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Running it through the body

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Abstract

Video data from three large captures of choreographic dance making was analyzed to determine if there is a difference between participant knowledge – the knowledge an agent acquires by being the cause of an action – and observer knowledge – the knowledge an observer acquires through close attention to someone else's performance. The idea that there might be no difference has been challenged by recent findings about the action observation network and tacitly challenged by certain tenets in enactive perception. We explored why a choreographer 'riff's' when appropriating and evaluating the movements of his dancers. By recruiting his body to help him cognize he is able to understand the possibilities of movement better than observation. He acquires participant knowledge.

Keywords: embodied cognition; thinking; choreography.

There is a tacit assumption in situated cognition that performing an action yields a type of knowledge – *participant knowledge* – that is irreducible to knowledge acquired by observing someone else performing the same action – *observer knowledge*. A violinist acquires more knowledge by playing a piece than by listening to someone else. He is embedded more profoundly in the situation. A dancer is able to understand something qualitatively different about a dance phrase by dancing it. Just watching leaves something out.

I present data, from a major study on dance creation that supports this intuitive claim: in dance, using one's body to explore a dance idea is a better way to understand the idea than watching someone else explore it. This may seem so obvious as to need no justification. But, there is extensive neurophysiological evidence of a close link between action observation and action execution [Viviani, 02; Wilson & Knoblich, 05]. Whenever we observe another person's goal directed actions we re-enact or mimic that actor's movements by covertly behaving as if we are performing the action ourselves. [Sebanz, N., & Shiffrar, 07]. Activating the motor resonance system may be comparable to actual performance [Rizzolati & Sinigaglia, 07; Agnew et al, 07; Aglioti et al.].

The idea of a covert action was introduced by Jeannerod [94] to describe the subliminal activation of the motor system by "[intended] actions that will eventually be executed, [and] also [by] imagining actions, recognizing tools, *learning by observation*, or even understanding the behavior of other people". [Jeannerod 01, emphasis added] Covert action involves motor planning, just as overt action does; and perhaps it involves some level of motor preparation, though probably less than overt action. The real difference is that covert action does not activate muscular control. Yet, the activity in the covert system is nonetheless so strong that even just watching an action can be as powerful a learning experience as performing the action oneself. [Cross et al., 09]

If it is true that the motor system is activated through observation as powerfully as suggested it is worth asking whether actual execution is required for action understanding and deep processing of action. Maybe observation is indeed enough. What extra does one get by adding overt movement over and beyond what one gets from mentally simulating the same movement covertly?

Exploring this 'extra', at least in the dance context, is the topic of this essay. I begin by clarifying what is meant by participant knowledge. I then explain the methodology we used for studying participant knowledge. That section is followed by a presentation of empirical results – observed regularities about when and how a choreographer *runs dance phrases through his body* in order to understand a phrase better – to deep process it. The paper closes with a discussion of the central ideas of bodily mediation, and enactive thinking. Jointly these last two ideas form the basis for an explanation of why authoring an action can lead to a more profound understanding than observing it.

What is participant knowledge?

If there is something special about participant knowledge, then on those occasions when a violinist – say, Yitzhak Perlman – physically plays a musical piece, he will connect with the piece in a way that is special because he is the one playing. The same holds true for dancers: they will connect in a special way when they take to the floor and perform.

As intuitive as this is it runs contrary to a theory even more general than motor resonance: the theory of internalization. According to Vygotsky [78], whenever Perlman is listening, his internalization of what it is like to play mediates his listening. He will engage violin music as if playing it because, as a result of constant practice, he has internalized the performance mode of interacting with music so deeply that he doesn't need a physical instrument to participate in music making. He has an inner violin and plays it when hearing others play.

An analogy is private talk. It starts as real talk outside, it is shaped socially by norms and practice, it is internalized and then it is available inside [Vygotsky 86]. After that, we can keep our mouth shut and think entirely in our heads.

In this sense, acquiring mastery of an instrument leads to the internalization of a principle of organization – a way of perceiving the world that comes from having mastered externally a highly structured form of interaction. It is artifact-mediated cognition, but without the artifact. If you play enough, you eventually can simulate playing without an

instrument in your hands. Thus, Perlman understands the meaning structure of a musical piece because of acquired knowledge of music, because he has internalized the way a violinist would approach the music, and because, while listening or watching, his resonant system simulates playing it. [Cisek & Kalaska 04] His vast experience and prior practice grounds his perception sufficiently for him to realize the musical possibilities at each moment.

