

Gesture and Imagination:

On the Constitution and Uses of Phantasms

Ricardo Nemirovsky (nemirovsky@sciences.sdsu.edu)

Molly L. Kelton (mollylou.kelton@gmail.com)

Bohdan Rhodehamel (bohdanr561@yahoo.com)

Center for Research in Mathematics and Science Education, San Diego, California

San Diego State University

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Correspondence concerning this article should be addressed to Molly Kelton, Center for Research in Mathematics and Science Education, 6475 Alvarado Road, Suite 206, San Diego, CA 92120-5013. E-mail: mollylou.kelton@gmail.com.

### Abstract

This study examines the role of gesture in collective imagining, the embodied process of bringing objects and events into quasi-presence during social interaction. Drawing on the phenomenological tradition, we argue in favor of an alternative to the gestures-as-simulated-action account proposed by Hostetter and Alibali (2008). Specifically, we suggest to view gestures as key constituents of *phantasms*, quasi-present objects that are produced through multi-modal utterances. This perspective highlights the ways in which gestures mark profound transformations of participants' experiential histories -- transformations that open up, for the speakers, new insights into the matters they strive to imagine. The study of these insights led us to emphasize not the simulative, but the creative roles of gestures. Our account of gesture in collective imagining is illustrated by a microanalysis of an episode from an interview with a mother-child dyad following their interaction with a mathematics exhibit in a science center.

**Keywords:** gesture, simulation theory, imagination, embodiment, mathematics education

**Biographical note:** Ricardo Nemirovsky is the director of the Center for Research in Mathematics and Science Education in San Diego, CA. He is also a professor of mathematics at San Diego State University. He holds an EdD from Harvard University. Molly L. Kelton is a PhD student in mathematics education. She holds an MS in mathematics from the University of Utah. Bohdan Rhodehamel is a project research specialist. He holds an MA in mathematics education from San Diego State University. All three authors share an interest in the role of embodiment and multimodal interaction in mathematics thinking and learning.

## Introduction

This paper examines the participation of gesturing in imagining. In a general sense we conceive of imagining as the experience of quasi-presence: bringing to presence something which is absent in the current surroundings of the speakers (Casey, 1979; Sartre, 2004). While the imaginers are aware that the events, bodies, objects or signs they imagine are not "actually" around them, they act as if, in some incomplete ways, they are. It is a common observation that as we imagine collectively or with others, gesturing is pervasive. Given the plausible conjecture that we do not gesture as much when we are by ourselves because we inhibit their enactment (Hostetter & Alibali, 2008), we might infer that in solitude gestures are part of imagining as well, although covertly. The common participation of gestures in imagination has led to the design of many gesture studies based on contexts in which actors are asked to imagine jointly. Several of McNeill's classic studies are based on the examination of gestures by storytellers narrating to someone else a cartoon or movie they had just watched (Kita & Özyürek, 2003; McNeill, 1992). Kita (2003) studied people giving directions to unseen destinations. LeBaron and Streeck (2000) analyzed a conversation between two Japanese speakers telling each other about car accidents they had been involved in. In many circumstances imaginers incorporate props, tools, signs, models, and other "material anchors" (Hutchins, 2005) to their gesturing; two examples of teachers using material anchors to physically highlight aspects of imaginary uses and entities are included in LeBaron and Streeck (2000).

Many of the gestures that participate in imagining are identified as 'iconic' or 'representational,' which, in the words of Streeck (2008, p. 285), are the ones that "make

pictures": iconic gestures seem to depict something. In semiotics the word 'icon' is often defined as a sign that displays a likeness or similarity to its referent. Streeck (2008), espousing Goodman's critique of this definition, proposes that icons are not mirror images but interpretations: "the [iconic] gesture *is not* like its referent, but rather shows *what the referent is like*" (p. 286. Italics in the original). Kendon (2004) characterizes three types of representational gestures: modelling, pantomime, and depiction. Modelling is the gesture in which a body part is used as a model of an object; for instance, people in the Boston area often display Cape Cod with an arm bent at the elbow and the wrist, using the other hand to point out locations in Cape Cod. Pantomime are gestures that enact aspects of a pattern of action they refer to, such as when someone asks for a pen by enacting a writing hand. Depiction are gestures that appear to draw, sketch, or sculpt an object; they are "recognized as 'creating' an object in the air" (Kendon, 2004, p. 160).

Streeck (2008) views gestural depictions as "evocations by minimal means" (p. 297) of multiple practices that are familiar to the speakers; these practices include, among others, drawing, making things, transporting, and handling:

. . . we show each other things by holding, molding, making, or handling them *into being*. Gestures render them into the common imagination. And, as we make things appear, we put them in relation to other things. Gestural depiction is grounded, then, not in visual resemblance, but in the everyday interpenetrations of actions and things. (Streeck, 2008, p. 298. Italics in the original.)

The following analysis provides an example of this account. Given that iconic gestures synthesize or bring together, in a minimalist manner, a broad range of heterogeneous practices, the issue that we take up is the nature of such synthesis: How do all these elements coalesce together in a stream of gestures to render things "into the common imagination"? This is the specific question that we strive to address in this paper.

Hostetter and Alibali (2008) have addressed this question, suggesting that representational gestures simulate actions. They draw on results from gesture studies, experimental psychology, and neuroscience to forward the gestures-as-simulated-action framework. We find much in common with this framework, especially its drawing on embodied cognition and the portrayal of gestures as motor activities whose inhibition demands additional effort. However, we believe that invoking a process of simulated action is unhelpful. We make the case for this objection on two grounds. First, simulation tends to elicit the notion that through gestures we perform an abbreviated or impoverished replica of actual actions; in contrast our ethnographic case studies have led us to conclude that gestures enact profound *transformations* and often *enrichments* of actual action. Second, because gesturing encompasses both motor *and perceptual* activity, and given that the notion of simulated perception is closely related to the one of mental image, a simulated action framework is ambiguous with respect to the tenets of mentalism: fundamental questions about the nature of mental images remain unaddressed by the simulation framework (e.g. Is the mind "watching" such simulation?). Hostetter and Alibali (2008) base much of their simulation framework on the evidence provided by numerous results from neuroscience and experimental psychology indicating a neuronal

and behavioral overlap between imagining the perception or the doing of something, and perceiving or doing it. However, we caution that this neural overlap does not necessarily translate into a simulation account. A neuronal and behavioral overlap neither excludes fundamental transformations between the imaginary event and the actual perceptuo-motor event, nor shows that the imaginary event is a mental version of the actual perceived by the mind's eye.

