lines seen in the environment.

Lines as a phenomenon do not inherently constitute a codified semiotic system, nor do they necessarily rely on other signs for their forms or meanings. Tilley, as well as MET, also questions the reflective approach to interpreting ancient line drawings in the attempt to propose that cognition extends into materials. "Meaning does not just reflect; it is also produced, contrived. In other words, meaning arises from operations performed on things" (Tilley, 2015, p. 126). In the dance practice, one dancer explained her position. She noticed that one dancer may have been translating a line of color on a wall as a linear movement in their body. Another dancer then used that dancer's body as an affordance[5] to incite movement in themselves. Lastly, she then used the second dancer as material that she could trace. She summarized the situation as, "I am translating the body of someone translating someone else's interpretation of gray." The meaning exacted in this description exemplifies what Tilley is highlighting—that meaning is not passive and reflective, but through the performance of these dancers interacting and their awareness of each other, this unique moment of situated understanding prevails. As the third dancer, she is aware she may be holding the color of the wall that is extended through the body of two other dancers by her deliberate engagement. The meaning of color, in this case, extends through the materiality of multiple people creating lines. Returning to think about this in relation to ancient cave drawings, Malafouris points out that we could surmise how over time they took on symbolic functions (Malafouris, 2013, p. 193) due to the original embodied kinesthetic actions needed to create them. As dance is an embodied kinesthetic action, the main difference between dance and cave drawing lies in whether the gestures made leave perceived permanent lines, as with drawn figures, or imagined temporal lines, as with dance.

In the dance practice, the dancers bring the lines they see around them into their body by using different parts of their body to trace proximal, distal, large, or small lines. Through their movement, their perception of the space also changes. Compared to the creation of the rock art that Malafouris discusses, Tilley explains throughout his writing that engaging with rock art, be it cave drawings or rock carvings, also requires movement; one must move across landscapes and situate oneself in certain positions in relation to the images while standing on the very rocks themselves. "All perceptive experience has a bodily basis in movement through and exploration of the landscape, as the site of all the sense organs and the brain, and as a sense organ in itself with the skin as its boundary" (Tilley, 2008, ch. 1, sec: from Sensory experience to a kinaesthetic perspective on rock art, par. 4). Tilley explains that the dynamic interconnection between kineasthetic and sensory experience connects the perceiver to the environment they are in, changing them. "The landscape provides a rich and structured sensory domain through which the body moves and thinks, and the manner in which this movement and thought take place is fundamentally influenced by their particular material characteristics" (Tilley, 2008, paragraph 7). Like the prehistoric cave drawer and the archaeologist investigating, the dancer is the line creator and simultaneously the perceiver, moving through the landscape's surface, observing as they create.

5 Affordances, in the Gibsonian definition as it relates to interactions between humans, are the behaviors and possible interactions that another person affords (Gibson, 1979, p. 135).

The relationship the dancers have to the lines in the architecture are not like relating to art hanging on a wall, but like Tilley brings our awareness to when viewing rock art, the dancers are also on and in what they are perceiving.

Signature: Becoming one with the line

In the "reading" of cave drawings and rock carvings, the lines marked to account for elk, people, boats and fish, had been traditionally deciphered as if they were a text (Malafouris, 2013, p. 91). Tilley and MET approach rock art differently. Tilley proposes the body in motion is a necessary element in reading rock art and MET proposes the rock art should not be seen as representational signs to begin with.