Despite the allure of motor neuron theories, and despite the importance of recognizing that humans internalize principles of organization I think intuition is against Vygotsky and motor resonance here. Neither dancer nor violinist can mediate their encounter of dance and music to quite the same depth with and without their instrument. Physical performance matters. Whatever Perlman may know about a piece through watching and listening, and it is considerable, he cannot know all that he would feel or register were he playing the piece personally. The difference – the remainder – lies in what it means to be situated and to be an agent; it depends on being the prime cause.

Part of the 'extra' that using a physical instrument provides an agent is a consequence of how working with a physical instrument causally shapes what a performing agent understands about the possibilities of a situation. This extra includes a phenomenological sense of freedom and responsibility. By being the person who is creating the music, a violinist has a responsibility to succeed, and during his performance he or she has access to a set of performance specific concepts and experiences unavailable to an observer, even a violinist observer. These concepts are ad hoc [Barsalou 10], situated [Greeno 89, Kirsh 09] and embodied [Barsalou 08], and they permit the agent to project a future that is conceptually and experientially richer than the future projected by an observer. They provide the performer with a framing of decisions at each point: how long to hold a note, how to attack it, its mood and emotionality. These differences are not reducible to the specifics of what it is like to play the violin – to move the bow on a string, to hold the violin under the chin. Those are practical elements that might bear on the moment-by-moment musical decisions that must be made, but many of these mechanical aspects of working with a violin are irrelevant to the performer's conception of the musicality of the piece. The extra elements of knowledge conferred by participation concern the music itself. Agency is a special mode of making contact with that. The result is that in probing music with his violin, Perlman is able to discover something about the music he himself would miss were he just to listen. He needs the violinistic encounter with the musical composition to activate some of those concepts and sensory experiences. At least that's the story.

This is a complicated and remarkably strong thesis, one that I believe lurks at the soul of the frameworks of situated and embodied cognition. To my knowledge it has not been closely considered.

Method

The data for this research comes from two extensive case studies in which we captured the making of new choreographic work created by the celebrated choreographer Wayne McGregor and his contemporary dance company Random Dance. In the course of three periods – the first two occurring in two three-week periods (winter and fall of 2009), the third in a six-week period (fall of 2010) – all the face-to-face encounters between choreographer and dancers, (about 5 hrs/day) as well as all practice sessions involving the dancers and the associate choreographer Odette Hughes, were recorded by six high definition video-cameras. Over thirty 60-90 minute interviews were recorded between the choreographer and author and also with the dancers individually or in small groups. All notebooks, brain storming stimuli and real time notes were collected. Several experiments on marking, mental simulation, imagery ability and movement memory were carried out. Each case study yielded about 20TB of video. All videos had to be transcoded, collated and organized – altogether a massive process that required the help of several teams of students too numerous to thank individually. [Kirsh 10]

Once all materials were organized, work sessions were identified and cursorily annotated. Specific phenomena were then identified for intensive examination. We discuss here our observations and analyses of a process we call 'riffing' – an activity the choreographer regularly performs in which he tries out ideas by dancing them himself.

The detailed coding of riffing was performed by three college seniors long involved in this project. Each coder worked on separate days in the corpus and intercoder reliability was measured on 10% of the material done in common yielding .77 using Krippendorf's alpha measure.

Riffing off-of-others, the phenomenon studied. When the dancers we studied are working on an assigned choreographic task, or when working on a duet, trio or quartet, we regularly observed that the choreographer, WM, would observe them closely, and then, if the dancers were to do something interesting or untoward, he would try out their movement himself. He would physically sketch the movement, appropriate what he likes, and then work on the phrase himself, substantially modifying it before sharing it. We call this activity *riffing off-of-others*. Superficially, it is the equivalent of playing a musical piece himself.