Inspired by the history of cubism in 20th century painting, we propose that the transformational and synthetic character of iconic gestures, as they render a complex assortment of practices and events in a unitary minimalist nutshell, can be described as "cubist composition." For the most part we do not imagine in order to simulate actions, but to inhabit a world that transcends our material surroundings, to bring the absent into quasi-presence, including that which is absent because it does not exist. Inhabiting or dwelling in worlds that merge and cross boundaries between real and fictional, reasonable and absurd, recollection and innovation, we experience unexpected possibilities that pervade everyday life. Before we direct our attention to the data of our case study, we will outline our perspective on embodiment and imagination by interpreting some of Husserl's ideas about the experience of imagining.

### **Imagining and the Constitution of Phantasms**

Husserl's philosophical trajectory can be understood as a lifelong struggle to grasp the nature of intentionality. Consciousness, by virtue of being consciousness of something, is intentional; in other words, every moment of consciousness intends something. Husserl proposed in many texts and using changing vocabularies, that intentionality constitutes an

ongoing correlation between two "poles" of consciousness: act-pole and object-pole. These two "poles" of consciousness coexist and echo each other. Perceiving an ashtray, to pick up one of Husserl's examples, entails an act pole that may engage my gaze and eye motion, my smelling in different directions, my urge to drop smoke ashes somewhere appropriate, my desire for cleanliness, or the motion of my hand to grab it. On the other hand, in the course of such a complex act, the object pole gets constituted as well: that small ashtray, full of extinguished cigarettes, familiar, in need of being emptied, and so on. After 1913, the year in which *Ideas I* appeared, Husserl used the word "noesis" to refer to the act pole, and "noema" to the object pole. Each aspect or trait of the noema (i.e. object-pole) correlates with certain components of the noesis (i.e. act-pole) and vice versa; for instance, perceiving that the ashtray needs to be emptied, which is a noematic feature, might correlate with my noesis element of reaching it to drop its contents inside a box under the desk. Note that the object-pole is not equivalent to the ashtray as a physical object standing on the table. What we usually intend as "physical object" or the "object in-itself" is a thing that we constitute as a detached observer of properties (e.g. that white object with circular shape made out of ceramics); an object as-such is for the most part a noema that we experience in this kind of detached observation, which is one among many other possible intentionalities we may experience, such as the one embedding our recognition that the ashtray needs to be cleaned.

Correlations between acts and objects can be of many types, such as perceptions, recollections, imaginations, and so on. The ashtray that I remember or the one I'd like to have are distinct noemas correlated with differing noetic components, e.g. the ashtray I'd

like to have might correlate with the act of drawing it on paper. Perceptions are primary because they constitute points of reference to study all other act-object correlations.

Husserl emphasized that in perception the object is only partially given: visible from this or that side, kept in the closet or thrown in the garbage, within reach or out of reach, and so forth. A perceptual object is never known absolutely, it remains forever open to hitherto unrealized possibilities and features.<sup>1</sup> At the same time, and this is a result about which Husserl never ceased to wonder, we normally examine something from different sides and conditions (e.g. low and high intensity of light) with a strong experiential sense that in spite of all the differences that we perceive, they all describe "the same thing." The thing that we perceive is, as Husserl was prone to say, "an X," a variable-like unknown that remains the same X, regardless of its countless particular "values." One aspect of the constitution of the "same X" is body motion or kinesthesia: the object seen from here is the same as the one seen from there, in part, because if I moved there I would see it again as I have seen it over there (Gibson, 1979; Noë, 2004). In other words, perceptual differences can be neutralized or cancelled by kinesthesia.

How can we conceptualize the act-object correlations in the case of imagination?

The question is extremely complex, if for no other reason, because we imagine all kinds of events or things in extraordinarily diverse circumstances. Consider one of the many examples Husserl considered:

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<sup>1</sup> Over periods of his life, Husserl worked to distinguish between external and internal perception. Internal perception, such as the perception of a pain in the chest, would be absolutely available, without "sides" and unending points of view. This would be the case because a pain in the chest is "immanent" to consciousness, it exists "in" consciousness, whereas a physical object is transcendent to consciousness.

If I am imagining a centaur I cannot help but imagine it as in a certain orientation and in a particular relation to my sense organs: it is "to the right" of me; it is "approaching" me or "moving away;" it is "revolving," turning toward or away from "me" -- from me, i.e. from my Body, from my eye, which is directed at it. (Husserl, 2005, p. 62)

What are the noesis and noema for this imaginative act of a centaur? We can infer that this noesis entails bodily activities, such as organ displacement and tuning (e.g. moving one's eyes, focusing them at different distances, even with the eyes closed); emotional expressions (e.g. facial expressions associated with being surprised or threatened); and being primed to different perceptual qualities (e.g. being primed or 'ready' to see white if the imagined centaur is white). With regard to the correlated noema, Husserl called it a "phantasm;" his centaur, like all other imaginary noemata, was a phantasm. If perception were to be taken as a point of reference, we might ask: How is, say, a horse that we see in front of us different from a centaur we imagine? Aside from the obvious anatomical differences between horses and centaurs, it is relatively straightforward to point out qualities that the phantasm lacks. For instance, as opposed to the visible horse, the centaur is not there "in person;" the centaur is experienced "as it were," the centaur is blurred and under-defined, and so forth. This line of analysis tends to highlight what a phantasm is not, which conveys the sense that ultimately a phantasm is a nothingness:

In relation to sensations, phantasms are like nullities. They are unreal. They are taken to be nothing by themselves (...). But a great difficulty arises here. The evidence of the *cogitatio* certainly teaches me that phantasies,

and, accordingly, phantasms as well, are actual lived experiences. (Husserl, 2005, p. 84)

In other words, phantasms, being actual lived experiences, must have positive qualities that distinguish them from nothingness. We attempt to address this issue --the positive qualities of phantasms-- by invoking the notion of *emptiness*. An empty cup defines an interior that has a certain shape, location, and potential to be filled up by certain substances and not others (e.g. hot water can melt the cup). The emptiness of a cup is not a self-standing object "in person;" it is a being derivative from the cup, but it has noematic features correlated with noetic ones. For example, my thirst and hand motion grabbing the cup to fill it up with water are correlated with noticing the emptiness of the cup. It is clear that emptiness is not to be identified with nothingness. The emptiness of a cup has particular features and potentials correlated with numerous traits of one's act-poles.