"A kinesthetic approach" says Tilley, "is one that attempts to restore the power of imagery in relation to human agency. Images are fundamental in society not because they can be verbally described as meaning this or representing that, but because they require different forms of bodily actions in order to encounter and experience them. Experiencing the image through our bodies is powerful because these images alter us in subtle ways that may require no talk of their meaning" (Tilley, 2008, ch. 1, sec: Images in the Landscape, par. 6). Here Tilley brings our attention to the idea that the importance of imagery is not what it stands for, but that the experience of the body when interacting with them is meaningful in itself, and that this space of interaction moves us in ways we are not able to articulate with words. He continues, "So the significance of the image is not primarily what it stands for, or seeks to represent, but the event of its bodily experience" (Tilley, 2008). Malafouris agrees: "Material signs do not represent; they enact. They do not stand for reality; they bring forth reality" (Malafouris, 2013, p. 118). For this reason, MET sees external representations not as a starting point of investigation but as an ending (Iliopoulos, 2019, p. 50). The act itself makes the experience important. In prioritizing the drawing of a line as an act of improvisation, Ingold states: "A graphic anthropology, then, would aim not at a complete description of what is already there, or has already come to pass, but at joining together with persons and other things in the movements of their formation" (Ingold, 2010, p. 304). Ingold defines drawing as a tool of observation in that it "combines observation and description in a single gestural movement" (Ingold, 2010, p. 303).

Phenomenologist Sheets-Johnstone also directs our attention again to the moving body's importance in the development of signs and language: "When we frame the inquiry 'how did human languages originate' in terms not of adaptations but of living bodies, we are necessarily confronted with the creation of meaning, a creation that did not arise *de novo* but that was grounded in an already present semantic repertoire, itself grounded in archetypal corporeal-kinetic forms and relations, as suggested, follow along biological Family lines, i.e., for hominids, along primatological lines" (Sheets-Johnstone, 2009, p. 234). What she is addressing here reminds us, when thinking of how we as humans developed and learned language and meaning, not only within our own individual development, but as a species, the prelinguistic movement and experience went hand in hand with the growing thoughts and then came to be expressed in language systems.

Following on the proposals from Tilley, MET, and Sheets-Johnstone, if lines in rock art are not approached for their symbolic reference, the abstract lines seen in these different creative practices are not themselves after-the-fact signs of reflection either. Instead, as we argue, these creative practices aim to place importance on the materiality of the line as an act of extended cognition. The lines' potential for multimodal interpretation in terms of their movement characteristics (either the movement required to create them or the movement they inspire in the viewer) allow them to be meaningful. In the act of using cognitive archelogy to compare the use of lines as deliberate-sensemaking tools in dance, the concept of *signature* comes to mind as a more applicable term than that of *sign*.

Whereas, a line drawing of a rhinoceros provides a representation that is sufficiently iconic as to allow one to link it to the actual animal, drawn lines from cars moving in landscapes or ephemeral lines of the body tracing cracks in the cement of a building do not bring the original object into focus in the same way, but rather only the dynamic qualities and contours from those lines themselves. In this way, lines bring focus to the movement within the perception of the referent object and this brings us to why the term *signature* is offered here in exchange for *sign*.

A signature marks a personal, distinctly unique, situated time and place for one subject. It is recognizable by the line's movement characteristics and even is expected to be different each time. For these reasons, a signature varies greatly from a sign, as it gestures toward a movement of sense-making of identity and location. A signature extends the individual thoughts as traced lines into the world as movement. "To bring forth a world means to enact dimensions of meaning and significance through the living body in action and through multiple kinds of physiological, sensorimotor, and interpersonal couplings. The mind is what occurs in these enactments and [is] not what goes on in the head" (Di Paolo et al., 2018, p. 17). Here we find a question from (Ingold, 2010, p. 300) appropriate: "What if the living being *is* the line of its own movement?" A signature is a sign in motion connected to the internal/external world of one person.

A person's signature (in the traditional sense of the word as well as the way we are using it here) is also directly related to one's body. Thoughts from Bergson on the body relevant to this are referred to by Tilley: "As my body moves in space, all the other images vary, while that image, my body, remains invariable. I must, therefore, make it a center, to which I refer

all the other images. My belief in an external world does not come from, cannot come, from the fact that I project outside myself sensations that are unextended.... *My body* is that which stands out at the center of these perceptions: *my personality* is the being to which these actions must be referred" (Bergson, 1991, p. 46–47). Tilley explains that, for Bergson, the moving body and personality are indistinct from each other in that they are the person (Tilley, 2008, ch. 1, sec: Body, Image and Memeory in Bergson, par. 3). If we think of the moving body as an act of *signaturing*, we can also make correlations to one's personal way of moving as the center of their perception. "Cognition is not about transposing a world of predefined significance into the inside of an agent. It is about agents moving within the world and singly or collectively changing it in ways that are significant according to the forms of life they enact" (Di Paolo et al., 2018, p. 21). The act of signaturing can be seen as a form of deliberate sense-making—a making sense of lines as movement and the intertwined materiality of body, cognition, and world.