When asked in interview why he riffs off-of-others WM said he does it "to feel the moves", and also "to redo them with [his] own signature", "to ensure that they are authentic" or to test if they are "consistent with [his] artistic style and the integrity of the piece as a whole". Executing the movement also lets him see its possibilities, its ability to "support invention", its potential fertility. We cannot confirm these views on the basis of videographic observation because much of the interest of a movement for WM, he reports, lies precisely in its physical or dynamic novelty, something he recognizes in the movement that is quite different from previous movements he has worked on, owing

perhaps to weight, balance, force, resistance or other attributes that are kinesthetically meaningful but almost impossible to discern visually. This is a key point.

Empirical Results

Because we have no access to our subject's motor encoding through imaging or otherwise, our empirical study (the non-interview part) involved reviewing nearly a thousand episodes of riffing and measuring about 15% of them. Our goal was to observe when the choreographer riffs, how faithful his riffs are to the target movement he is sketching, how he modifies the movements, and then what he does with these modified movements.

We found that riffing off-of-others follows a common pattern: 1) the choreographer watches a dancer or small group develop a movement idea; 2) he personally sketches or 'marks' their movement, though he also adds or subtracts from their idea by prepending, appending or deleting components in the first pass; 3) he runs through (i.e. he riffs) several more times, each occasion adding, subtracting, or altering more of the phrase as he initially sketched and modified it; 4) he then works with the dancers to share the new idea. The process is very collaborative, though not quite a dialogue, for the dancers do not attend to what WM is doing when he is riffing – they are busy dancing themselves – and WM himself does not seem much concerned to get the dancers' movement exactly right. He does not stop, look again, practice. Instead, he watches, physically sketches and remakes his own versions, all in relatively high speed.

This kind of physical sketching and riffing seems a way for him to pick up ideas he did not originate, and then play with them. He runs someone else's movement through his own body because it is not enough for him to see what others are doing; he needs to appropriate the full structure of the movement to explore how it might be developed, continued. In short, riffing is a way he thinks with his body. He wants 'agentive' knowledge.

Before we look at the data supporting this view, it is worth commenting on how this practice departs from the case where a violinist plays a piece to understand it rather than listening to another violinist playing it. In the musical case, both soloist and listener share a common musical specification: the score. Playing is a better way of appropriating the score. In dance, and most especially in creative dance, there is no prior score and no real-time capture used to 'freeze' a movement. WM never uses a score (or video, though the dancers sometimes do later in the process); and the company makes no effort to transcribe their movements in a dance notation, such as Laban. Understanding must happen on the dance floor and in real time. More importantly, the kind of understanding the choreographer is after is dynamic. He needs to deep process the movement to see its potential. But this does not always mean recreating it exactly. In interviews the choreographer says he wants to appropriate the movements his dancers make. The curious thing is why he does not feel compelled to duplicate their movements more precisely.

Data. The data shown in Table 1 are derived from studying the first Make session of the first day of creating a dance made in 2009. Ten sequences of riffing off-of-others were found in this one session. By studying them frame-by-frame we were able to measure the time in seconds of the mean duration of the referent movements – the dancer movements – that WM chose to riff off of, and the timing of his subsequent activity.

Riffing Off-of-Others (measurements in seconds)							
	Referent Move by dancer	Gap 1	Riff 1	Gap 2	Riff 2	Gap 3	Riff 3
Mean Sketch Duration	2.7 secs		2.8s		1.7s		2.4s
Mean gap		0.7s		20.2s		28.1s	
Mean Fidelity	100%		50%		29%		25%
Mean WM- added content			4.1s		3.1s		2.8s
Total			6.9s		4.8s		5.2s

Table 1. Riffing off-of-others

Looking at the columns, Gap 1 measures the time between the moment when a dancer performs a movement and the moment WM sketches it. Gaps 2 and 3 measure the time between subsequent riffs. WM-added content is the material he adds that is not found in the referent movement or in his sketch of that movement. It was surprisingly easy to recognize the referent material even though WM's sketch was not perfectly similar to the referent. Our interest was to determine how much of WM's movement was derivative, based directly on a referent, and how much of WM's movement was his own authored content.

In a typical riff, WM observes a referent move he likes and watches it a few times before sketching it in real time, immediately after the next time he sees it. As can be seen in table 1 this delay between seeing the referent and sketching it (after having seen it at least once before) is less than a second. After his first riff he then waits about twenty seconds, either watching other dancers or just standing pensively off stage. He then riffs again, which we call Riff 2; there is a gap again, on average 28 seconds, and then he makes a final riff, Riff 3.