If we are to describe phantasms as emptiness, the example of the cup prompts us to ask: What plays the role of the cup in the case of a phantasm? Our response: the body. Living bodies are uniquely capable of generating the kind of emptiness that we experience as phantasms. For example, pantomime is a type of public performance that involves the constitution of phantasms as "actual lived experiences" for the mime and her audience. In Figure 1 a mime is inflating a balloon phantasm that she then holds as if it were full of helium. Note the multiple strands of bodily activity that participate in her miming: gaze, arm and hand motion, finger motion, breathing, posture, facial expression, and so forth.



*Figure 1: Balloon phantasm.*

Her active body creates an emptiness around her that seems suitable to envelop a balloon in different states. The absence of a perceptually present balloon does not preclude us from noticing an as-if presence indirectly manifested by her body, an experience that we commonly call imagining. Artistic pantomime is a special case because the mime works to constitute the phantasm with a degree of detail, explicitness, and emotional infusion that is not characteristic of the great majority of situations in which we imagine. Nevertheless, while overtly larger-than-life, some of the qualities of pantomime are inherent in the everyday constitution of phantasms: bodily creation of an emptiness infused with emotional values and woven in the flow of lived time. Often we imagine without overt bodily activity: a relatively quiet body may experience rich and complex phantasms while preventing its emptiness-generating activities from reaching the periphery of the nervous system.

## **Methodology**

### **Data Collection**

As part of a larger research project related to learning mathematics in informal environments, visitors to a science center were observed while they interacted with a

mathematics exhibit called *Drawing in Motion*. *Drawing in Motion* is an interactive exhibit that requires the collaboration of two visitors. Each visitor controls the motion of a handle along a 3-foot linear scale, corresponding to a graphical vertical or horizontal axis (see Figure 2).

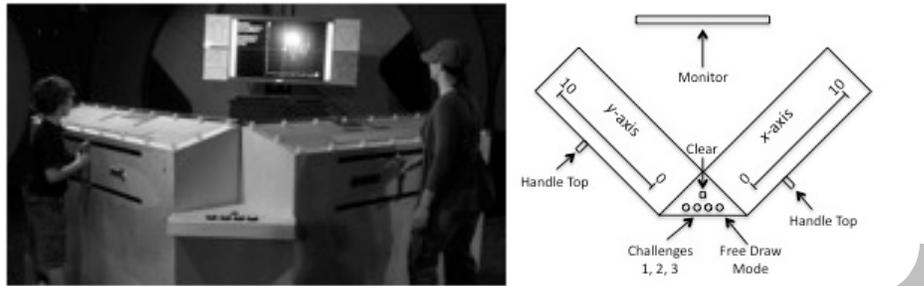


Figure 2: Image and diagram of *Drawing in Motion*.

A large LCD screen displays a cursor controlled by the two handles that determine their  $x$  and  $y$  coordinates. The two participants jointly draw on the screen by moving the handles. The exhibit includes three challenges as well as a free drawing mode. In all modes, the graphical display includes a vertical and horizontal line through the point represented by the cursor; these lines move as the cursor moves and aid in determining the  $x$ - and  $y$ -coordinates of the cursor (see Figure 3).

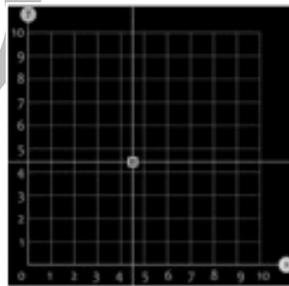


Figure 3: *Drawing in Motion* screen without drawing in free drawing mode.

*Drawing in Motion* was installed in a secluded area of a science center, to which only research staff and study participants had access. Data were collected from 17

different visitor groups, including both adult participants and children as young as 5 years old. While some visitor groups included only adults, other groups consisted of a child-parent dyad or sibling pairs accompanied by parents. Each visitor group was invited to engage with *Drawing in Motion* for as long as they liked, with exhibit experiences ranging from 4 to 23 minutes long. Following their exhibit experiences, visitor groups collectively participated in an informal stimulated-recall interview with one of the researchers. Interviews were video-recorded and ranged from 8 to 23 minutes long. All participants provided informed consent and assent where appropriate, and all data collection and analyses were done in compliance with IRB requirements.

The research team collected a video screen capture of everything displayed on the LCD-monitor of the exhibit throughout the visitors' entire engagement with the exhibit. The video screen capture was made available throughout the subsequent interview, and much of the interview consisted of stimulated recall using the video screen capture. Participants were asked to offer explanations for the appearances of their various graphical productions, as well as to reenact or describe the necessary handle movements to reproduce them or to create novel graphical images.

In the following microanalysis, a boy and his mother attempt to explain the necessary handle movements to produce a circle with *Drawing in Motion*. We selected this episode because the mathematics of drawing a circle with the exhibit are non-trivial, and because the episode was marked by the frequent production of highly complex co-speech gestures.

### **Analytical Framework**

The overarching methodology for this study derives from microethnography, a collection of techniques that focus on moment-to-moment bodily and situated activity. Microethnographic techniques may trace, inter alia: talk, gesture, facial expression, body posture, inscription, tool use, pace, and gaze (Erickson, 1996, 2004; Goodwin, 2003a; Hall & Stevens, 1995; Stivers & Sidnell, 2005; Streeck & Mehus, 2005). We appeal to Husserl's (1991/1893-1917) phenomenological framework for experiential time in order to further detail the kind of microethnographic approach taken in this study. According to Husserl, all temporally extended experiences – for example, the experience of hearing a particular melody – consist of an ongoing flux of *retentions*, *now phases*, and *protentions*. For instance, Husserl observes that the perception of a single note in a melody is constituted by (a) the presently sounding tone, (b) the retention of prior notes, and (c) the protention, or anticipation, of notes that are about to sound.

Our analytic method produces a rich phenomenological interpretation of participants' unfolding experiences through the careful construction of a detailed account of this ongoing flux of retentions and protentions as they unfold over the course of a small period of time. Thus, our account of the following episode is based on frame-by-frame scrutiny geared towards inferring moments in which there was a perceivable shift in the ongoing evolution of retentions and protentions. For example, the performance of a gesture or the shift of eye gaze were considered evidence of a noteworthy change in a participant's experiential present. At each of these significant moments, we used the rich store of available behavioral data to develop possible descriptions of the retentions and protentions constituting that particular experiential present.

We feel that it is important to explore in depth those aspects of multimodal utterances that resist a single interpretation. Communicative ambiguity is a common phenomenon that runs the risk of escaping traditional methodological approaches based on a priori coding schemes. Thus, at several points in this analysis we offer multiple conflicting interpretations of an utterance in the event that, even after extensive discussion by our research team members, several interpretations of the data remained viable.

