

Eye of the Beholder

April 23, 2007

7:30 PM

The Philoctetes Center

Levy: I'm Francis Levy, co-director of the Philoctetes Center. And welcome to Eye of the Beholder. I'm proud to introduce Dr. Edward Nersessian. Edward Nersessian is Clinical Professor of Psychiatry at Cornell Weill, founding editor of the *Journal of Neuroanalysis*, and Co-Director of the Philoctetes Center. Dr. Nersessian will moderate this afternoon's panel and introduce our other distinguished panelists.

Nersessian: Thank you. I will introduce the panelists in an anti-clockwise way. So I will start with David Freedberg, who is Professor of Art History at Columbia University and Director of The Italian Academy for Advanced Studies in America. Barbara Stafford is William B. Ogden Distinguished Service Professor of Art History at the University of Chicago. Vittorio Gallese is Associate Professor of Human Physiology at the University of Parma, where he teaches cardiovascular physiology and neurophysiology in the School of Medicine. Suzanne Anker is a visual artist and theoretician working with genetic imagery. And Francis Baudry is a Training and Supervising Analyst at The New York Psychoanalytic Society and Institute.

What I've told the panelists today is that what we would like to have is a conversation for about an hour and 15 minutes, and then we will open up for questions from the audience. And to orient people, I've asked Vittorio Gallese to first say a few words about what motor neurons are, and then David Freedberg to say why he thinks they have any relevance to art. And then we will have everybody participate. Vittorio?

Gallese: Good evening to everybody. It's a pleasure to be here. Well, we discovered mirror neurons during the July of 1991. We weren't looking for them. We weren't aware of their existence. We were, nevertheless, investigating the relationship between action and perception in the macaque monkey brain. We had already discovered neurons that discharge, that fire, every time the monkey is involved in motor acts, like grasping objects. And the same neuron would fire also when the monkey is passively inspecting the same object.

So these neurons translate the shape and size of an object into the motor program required to interact with that object. So we were grasping different objects at hand in the lab in order to present them to the monkey so that the monkey could look at them, and we realized that the timing of the discharge of the neurons were quite odd. So the neuron fired not when we were presenting the object to the monkey, but immediately before, while we were grasping the object in order to present it to the monkey. And at the beginning it looked really odd. I mean we didn't expect it, and we thought maybe there was an artifact—maybe the monkey was moving—that we didn't see. So we made a series of experiments to at first falsify the possible interpretation that the neurons were indeed responding to the observation of an action performed by someone else. All these control experiments gave negative results. Then we realized that we had discovered something new and, to be honest, from the very beginning we were fully aware of the possible implication of this discovery.

The next step was to see whether such a mirroring mechanism could also be detected in the human brain. So we started first with the experiment using transcranial magnetic stimulation—you excite a part of the motor cortex by delivering a magnetic stimulus on top of the motor cortex. According to where you place the coil you may be capable of exciting, for example, the motor neurons which excite the muscle of your hand. And we realized that when participants were observing the action of someone else, their motor cortex was getting a facilitory effect. Then, after this evidence, the next step consisted of pinning down this mirror neuron system by means of brain imaging technologies. So we started first with a PET—positron emission tomography—a quite invasive method. Luckily enough, immediately afterwards we could shift to fMRI, which is a non-invasive method. And the outcome of these experiments was that, yes, we do have a mirroring mechanism in our motor system, and the location of the system is quite analogous to that disclosed in the macaque monkey brain.

So part of the premotor cortex and the posterior parietal cortex are activated not only when we perform action, but also when we observe the actions done by someone else. We then extended our investigation to other domains, like emotions and sensations. So in one study that we published in *Neuron* in 2003 we were able to show that there is a region within the frontal lobe, called the insula, that relays the analysis of sensory stimuli with the autonomic reactions to those stimuli. Well, this part of the insula is activated when people perceive disgust in the facial expression of someone else, but also when they subjectively feel disgust. So, again, we have another instantiation of a mirroring mechanism. The same part of my brain that is active when I have a first-person experience of a given emotion is also activated when I am witnessing the same emotion as experienced by someone else.

Another step consisted of investigating what we may wish to call tactile empathy. When our body is touched, there are regions in our brain that are mapping where these tactile sensations occur. It is because of these sensory areas that we are capable of localizing, for example, a tactile stimulus. So the question was, do these areas that are activated when a part of my body is being touched also respond when we see an equivalent part of the body of someone else being touched? And the answer was yes, was positive. These results were replicated one year later by a group led by Chris Frith at the University College London. And they further extended the result. They brain-scanned a synesthetic patient—a patient who not only knows how does it feel to be caressed, but literally feels on her body the physical sensation experienced by the person she's looking at. And in this particular patient, this mirroring mechanism turned out to be hyper-activated. This in a nutshell is what mirror neurons are about—a part of the story.

Nersessian: Thank you. David Freedberg?