Looking at the values in table 1 we see that on average his first riff is only 50% faithful to the referent. To determine fidelity we graded the quality of a riff along the dimensions of technicality, memory, timing and dynamics, the same dimensions we used in our marking experiment. (See this issue [Kirsh et al] and Kirsh [forthcoming]). Each dimension has four ordinal values: A, B, C, D. Overall fidelity was defined as the averaged score on all three dimensions. To calculate the mean and then return a letter grade for fidelity we converted letters to a percentage in a linear fashion (A=100% faithful, B=75%, …).

Given his skill at real-time sketching WM's low fidelity suggests that his first riff is more selective than realistic sketching. It may mean that he is interested in appropriating only certain aspects of what another dancer is doing. In this

first riff, we found, further, that on average he adds more than twice as much of his own content to the material he appropriates. After a gap of 20 secs he seems to tighten up the movement by reducing the duration of both derived and WM-made content. Following another delay of 28 secs he increases the duration of the movement. He now has a phrase that contains only 25% of the original 2.7 secs movement he took, making that sketching look less like appropriation and more like inspiration; his own contribution is about the same length. It is this new movement, totaling on average 5.2 secs, that he eventually shows to the dancers in this or a later session.

What does this tell us? First, Table 1 shows that we were wrong in a conjecture we had made. We had assumed that riffs would unfold as a quick sequence of increasingly faithful sketches. WM would fully appropriate the referent phrase before his modifications and divergent sketching. This is typical of the way dancers sketch, when mastering the phrases of others. But it was not the case for WM. On average, WM will riff once, with only moderate fidelity to the referent, and then begin to truncate, add or modify the phrase. Even in his first riff he usually adds more of his own content than the phrase he appropriates.

Second, it suggests that his concern is with only certain aspects of a movement. The obvious analogy is with sketching on paper. An artist inspired by Soutine may sketch one of Soutine's paintings or drawings, hoping for ideas. But the sketch, much like WM's, is rarely faithful to the original and the creativity seems to lie in how the artist departs from the original.

Let us look at the process of choreographic sketching more closely to see if it may illuminate the nature of how physical movement acts as a mediating structure for thought.

Sketching in Dance is the process of copying in real-time the movements of another dancer – the referent. The referent dances, produces a target phrase, and the sketcher does her best to duplicate the target phrase herself. Inevitably there are stylistic differences, and most of all, differences owing to variances in dancers' height, weight, body form, strength, and gender. Sketching in this sense is an early shot at mastering a movement the way the referent does it. It is not to be confused with an artist's sketching, or a musician's sketching where often there is no referent – no touchstone of correctness.

If the sketching process in dance follows a normal pattern of structural approximation then the first sketch will be coarse, capturing essential elements of the referent such as emotion, general shape, gross dynamics, key positions, and occasionally sporadic details that they notice or like. What then follows is a trajectory of practice, a sequence of improvements and modifications to the original sketch to improve verisimilitude. The process is remarkably fast for professionals and a phenomenon worthy of study in its own right. After a minute or two, a talented dancer will stop watching the referent and practice on her own.

The majority of sketching we observed among the Random Dancers was real-time sketching. Each time the choreographer makes a new phrase on one person (or a small group) the rest of the company is expected to learn the movements too. This is expeditious because when crafting phrases for duets and trios it is easiest to 'make' on a referent duo or trio on the assumption that the others, who typically were already doubled or tripled up (usually at WM'S explicit direction) would learn the phrase in their own duo or trio. In this dance company, moreover, the choreographer would sometimes swap dancers, putting a different dancer in the target role in the final piece, so dancers were expected to learn virtually all phrases.

Sketching in dance is a topic of interest because of what it can teach us about how the body is used to manage attention. In my view, a major function of a mediating artifact is to regulate attention and activate priming. A hammer helps us drive nails into wood. It is a purely physical, non-cognitive artifact. [Norman, 91] But when it is in our hand it also coordinates a complex pattern of movement and attention shifts – sensori-motor adaptations and interactions. Some of these are below conscious threshold and involuntary (e.g. grip in mid-swing). Others are fully conscious, but often they too are almost involuntary. For instance, when a hammer glances off a nail imagine how little control we have in seeing where it lands. Our eyes are drawn to it. It is this pattern of action and attention that is hard to duplicate without a physical thing driving it. The physical artifact mediates our knowledge of hammering. It plays an essential role in organizing our hammer'ish interaction with things.