### **Microanalysis: Silas and Janene Imagine Producing a Circle**

In this section we trace Silas' (age 8, accompanied by mother Janene) utterances to document instances of mathematical improvisation. In these episodes, Silas generated spontaneous, insightful, and innovative ways of performing the imaginative use of *Drawing in Motion*. Below is a verbal transcription of the episode that transpired just after the interviewer posed the question, "What do you have to do with speeds for a circle." The group had been discussing the speeds and relative speeds of manipulating the handles of *Drawing in Motion* and it appears that this question was interpreted as a prompt to explain how to produce a circle with the device. Because this episode is fairly complex, the utterances framed by rectangular borders are the ones that we discuss in detail. Numbers in parentheses indicate pause duration in seconds. Bolded speech indicates simultaneously produced speech. Italicized parenthetical remarks include descriptive commentary of prosodic features and non-verbal participation:

S: Uh kinda like (1.2) wa the right and uh (0.7)  
like the right left one that goes left right left

INT: mm hmm  
 (1.1)

S: and the one that goes up n' down, you have to kinda like (0.2) go like this, go **like um**

J: **((laughing))**  
 (0.5)

S: right left well the one that goes side to side, go, kinda goes a little (0.6) and (0.4) it goes like (0.6) it's hard to understand but like the (0.6) up and down one (0.2) would kinda go slowly so then it kinda makes a little **diagonal**

J: **yeah**  
 (0.4)

S: **and**

INT: **mm hmm**  
 (0.3)

S: and you and the um

---

J: and then once it curves then the up and down would have to go faster

S: no the  
 up and down might have to go kinda right, like (0.4) left

---

so it kinda goes like this and I would go  
 (0.6)

J: yeah **and then you have** to go right

S: **so**  
 (0.4)

INT: alright **okay, sounds like you** guys

J: **it'd be a lotta work**

INT: got a good idea of **how**

S: **yeah**

INT: how to **do that**

---

S: **kinda go** like diagonal mostly

**Annotated Episode**

What follow are annotated commentaries on the utterances framed by rectangular borders in the transcription above. Underlined text in the verbal transcript segments is sometimes accompanied by the video frame corresponding to that verbal utterance. The

accompanying video images are also graphically annotated. Solid arrows correspond to body movements, and dotted arrows indicate inferred eye gaze direction.

**Utterance 1: The axis|handle.**

The first utterance we analyze is the one in which Silas says, “like the right left one that goes left right left.”

- (1) S: like the right (Figure 4) ((*Silas has his right hand and forearm aligned nearly vertically. As he says, “right,” he moves his palm to the right.*))



*Figure 4.* Silas says, “like the right.”

*Drawing in Motion*’s graphical display always shows vertical and horizontal lines that intersect the cursor location and move in response to handle movements and in accordance with the movement of the cursor (see Figure 3). We suggest that, in this utterance, Silas’ right arm gesturally enacts in front of his body a blend of the vertical line and the corresponding  $x$ -axis handle. The axis|handle is given material shape that publicly disambiguates the verbal utterance by making it clear that Silas is talking about horizontal movement rather than a vertical movement that would also be achieved via a right-left handle displacement along the  $y$ -axis panel. In other words, he is not imagining movement along the  $y$ -axis panel because it would have corresponded to his hand being horizontal and moving up/down.

In the theoretical framework articulated by this study, we might say that Silas has constructed an axis|handle phantasm. The noetic dimensions of the phantasm include Silas' speech, his eye gaze directed towards the emergent imagined object, and, crucially, the gesture he enacts with his right hand and forearm. Together, these strands of the phantasm's noesis correlate with the phantasmic noema: a quasi-public, imagined fusion of an axis and a handle.

(2) S: left ((*Silas moves his hand to the left.*))

As Silas says, "left," he moves his right hand to his left in front of his body. He acts on the axis|handle phantasm within his gesture space. Line 2 reflects what is, perhaps, the most immediate and common transformation of the imaginary: while the use of the actual *Drawing in Motion* imposed relations of distance and symmetry set by the material design of the exhibit, the imaginary use of *Drawing in Motion* is established with respect to relations of distance and symmetry organized from the body acting in its gesture space. Silas does not need to walk towards his left side, or to push the handle with his left arm, as it might be required with the actual device. His phantasmic *x*-axis panel can all fit within the space accessible to his moving arm.

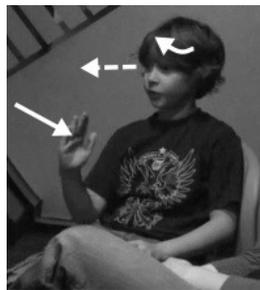
Silas' gestures generating the phantasmal axes|handle is only poorly described as a simulated action. The motion of his extended right hand does not simulate moving the handle, which is the action he had performed with *Drawing in Motion*, rather it juxtaposes the movement of the handle with the visual appearance of the vertical axis on the screen moving sideways. This kind of juxtaposition illustrates the phenomenon that we call "cubist composition". Silas' gesture juxtaposed in a single configuration of his arm entities

that in actuality were distant from each other, one in his peripersonal space (i.e. the handle) and another in his extrapersonal space (i.e. the vertical axis).

- (3) S: one that *((Silas moves his hand more slowly to the right. He appears to turn his gaze to the left, then forward in front of him.))*

The "one" is the horizontal axis|handle. Silas turns his gaze from the interviewer to a direction that is occupied by a black wall at around 10 feet in front of him, suggesting his disposition to move the axis|handle *as* he imagines the corresponding circle graph being generated. This head turn not only releases his gaze from any attention-demanding object in order to visualize an about-to-be produced imaginary circle, it also re-creates the bodily orientation he had held while seeing the graph emerging on the display because when he moved the handle on the actual device he was mostly looking at the graphical display in front of him. Here we see a sense in which Silas' hand gesture is constituted by its role within the larger unity of Silas' bodily orientation: the upcoming phantasmic image of the circle is right in front of him and gets positioned at a distance that beyond the gesture space. The gaze into the "blank" space in front of him and the axis|handle gesture mutually elaborate one another to bring forth the use of an imaginary device.

- (4) S: goes left (Figure 5) *((Silas moves his right hand to the left and returns his gaze directly in front of him.))*



*Figure 5.* Silas says, “go left,” and moves his hand left.