By bringing focus to the enactive creation of the line making, and the kinesthetic movement involved in perceiving lines, we see the relevance in the term *signature* in order to put focus on meaning that originates from the engagement. "Meaning does not reside in the material sign; it emerges from the various parameters of its performance and usage as there are actualized in the process of engagement" (Malafouris, 2013, p. 117). MET acknowledges that a material sign can be both a signifier in itself and simultaneously a signified representation of something else (Malafouris, 2013, p. 17). Due to this double nature of material signs, the shift toward the term signature also brings together the maker and the traces left when focusing specifically on the materiality of lines. The act of signaturing is then thought to bring individual meaning through the proposition of extended mind to the lines that are drawn. What seems like meaningless lines, can therefore be given importance when we focus on the actions involved in their material creation. "In the case of material signs, we do not read meaningful symbols; we meaningfully engage meaningless symbols" (Malafouris, 2013, p. 117). In this way, the materiality of lines in this practice maintains a scope of ambiguity over iconicity: only the spatio-temporal-energetic meaning related to the lines is intended to be conveyed in the practice, rather than iconic forms for the purpose of communicating what the referent object is. Therefore, let us look at the element of ambiguity within the context of linear engagement within artistic practices through the lens of material culture.

Ambiguity: Landscape to mindscape

The field of material culture studies proposes that an artifact may be ambiguous in its meaning because it relays a variety of information, often layered and contradictory, through the same media (Tilley, 2002, p. 28). From the perspective of visual thinking, Arnheim draws our attention to meaning made through experiential associations. "Remember the old laws of association: items will become connected when they have frequently appeared together; or when they resemble each other" (Arnheim, 1969, p. 54). He goes on to say things that "resemble each other are tied together in vision" specifically (Arnheim, 1969, p. 55).

Tilley proposes that images of different concepts resemble each other, or look the same on purpose in cave art, to create ambiguity. The ambiguity is thought to be used to link things together (Tilley, 2015, p. 144). In the drawings, "Many of the boat depictions resemble water birds" (Tilley, 2015, p. 76). Tilley also points out that the removal of the elk's legs transforms it into a boat. "Such ambiguity, it might be suggested, is not just the result of incomplete preservation or of a technically inept artisan but is intended to forge connections and links" (Tilley, 2015, p. 77). Neuroscientist Zeki studies the neurobiological foundations of ambiguity and explains that the brain's organizational structure makes possible the ability to see things with multiple interpretations and that this attribute makes ambiguity for the visual brain a stable feature (Zeki, 2004, p. 187).

In viewing these links, "Visual perception, [...], is not a passive recording of stimulus material but an active concern of the mind" (Arnheim, 1969, p. 37). We could also say it is an active concern of the body, as the eyes move, the breath and body engage in a whole kinesthetic response, as Tilley has drawn our attention to. Malafouris sees perception as a mode of probing the outside world rather than representing it and thus the cave drawings are continuous prosthetics of this probing mechanism which extend the visual brain (Malafouris, 2013, p. 203). Perception is not discovering things already there—it is about being present and aware in the very moment of formation itself (Ingold, 2022).

Instead, the articulation of ambiguous lines is an attempt to bring like-minded things (in the thoughts of the one drawing or dancing) together. O'Connor (2022) proposes that the ambiguity of lines allows for a type of *withness* (Shotter, 2010) between the mind, body, and environment, allowing us to consider the mind as extended. Shotter defines withness as our ability to "think along with subsidiary awareness of certain felt experiences as they occur to us from within our engaged involvement in a particular unfolding process and [...] these inner feelings play a crucial role in guiding our actions" (Shotter, 2006, p. 586). As cognitive archeology suggests, lines with indistinct references do not necessarily appear because the agent could not articulate better what they meant, or what they wanted to express. As Zeki shows us, ambiguity is a natural part of human experience. Shotter proposes, when we experience things we do not fully understand, we have the opportunity to orientate ourselves around yet-named "things" and we should move "to *sensings of likeness* that can be meant and understood as one-and-the-same in countless different circumstances (Shotter, 2015, p.