To return to our violinist, we would expect that Perlman can partially simulate his pattern of attention to a musical piece when not physically playing his Stradivarius. He has his inner violin, with all its interaction-organizing principles. Numerous behavioral and imaging studies suggest that when humans mentally rehearse a familiar action they execute some of the same neural operations used during overt motor performance. [Jeannerod 01] When listening, Perlman would have no problem imagining himself playing. And he would engage similar neural and cognitive operations. [Munzart 2009]. But there will be many involuntary, fast paced adjustments to playing for real that would demand his attention physically that simply do not arise during simulated playing, where there can be no direct sensory feedback from the environment. In short, his simulation of playing is at a lower resolution than actual playing.

The special role that a sketch, as mediating structure, may play in dance cognition can be appreciated by analogy with sketching in paleoarchaeology, where Lithic sketching is used to solve a hard problem: distinguishing human made from natural stones in lithic eras.

In figure 1 there is a picture of three stones, any one of them may be from the Paleolithic era, and below them are some drawings made by an expert sketcher following the principles of lithic illustration. According to Addington [86] and Lopes [06] the best method to tell whether a given Paleolithic stone is a cutting tool is to sketch the stone. Not just any form of sketching will do. There is an expert mode of sketching for Paleolithic objects codified in a set of

principles of 'lithic illustration'. Good archaeological illustrators will draw a lithic stone to reveal the physical 'problematic' the tool cutter faced. They will show the "scale; the pattern, sequence, direction, and force of blows to the stone; the bulb and platform of percussion; areas of retouch, snapping, and truncation; areas of grinding, battering, or abrasion; fractures caused by heating; the effects of materials; and pitting and sickle sheen." [ibid] Potentially

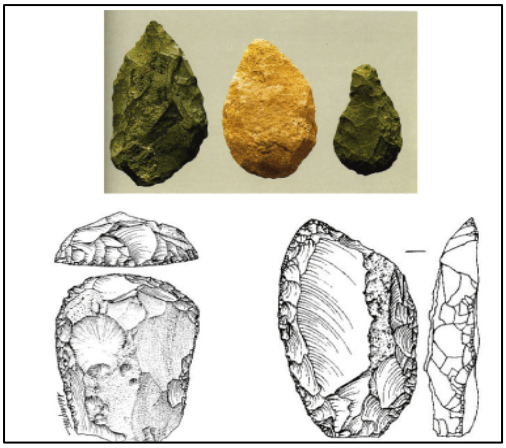

Figure 1. Lithic sketches are drawings of stones made according to the strict principles of lithic illustration. The stones in the top picture are either human made – artifactual – or they are nature made and not shaped by humans.

confusing features of the stone such as embedded fossils, variegated coloration, patina, seams, banding, and crystallization are left out of the drawing.

The implication is that expert illustrators, when practicing their craft, are forced to scrutinize stones in a special way. They coordinate hand and eye to interactively probe the stone to reveal knapping related features. The need to draw certain lines drives perceptual inquiry. Attention must be managed, and arguably, without the need to sketch, without the presence of an external structure that the illustrator is creating, attention would not be managed adequately. Of course, this is an exaggeration. Illustrators have professional vision [Goodwin 93] and so can see elements of what they *would* draw without actually drawing. But in drawing, the process of making lines and ensuring they are spaced revealingly, is itself a process that simulates knapping. Using a pencil to draw a curve is physically related to using a knapping stone to flake a chip off a stone. It physically simulates knapping. So, the drawing process can help the illustrator walk through the history of the axehead's making. The drawing is an external representation, but the process of making this representation is a powerful method for structuring attention. It helps the illustrator figure out what an artifact is by studying 'the details of its making' (ibid).