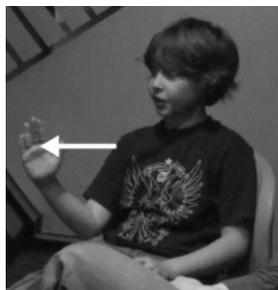
One interpretation of line [4] is that it is the first of three utterances in which Silas imaginarily produces the circle: “left right left.” The first verbalization of "left" could correspond to the horizontal handle movements needed to trace the circle either clockwise beginning from the bottom or counterclockwise beginning from the top (Figure 6).



*Figure 6.* Quadrants of the circle that Silas may be tracing in line [4].

Alternatively, it may be that Silas uses the words “left right left” and the co-speech gestures to highlight the  $x$ -axis handle and distinguish it from the other handle. This seems to us less likely because: a) it would be redundant with respect to Lines 1 and 2; b) it would refer to axis by three motions instead of two, as he had done previously (Lines 1 and 2) and will do later (Line 12); and c) it does not account for the gaze shift in Line 3, which seems to mark a transition from telling the interviewer that he is referring to the  $x$ -axis to envisioning the circle.

(5) S: right (Figure 7) ((*Silas moves his right hand to the right.*))



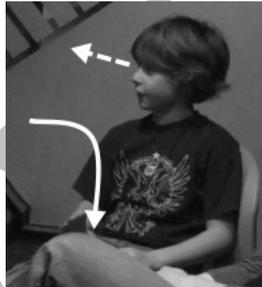
*Figure 7. Silas says, “right.”*

Silas moves the axis|handle from left to right, perhaps tracing either the upper half circle clockwise or the lower bottom circle counterclockwise (Figure 8).



*Figure 8. Semicircles that Silas may be tracing in [5].*

- (6) S: left (Figure 9) ((Silas moves his right hand to the left then rests it in his lap. He turns his gaze towards the interviewer and the monitor.))



*Figure 9. Silas says, “left,” moves his right hand left, then rests it.*

In [6] Silas moves the axis|handle from right to left, perhaps tracing the lower right quarter clockwise or the upper right quarter counterclockwise. If Line 6 indicates his tracing of the last portion of the circle, there are, overall, two possible sequences for lines 4-6 shown in Figure 10:

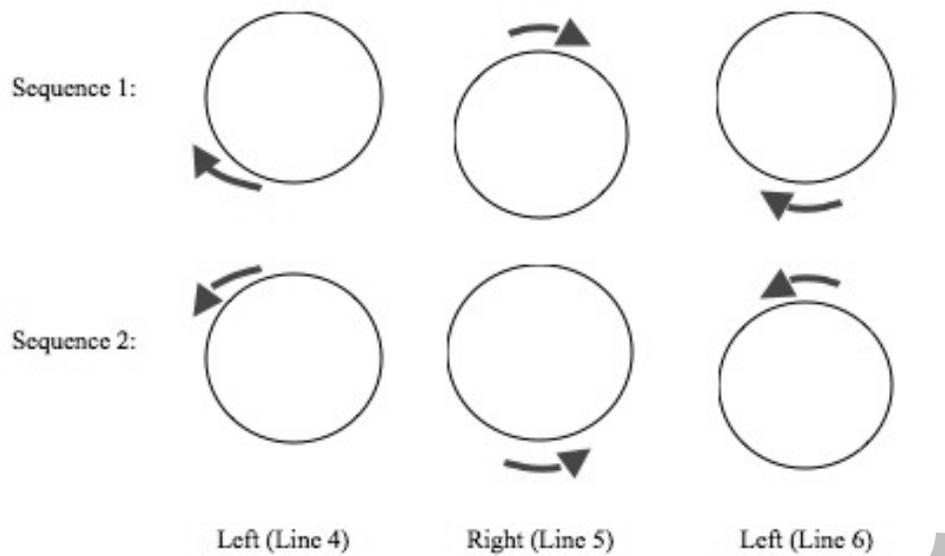


Figure 10. Possible sequences for the circle Silas may be tracing in [4], [5], and [6].

So far, the only evidence that we see favoring the second sequence is his hand motion in Figure 6 which appears to finish the tracing of the circle by extending an anticlockwise motion on the left side. In addition, shortly later (Lines 16, 17 and 18), Silas will enact the tracing of the imaginary circle by moving the x-axis and clearly using the second sequence.

He shifts his gaze toward the interviewer in closing his talking turn. We see this Utterance 1 as one through which Silas imaginarily places *Drawing in Motion* in front of him, with the handle in his peripersonal space, while envisioning the graph that would gradually emerge on the more distant screen. This embodied imaginative enactment relies on, among many other streams of verbal and bodily activity, the gestural constitution of a phantasmic axis|handle. Moreover, this emergent phantasm is produced by noetic components that profoundly transform – rather than merely simulate – Silas’ history of experience with *Drawing in Motion*.

**Utterance 2: Janene's tracing of a circle.**

In this section, we micro-analyze the following transcript excerpt which began right after Silas turned to Janene indicating that it was time to address the motion of the vertical handle that had been operated by her:

J: and then once it curves then the up and down would have to go faster

S: no the

- (7) J: and then once (Figure 11) ((*Janene lifts her right hand upwards and rightwards, palm facing medially.*))



*Figure 11.* Janene says, “and then once.”

Janene attempts to help Silas complete his explanation of how to draw the circle. She raises her right hand up and to the right, enacting a phantasmic circle while tracing the right side of the circle with her right palm (Figure 12). Here, again, we see the central role played by gesture in the collective constitution of phantasms.



*Figure 12. Janene's hand on the imaginary circle.*

- (8) J: it curves then the up and down (Figure 13) (*Janene raises her right hand higher, flexing her right wrist so the palm curves along a circular path. Silas looks at Janene and raises his right hand in a shape similar to that of Janene's.*)



*Figure 13. Janene says, "it curves then the up and down."*

In this line, Silas gesturally mirrors the right-hand gesture produced by Janene. We suggest that, in this moment, Janene's gesture is functioning to render the phantasm of the circle that she had begun to produce. In other words, the phantasmic circle corporeally manifested through Janene's gesture, is echoed by Silas allowing him to co-produce the circle phantasm. Notice that Silas is re-enacting Janene's gesture in reference to *his own* peripersonal space. We see that gestures can help bring imagines noema into quasi-presence both for speaker and listeners in a way that allows listeners also to act on shared imaginary objects.

Note that "the up and down" refers to the y-axis handle. Janene is preparing herself to articulate a relationship between the part of the circle shown in Figure 12 and the corresponding motion of the handle.