234). Shotter points out that we "continually ignore the original openness and unfinishedness of world processes" when we seek out determined things with the mindset that they just need to be discovered (Shotter, 2016, p. 37). Rather than approaching lines that we make as some problem to solve, we take Shotter's suggestion in that "we are seeking to resolve what we at first encounter as an indeterminate, ambiguous, or bewildering situation by our active inquiries within it—conducted in the course of our living, engaged, attentive movements within it" (Shotter, 2016, p. 79). Respectively, Ingold describes these moments as "coupling our own movements of description with our observations of what is going on in the world, which are, in turn, necessarily coupled—through the participatory act of togetherin—with the trajectories of those with whom, or with which, we join" (Ingold, 2010, p. 304).

How this can be understood within the practices here, is that the practitioner should not try to be creative, nor try to execute a goal, a specific movement, nor aim for bringing oneself to a certain after-the-fact thought-out ideal situation. Instead, the practitioners engaged in these tasks should allow the perception to be indeterminate such that their actions can forge ambiguous connections with the material environment. Zeki relates the relationship of ambiguity to unfinishedness as a strength in art work, allowing works to be open for different interpretations (Zeki, 2004, p. 190). If we consider lines as something that moves, then the very nature of lines in architecture conjure movement when viewing them. By translating those lines into movement made by the body, we give the opportunity for our movement to make sense because of proximity and relational similarity. "Meanings resulting from relations between events and dynamic happenings are contingent on movement" (Sheets-Johnstone, 2009, p. 169). It is the deliberate sense-making, or (what can now be called) signaturing one does when generating lines in these practices that, like the similarities between figures in rock art, bring meaning between the ambiguity within lines.

Malafouris invites us to see that while the "toolmaker brings forth the possibility of a new form of tactile thinking, the image maker brings forth the possibility of a new form of visual thinking (Malafouris, 2013, p. 203). With this approach, we can see that the dancer, using their body as a tool to make kinetic images, either drawn or through gestures, brings forth a *visual-tactile way of thinking*. Thus, if in these practices, the body is attuned with the lines in the space around them, the thinking is taking place with the material. The lines are the material in which the dancer is engaged. Further, as Arnheim proposes: "Thoughts need shape, and shape must be derived from some medium" (Arnheim, 1969, p. 226). In continued questioning of what the medium shaping thoughts is, if we consider the moving body, which makes temporal lines, to be *thinking as an extended mind through its engagement with linear materials*, the medium, the materiality of thinking, is also lines. As Arnheim (1969, p. 27) asks, "What are the mental shapes of thoughts[?]", we would not go further in finding what the shapes are, but rather we can consider what all shapes are made of, and for this we can say: lines. The shape of our thoughts can be seen in the shape of the lines we produce.

Possible beginnings

Looking at the lines of dance practices in the way we look at ancient rock art involves not only a metaphoric logic, mapping thinking about the latter onto the former: the kinesthetic approach to rock art proposed by Tilley brings movement-based meaning as a crucial element to this field, opening the door to dialogue with dance as artistic research. These fields of inquiry find a common ground in that "The counterpart to linguistic metaphor is material metaphor, metaphorical *material* relations between things, or aspects of a thing" (Tilley, 2008, ch. 1, sec: Kinaesthetics and phenomenological semiotics, par. 9).

Malafouris states archeology has yet to reach a consensus on how to answer the question of how modern symbolically competent humans came to be. Perhaps dance research cannot answer how we came to be, but can demonstrate, in real time, the multifacetedness of our ability to move, perceive, and think in lines, which enacts remnants of our ancient cognitive processes. But whereas in cave drawing, there is a tool, a tool maker, and the tool users, in dance, to say the body is the tool and the dancer is the tool user is inappropriate, because it separates the body from the dancer. The body and movement combine to become the material.