The analogy to riffing should be clear. By riffing, the choreographer is forced to direct his attention to the central aspects of a movement. By running the phrase through his own body WM gets to feel its dynamics, balance, gravity, internal shape. Not as seen in a mirror, but as felt through movement – he experiences 'the details of its making' including the many body decisions the dancer made.

We turn now to what riffing teaches us about the power of using the body to help think about dance; how being the agent of movement offers privileged knowledge of dance.

Discussion

It is no surprise that dancers physically sketch, explore or probe movement ideas by using their bodies. The question at issue is why, when our choreographer sees an interesting movement performed by one of his dancers, he bothers to mimic it? Given his capacity as a super-expert he ought to be able to attend to enough aspects of the movement by observation alone, or perhaps by inner simulation, making external movement unnecessary. One would suppose that he can think through the possibilities of a movement well enough in his imagination. Observation of the movement ought to give him an adequately precise 'perceptual blueprint' [Hodges et al, 07] that he can then imaginatively work with.

Support for the idea of imaginative simulation being sufficient can be found in the idea of enactive perception. [Noe 05] On an enactive account of visual perception, an observer should see the counterfactual futures in the present. He should phenomenologically experience possible ways a phrase may be continued. In this case that would mean anticipating a dancer's possible movements just before they were made, then saccading, moving the eyes, head, trunk and attending closely to see which of the movements that might have been made do in fact occur, and then revising perceptual expectations appropriately. The enactive process happens during perception, but it grounds an understanding of the movement process that encompasses more than what was literally seen and supports imaginative replay and exploration. [Thomas 99]. It supports projection [Kirsh, 12].

A second reason overt action might be superfluous is that humans have the capacity to improve motor performance by observation alone, without concurrent physical practice, [Torriero et al 08, ibid]. The fact that there are older choreographers (notably Merce Cunningham) who continued making noteworthy pieces after drastically reducing their physical exploration [Nolan, 12] offers further support that physical practice is not necessary for grasping the choreographic potential of a movement; observation and mental simulation may be enough.

For our forty-year old choreographer that is *not* what we found. He regularly runs possible steps and phrases through his own body, and he seems to rely on that process as part of his choreographic practice.

I suggest we view Riffing as a type of enactive thinking. It is not just a way of better activating what vision can supply. It constitutes a more interactive probing. Interaction requires more than simply changing one's eye, head, trunk and body position to observe; it involves changing the object of inquiry. It is an intervention.

Thus in reply to the question how can thought be partly constituted by bodily movement I have a few answers.

First, since bodily movement is by definition part of the action-perception system it can be harnessed reliably as part of a simulation process as well as 'mental' simulation inside cortex. If internal simulation is good enough to ground thought, then why not regard the act of materializing the target process an even better source of grounded thought? Moreover, if nature plays a role in simulation the progression of states will be more detailed and reliable than mentally projecting, imagining, or simulating the next state, which is more error prone. So dancing a phrase ought to be a better way of grasping the possibilities of a phrase than simulating it. And perceiving possibilities is a lot of what understanding is. This leads to the second reply.

Badets et al., [06], showed that physical practice is better than mere observation for learning new movements. This may not always be the case with simple and even moderately complex movements [Cross et al, 09]. Presumably in those cases where physical practice surpasses prolonged action observation something extra is getting in. What is it? In Badets [op cit] the extra is detailed behavioral expertise and its neural basis. But with respect to thought, and not just skilled movement, the extra that comes from overt bodily involvement is an enhanced conceptualization of what the phrase is, a better grasp of what makes a performance *true to the phrase*. In simple dance phrases there is little to grasp or deeply conceptualize. But for complex, choreographically rich phrases this can be a real issue. It means being able to judge when two dancers with different genders, backgrounds and bodies have mastered the phrase 'correctly'.

Riffing falls into this enhanced conceptualization category because when WM executes a phrase he is making decisions at each moment; he is 'thinking' about it. He reports looking for possible lines of development, for novelty, for discovering a point in movement space that is uncharted. In lithic illustration you also feel the decisions: why here, and not there? In dance, part of conceptualizing possibilities means understanding key dynamics like the effect of gravity, balance, force, and bodily tension. These arise through physical interaction and are highly sensitive to momentary physical factors. Observation alone cannot expose these elements. Without agency, intervention and physical engagement, human knowledge is different. Angels can never understand dance as humans can.

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