- (9) J: would have to (Figure 14) (*Janene continues to raise her right hand a little higher. Silas turns his gaze away from Janene to the space in front of him. He*

*maintains the shape of his right hand and lifts his left hand up and to the left, palm facing medially.))*



*Figure 14. Janene says, “would have to.”*

In this line, Janene continues the trajectory of her right hand while Silas shifts his eye gaze to the space in front of his body, lifting his left hand up to face the right. We suggest that eye gaze is another constitutive element in the bodily enactment of the circle phantasm. Bringing his gaze in front of him, Silas attempts to envision the imagined circle in his peripersonal space while his closing of the left hand corresponds to grasping a handle, probably the *y*-axis one because that is the one that Janene was referring to.

(10) J: go faster ((*Janene continues to lift her right hand subtly. Silas relaxes his hands to his lap.*))

Janene completes her idea: the *y*-axis handle would have to move faster as it traces the more vertical section of the circle. It is not explicit whether it would be faster with respect to its own previous motion or to the simultaneous motion of the *x*-axis handle, but since she is describing "her" axis, the former is more likely. In this cubist composition Janine juxtaposes the tracing of of the circle with the motion of the *y*-axis handle, the former gesturally and the latter verbally.

- (11) S: no the (Figure 15) ((*Silas lifts his left hand up and extends his left index finger. He begins to lift his right hand as well, turning his gaze in front of him. Janene's right hand continues to slowly trace the circle.*))



Figure 15. Silas says, “no the.”

While Janene has been explaining that the vertical axis would have to go faster as the circle curves up on the region traced by her right hand (lines [7] through [10]), Silas, on the other hand, had been focusing on the direction of motion for each axis|handle as they trace the circle; possibly his "no" reflects that Janene's remark does not address these directionality issues.

**Utterance 3: The handle and the curve.**

In this section, we micro-analyze the following transcript excerpt:

S: so it kinda goes like this and I would go

(0.6)

J: yeah **and then you have** to go right

S: **so**

- (12) S: so (Figure 16) ((*Silas uncurls his right fingers and lifts his left hand from his lap towards his right so that the palms face one another.*))



*Figure 16. Silas says, “so.”*

In this moment there is a momentary action with his left hand that he drops in the next frame. In this frame, Silas changes his imaginary enactment. Instead of imaginatively grasping the handle, now his extended right hand follows the shape of the circle, starting the circle from the bottom right quadrant. This moment marks a shift from gesturally constituting the phantasm of handle manipulation to the gestural production of the circle itself.

The morphology of Silas’ right-hand gesture echoes the hand gesture initially produced by Janene in line [7] and again by Silas in lines [8] and [9]. This exemplifies how phantasms can be collectively produced, shared, acted upon, and reproduced.

- (13) S: it kinda (Figure 17) *((Silas lowers his left hand back down to his lap. He raises his right hand up, fingers pointing upwards, palm facing medially.))*



*Figure 17. Silas says, “it kinda.”*

Silas keeps tracing – or imaginatively touching - the phantasmic circle with his right hand. The gestural morphology in his right hand is gradually taking on a more central role within his overall improvisatory participation.

- (14) S: goes (Figure 18) *((Silas curls his right fingers in a little. He raises his left hand towards his right elbow.))*



Figure 18. Silas says, “goes.”

As he keeps sliding his right hand along the circle, Silas prepares to put his left hand in action.

- (15) S: like this (Figure 19) *((Silas moves his left hand to the right of his right hand, crossing his left arm over his right and curling his left fingers inwards. He positions his hands so that the backs of the hands are touching or nearly so.))*



Figure 19. Silas says, “like this.”

As he continues to trace the circle with his right hand, he grasps a handle with his left hand to go from right to left. Silas simultaneously brings forth the phantasms of both

the circle and the handle manipulation, not as isolated, haphazardly coincident elements but as richly integrated perceptual and motoric aspects of his imaginative experience. Imagined motor actions with the  $x$ -axis handle are intricately blended with corresponding visible (and, perhaps, tangible) changes in the location along the circle.

This creative juxtaposition – what we call here a cubist composition – also bears on recent developments on the relationship between gestural viewpoint and mathematical understanding. Specifically, Gerofsky (2010) analyzed data collected from interviews with secondary students who were asked to describe through gesture the graphs of a variety of polynomial functions. The author found that students who used gestures with a character viewpoint tended to perform more highly – according to teacher assessments – in their mathematics class than did students using observer-viewpoint gestures. In figure 19, Silas bimanually blends character (e.g. grasping the handle) and observer (e.g. tracing the associated visible trajectory of the graph) into a single solution to a mathematical problem requiring intricate covariational reasoning.

- (16) S: and I would go (Figure 20) ((*Silas moves both hands to the left, maintaining the hand shapes and mutual orientations.*))



Figure 20. Silas says, “and I would go.”

Now the two hands are in action. He says "I would go", and since "his" handle had been the horizontal one, he is moving it from right to left as it pushes his right hand -- the one sliding on the circle -- to the left.

(17) (0.6) ((*Silas curves both hands up and left. (Figure 21) He curves his right palm down.*))



*Figure 21. Silas curves his hands up and to the left.*

As Silas moves the left handle to the left, his right hand curves on the circle.

(18) J: yeah **and then you have**

S: **so** (Figure 22) ((*Silas continues to trace a circle with his right hand, always curving the palm to face roughly towards the circle center. He moves his left hand down and to the left, keeping the fingers curled in and turning the palm upwards.*))



*Figure 22. Silas traces the circle with right hand and enacts handle movement with left hand.*

As Silas moves the left handle to the left, his right hand curves on the circle. Note that in [15] he is also solving a "logistic" problem: he needs to displace down the left hand to let the right hand continue tracing the circle. While in *Drawing in Motion* the handle moved only horizontally, holding the left hand at constant height would "get in the way" of the right one. What we are calling here "logistical problem" arose because Silas was gesturing a cubist composition. In the original use of *Drawing in Motion* the circle drawn on the computer screen does not impede of the free motion of the handle, but in his gestural juxtaposition of both it did.

- (19) J: to go right (Figure 23) (*Silas continues the circular trajectory with his right hand, cupping his palm and orienting it towards the center. He lowers his left hand down while keeping fingers in a handle-grabbing position and turns his gaze towards Janene.*)



*Figure 23.* Silas continues to trace the circle. Janene says, "to go right."

As Silas moves the handle to the right, his right hand curves on the bottom side of the circle. Through this improvisation, Silas develops a new way to enact the imaginary use of *Drawing in Motion*. Instead of the circle being generated at a distant screen, he placed the circle in his peripersonal space making it "touchable" with his right hand.