Tilley proposes that a new method of analysis is needed in order to rethink the semiotics of rock art. The method he promotes explores understanding the rock art by placing emphasis on what the rock art *does* to the body. This kineasthetic method that Tilley seeks is comparable with the approach in the practices described here because, as seen in the argument we have presented from Tilley, the images produce sensory effects on the bodies of those who perceive them and one does not have to know what they might represent. However, Tilley also incongruously claims that a kineastehetic approach to rock art without reference to meaning "would be deeply and unacceptably reductive since we would learn rather little about the specific form and nature of the images themselves" (Tilley, 2008, ch. 1, sec: Kinaesthetics and a phenomenological semiotics, par. 2).

Being moved by the images in the artistic practices here *is* the active product itself. In these works, describing the lines substantiates those materials and concepts on a visceral level, and the understanding is placed only in that particular moment. In contrast to the idea that "thinking takes place through the syntactic arrangement of symbolic representations, MET must rely on a model of cognition wherein new thoughts emerge through a dynamical engagement between the human mind and the material world" (Iliopoulos, 2019, p. 44). As the present practices are intended to investigate movement generated by perception of lines for artistic purposes, what the environment *does* to the body and how that reveals the dancer's temporal

and situated perceptions is what is looked at and is what differs from rock art analysis. The significance is the signature it creates with the individual who is moved. By sensing, and attempting to notice, as a means of describing without words the dynamics of the lines that we can access, and how they move in and through our body, we gain the opportunity to understand a situation in the terms of the situation that we are part of. We need to be able to assess and access how we are involved, and to do so in an ongoing way from within, as Shotter requests (Shotter, 2016, p. 82). Ingold proposes that doing, observing and describing can be joined together in the acts of "following the materials, to copy the gestures, and to draw the lines" (Ingold, 2010, p. 304). Only then, from this point, where we are moved by the materials through our own linear engagement, can we move toward a different way of making sense with objects, materials, and landscapes. Through the perspective of material engagement and extended mind we can understand city landscapes through the lines of drawn gestures, and we can *make sense with* a building by translating its lines appearing as cracked cement, structural beams, and designed edges.

Material Engagement Theory wants to go against the view that a person has a closed off mind inside a skull, chooses to pick up a tool (disconnected from their own body), creates a line or mark somewhere out in space, and then the residue of that trace is something to be interpreted. This piece-meal approach to disjoined parts in time is for some easier to understand, but similar to Barad's notion of intra-action[6] (Barad, 2007, p. 33), we are making what Malafouris calls, "category mistakes" by thinking we can isolate minds, body, and things (Malafouris, 2013, p. 208). This is where dance, providing a trace in space, can be used functionally to offer a comparison with rock and cave art, to show how mind, body, and material unite. Dancing as line making uses the body as material, where cognition and body unite in motion and may leave subtle traces on surfaces or imagined ambiguous traces in space. Having put a tool in someone's hand, they can use the same gestures and movements that then create lines that only differ from movements with empty hands in that the line making with the tool has a more permanent or more visible result. Lines are seen here for their ability to intertwine cognition and material culture. Malafouris proposes they should not be seen as boundaries that separate (Malafouris, 2013, p. 201), but instead as the practices here have shown: as having a nature that slides between modes of expression and perception, creating a type of materiality of experience.

6 Barad defines intra-actions as agencies that emerge through relational mutual entanglements. "It is through specific agential intra-actions that the boundaries and properties of the components of phenomena become determinate and that particular concepts (that is, particular material articulations of the world) become meaningful" (Barad, 2007, p. 139).

Ethics statement

The studies involving human participants were reviewed and approved by the Ethical Committee Research of the Faculty of Humanities, VU Amsterdam under case ETCO0023.The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

MO contributed to conception and design of the study and wrote the first draft of the manuscript. AC contributed supporting points to the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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