**Utterance 4: Diagonal, mostly.**

In this section, we analyze the transcript segment in which Silas says, “kinda go like diagonal mostly.” The use of *Drawing in Motion* had made prominent the difference between a diagonal line and either a horizontal or vertical line, the latter requiring the motion of only one handle, as opposed to a diagonal line requiring the motion of both handles at the same time. In this utterance Silas makes a general statement about the circle: mostly it "goes" diagonal, as opposed to going vertical or horizontal.

(20) S: kinda go like (Figure 24) ((*Silas lifts his right hand then moves it to the left, extending his wrist so that the palm faces left and upwards.*))



Figure 24. Silas says, “kinda go like.”

Silas is beginning to assess whether the circle is for the most part diagonal. "Kinda go like" seems to vocally stretch the time he uses to observe/touch an imaginary circle. He is probably imagining a circle along which he positions his right hand touching it at different points, as if his hand were tangent to the circle. He is not actually "drawing" the circle, but assessing the overall presence of diagonal orientations at different points on it. There are least two senses in which his gesture in Figure 24 does not correspond to a simulation: 1) There is no obvious perceptuo-motor activity that he appears to replicate from his past actual use of *Drawing in Motion*, that, rather than touching the contours of a circle at different points, had involved moving the handles, pressing buttons, looking at the

video screen or the number scale on the panel, and so forth; and 2) his gestural activity is not subsidiary to an original one that he is as-if performing, but is itself an original act on an imagined object, an act from which he is about to conclude that the circle is mostly diagonal.

- (21) S: diagonal (Figure 25) ((*Silas raises his right hand, extending then flexing his wrist. As he finishes saying “diagonal” he moves his right hand upwards and to the right, extending his wrist so the palm faces upwards.*))



Figure 25. Silas says, “diagonal.” He extends, then flexes wrist, then moves hand up to the right.

Note that he avoids the vertical/horizontal (i.e. non-diagonal) orientations.

Silas's reaches his judgment of diagonality in the course of his gesturally-based perceptuo-motor activity. We further clarify why this perceptuo-motor activity is original or primary, rather than simulatory or derived: there is no reason to assume that actually producing a circle on the video display with *Drawing in Motion* would allow Silas more accurately or completely to assess the diagonality of the circle. On the contrary, generating a "good" circle with *Drawing in Motion* is actually difficult, beyond the capabilities that Silas and Janine had developed at this time, and would entail practicing a multitude of details only indirectly related to diagonality. Furthermore, even a circle drawn on paper

made accessible to him would not necessarily add anything to his perceptuomotor judgment. Instead, Silas' gestures on and around the imaginary circle focused exclusively on the property of interest (i.e. diagonality) serving as a ground for his ensuing conviction expressed in Line 21, which did not open a need, for him, of further testing of diagonality. This exemplifies our thesis that gestural enactments can be an enrichment of actual experience rather than an impoverished replica of the past because gestures constrain what is possible or specify what is necessary: in this case, the predominance of diagonality for a circle.

- (22) S: mostly (Figure 26) ((*Silas continues to trace a circle in the air with his right hand, moving it right and down. He brings his wrist to near maximal extension so that part of the curvature is captured by the angle of his wrist to his forearm. As he finishes saying “mostly” he returns his hand to his lap.*))

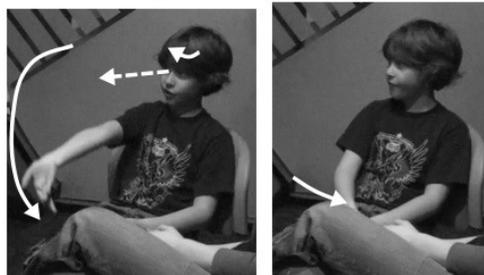


Figure 26. Silas says, “mostly. He continues to trace the circle, then rests his hand.

We propose that the verbal utterance, "mostly," indicates that it is diagonal for the most part, but not always. Through this improvisation, Silas expresses an innovative insight: the use of *Drawing in Motion* had made prominent the difference between a diagonal and either a horizontal or vertical orientation, the latter two requiring the motion of only one handle. Silas develops a perceptuo-motor improvisation that provides

evidence, to him, that a circle is almost always of a diagonal orientation. The judgment that Silas completed in Line 22 -- the circle being mostly diagonal -- corresponds to what Husserl called "categorical intuition." (Husserl, 1970) It is *intuitive* because Silas perceived it directly in visuo-tactile ways, as opposed to being told about it or inferring indirectly that that must be the case. It is *categorical* because it concluded his efforts to locate the circle on the diagonal "class" of curves; in other words, it solved the question of categorizing the circle on a diagonal/vertical-horizontal taxonomy. The taxonomy itself is richly grounded in his recent experience with *Drawing in Motion*, which had made so prominent the difference between moving the handles individually or in concert. But the attribution of diagonality to a circle is a new, improvisatory insight whose originality leads us to expect him to know, in advance of further interaction with *Drawing in Motion*, that to draw a circle he and Janene *would have to* move mostly in simultaneity.

### Discussion

The core theses of this paper are: 1) gestures are key components for the constitution of phantasms and therefore for the creation of the imaginary -- a co-creation shared by the participant speakers and animated by the emptiness generated through the ongoing activity of one or more living bodies; and 2) phantasms are constituted in the course of cubist compositions.

In Lines 2 and 3 Silas enacts aspects of *Drawing in Motion* by moving his right hand with a configuration that appears to blend the motion of one of the handles and a vertical axis, both moving along the right/left direction at a height approximately intermediate between the location of the handle below and the view of the computer screen

on the upper side. While the handle is a piece that he had grasped and pushed, the vertical axis slid on its own along the visual display. The axis|handle gesture fuses motoric (i.e. moving the handle) and perceptual (i.e. watching the corresponding axis line move) into a single gestural morphology, which arose spontaneously and had not been used in Silas' previous responses to interview questions. This combination of perceptuo-motor aspects expressed a subset of the bodily activities engaged in the use of *Drawing in Motion*, excluding other aspects such as walking, looking at the simultaneous actions of Janene, or carefully regulating the speed of the handle's motion. Furthermore, his gesture in Lines 1 and 2 transformed this subset of bodily activities, as can be seen from the fact that he had never moved his right hand vertically in this way during his use of *Drawing in Motion*. We propose that this gesture implicated the constitution by means of a cubist composition, for him, Janene, and the interviewer, of a phantasmic version of *Drawing in Motion* deployed in front of him. While only some perceptuo-motor aspects of the use of the actual *Drawing in Motion* were enacted, Silas bodily created an emptiness in front of him that brought the exhibit to quasi-presence. If our main interpretation of Lines 4, 5, and 6 is correct, once he had "placed" the instrument (Lines 2 and 3) Silas transitioned (Line 4: "goes," turning his gaze directly in front of him) to using it to draw a circle (Lines 5 and 6: "left, right, left"). We propose that turning his gaze expressed his need to remove visual distractions (e.g. looking at the interviewer, the computer display, etc.) in order to envision the genesis of a circle-phantasm responsive to the motion of his right hand. The transition in Line 4 suggests that in the constitution of a phantasm there may be an initial phase of setting it up (i.e. creating the "stage," Lines 2 and 3) and a subsequent phase of

use/performance (i.e. drawing a circle, Lines 4, 5, and 6), the end of which closes the conversational turn (Line 6, Silas turns his head towards the interviewer).

Utterance 2 began right after Silas turned to Janene indicating that it was time to address the motion of the vertical handle that had been operated by her. Janene immediately introduced issues of speed, addressing the original interviewer's question by spontaneously enacting a new gesture lifting her right hand upwards and rightwards. Janene's words in Line 8 made explicit that her gesture corresponded to tracing an up/down arc of a circle. Her hand was, as it were, touching the vertical curvature of a circle. At the same time, Silas replicated her gesture relative to his own body. Just after initiating this echoing of Janene's gesture, in Line 9 Silas turned his gaze right in front of him possibly in readiness to visualize the genesis of the circle, now with the right hand moving to touch the circle, rather than displacing an axis|handle. However, as soon as Janene said "faster" (Line 10) Silas stopped, relaxed his hands and then began to question her account (Line 11: "no"). We hypothesize that his reaction was prompted by a sense in which "faster" was unrelated to the issue that Silas was focused on, namely, directionality of motion. A phantasmic circle had been co-created by Janene and Silas, but they appeared to disagree on what to do with it.

In Utterance 3 Silas started again (Line 12: "so") in a different fashion. Now he recovers the gesture that Janene had introduced (Lines 13 and 14), adding the left hand in the role of grabbing the y-axis handle (Line 15). Silas performed the drawing of the circle (Lines 16, 17, 18, and 20) enacting the new setup. Janene agreed with this performance in Line 18 ("yeah") and voiced Silas' motion of the handle going "to the right" to trace an arc

that goes down (Line 19). Silas' incorporation of Janene's gesture from Line 8 and her simultaneous talk accompanying his performance are both expressions of the intersubjective nature of phantasms.

Connecting back to our thesis that activating phantasms entails a transformation of actual use rather than a replication, we stress that the complex bimanual gesture being produced by Silas in Lines 16-19 is in no way a straightforward kinesthetic echo of his previous engagement with *Drawing in Motion*. Instead, his bimanual gesture brings together elements that were spatially distal during the actual use of the exhibit (handle manipulations and corresponding graphical image), his right hand was not reproducing its activity moving the actual handle, his gaze focused on drawing events occurring in his own peripersonal space, rather than in the distant monitor, and his bodily motion grappled with logistic issues posed by the two hands crossing each other instead of regulating the speed of the handle motion. We call "cubist composition" this kind of bodily performance that juxtaposes, in a phantasm, aspects that were temporally and spatially disjoint in the original activity. A cubist composition may shorten the duration of a long event into a moment, trace large distances with a tiny motion, make successive occurrences simultaneous, or break apart simultaneous ones. In the analyzed utterances, Silas' flow of cubist compositions were prompted by: (a) changing the aspect of circle drawing focalizing his perceptuomotor activity (e.g. shifting focus between the motion of the  $y$ -axis handle and the  $x$ -axis handle), (b) facing what we have called a "logistic" problem, in which a part of the body interferes with the motion of another (e.g. moving his left hand down to let the right-drawing hand follow the shape of the circle in line [15]), (c) changing

the arrangement of the body activities (e.g. splitting the fused action of the right hand in the axis|handle gesture, into handle-grabbing for the left hand and visuo-tactile circle tracing for the right hand in line [12]), and (d) incorporating a distinct perceptuomotor aspect (e.g. turning his gaze in front of him to visualize the emerging circle on the display in line [4]), or leaving it out (e.g. Silas leaving out the motion of the handle by resting his left hand in line [17]).

This spontaneous flow of cubist compositions addresses one of our objections to a "simulated action" framework. We feel that the notion of simulated action evokes too much of the idea that gesture is some kind of impoverished replica of a prior experience. Our proposal that gestures are key participants in the constitution of phantasms suggests, instead, that gestures enact profound *transformations* and often *enrichments* of actual actions, a process we describe as cubist compositions. Our second objection, is that simulation theory is ambivalent towards mentalism and hence continues to fall prey to the long-standing inner-outer dichotomy that we think embodied cognition should dissolve. As we have illustrated with Utterances 1 and 2, the phantasms that Silas and Janene constituted were there, in front of them, for the most part in their peripersonal spaces; it seems unwarranted and objectionably Cartesian to claim these imagined objects are primarily inner mental images and only secondarily embodied.

Phantasms are not brain or mind entities, but bodily creations dwelling in an ongoing emptiness actively deployed by the participants. We believe that, were we able to image the brain activity of Janene and Silas during their use of Drawing in Motion and Utterances 1 and 2, in all likelihood we would notice some overlap between their brain

activations in the exhibit-use and interview settings. However, this (hypothetical) commonality in their brain activation patterns would not mean, we propose, that during the interview *Drawing in Motion* had become a mental image for them, but that their constitution of a phantasmal *Drawing in Motion* around them elicited such partially overlapping brain activity.

In Utterance 4, Silas elaborates on the circle-tracing activity of the right hand elicited during Utterance 3, leaving out handle motion (i.e. left hand is at rest). However, his current enactment is not centered on following an ordered sequence of arcs, but on making apparent that, overall, the hand rarely displays pure horizontality or verticality. Throughout its motion, his right hand stands closely to what we might see as tangents to the circle, making tangible to him that, for the most part, it is "diagonal." In the context of *Drawing in Motion*, Silas' notion of diagonality entails the simultaneous motion of both handles, as opposed to pure verticality and horizontality produced by the motion of a single handle. As opposed to re-telling the story of a previously experience, Silas is here creating a new one in the form of an insightful "categorical judgment." Thus, we conclude by observing that gestures are not only key constituents of the imaginary; they can also enact novel categorical insights about the very objects they bring into quasi-presence.

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