Freedberg: Dr. Nersessian asked me to talk a little bit about why I found the discovery of mirror neurons by Vittorio Gallese and his colleagues at Parma so important for art historians, and this is what I'm going to do. A long time ago, already in the late 1960s, I had become very interested in the phenomenon of iconoclasm. In other words, I asked myself the question, why is it that pictures and sculptures should matter so much to people that they should feel inclined to destroy them? This is not the kind of question that art historians, especially in that late Greenbergian stage, would ask of themselves, because it involved the act of iconoclasm, the act of the desire to destroy images, both historically—Byzantium, the Netherlands—and in our own time. It was

something that was supposed to be, and obviously is, too involved with image. Most of us come out of the great Kantian tradition in which we believe that emotion should somehow be detached from our assessment of works of art.

So from those early days on I was always concerned with the emotional dimension of aesthetic responses. If you think, though, of the matter of iconoclasm, you realize that emotions are not only involved, but physical actions are also involved. And so the matter of the relationship between physical responses to works of art and the emotional responses to works of art became central to my own concerns. When I wrote *The Power of Images* in 1989, there was a great compendium of emotional responses. It was very clear to me that one also had to consider that this was completely independent of what was to happen with the discussions of the insula later on—when we looked at an image of disgust or somebody reacting with disgust to a plate of porridge, shall we say, *The Bean Eaters* by Annibale Carracci, we had a similar feeling of disgust ourselves.

As an art historian I've always insisted that one of the most difficult exercises that you can engage in is to take a class into a museum, because you can't just fall back on historical stuff. You actually have to react to the image. And one of the things that you find yourself doing very often is somehow, either inwardly or externally, emulating the gestures that you see in a picture. There's a kind of natural imitative aspect to our responses to works of art. Now, of course, this is something that even then in the 1980s art historians were rather skeptical about. There were some exceptions. Barbara Stafford will talk about this in a moment. This whole matter of our physical reactions to works of art became very important to me. It was also very clear to me that our understanding of works of art had a lot to do with our empathetic responses to them. Many of you may know that the great French philosopher Merleau-Ponty wrote about his sense of physical engagement with works of art, and indeed the beholder's ability to replicate not only what was happening in the picture but even to emulate how she or he imagined the artist herself or himself drawing or creating the work.

So the matter of empathy was in the forefront of my thoughts, and then, like everybody else, I happened to be reading Tony Damasio's book *Descartes' Error*, in which he talked about the relationship between body and emotion. At one point in that book—it was quite early on—he mentioned mirror neurons. As soon as I saw this word “mirror neurons” I realized that we had the possibility of understanding at much closer range those feelings that we have when we look at the physical actions of actors within pictures, that we act out as if we were doing—we act as if we were actually engaged in the same gestures or actions as those whom we see in an image, even if we don't actually execute those actions ourselves. This was the fundamental principle that Vittorio Gallese and his team and his group in Parma had discovered, that when the macaque monkey sees another monkey reaching for an object, or reaching to grab a bunch of grapes, the neurons in the premotor cortex of the observing monkey fire as they would if the observing monkey were actually engaged in the same action himself. So it seemed to me that we had a new understanding of our engagement with the physical aspect of, or the action that is involved in, the protagonist of a work of art. Of course, Vittorio and I have now gone a little further in trying to explore not only our relation with what we see in a picture that is actually executed, but also the implied actions that one may see, for example, in the traces of gesture in a Jackson Pollack, in a de Kooning, and so forth.

So that's basically how we came together. I should say that I was so excited when I read about mirror neurons that I gave an interview. Somebody asked me about my work in an Italian newspaper in 2001, and I said I think mirror neurons are the most important tool for the understanding of our responses, our aesthetic responses. I explained why, and then I got a letter from Vittorio, whom I had never met, saying, "I'm one of the discoverers of mirror neurons." I immediately picked up the phone and that was the beginning of our fruitful relationship.

Stafford: Perhaps I'll approach this somewhat differently, because I assume this is a very diverse audience. If one thinks of mimesis, if one goes back to Aristotle, what's interesting, it seems to me, about this mirror neuron work is that it is both historical and in some ways trans-historical. And if we go back to something as basic as *The Poetics*, for example, Aristotle says that imitation is the first response, that it's the first thing that we do and it's natural. It's something that comes naturally. And then he makes a very interesting observation. He says that there is something beyond the child and the first imitation. There is a kind of adult education, and theater—I'm thinking of your next performance—is a kind of reenactment, or re-performance, as it were that situates the adult again and again in experience. So I just want to put that out there to say that there is maybe a wonderful long cultural beginning out there as well.

I'm particularly interested in mirror neurons, both in terms of how it relates also to contemporary philosophy movements—because mirror neurons give us the body and the feeling of the body as inhabited instead of just controlled—and a lot of contemporary neuro-philosophy now that says there is no "I" there. I think of people like Daniel Dennett, for example. If you think about it it's fundamentally about internalizing another person. In other words, you have both a first person sense, and you also have that very elusive second person. It allows you to emulate. And that too has a long tradition.

If you think of the whole culture of *sensibilité*, of people like Diderot, if you think of nuance, the development of a highly nuanced portraiture—the 18th century in particular is really quite special: people like Grosz or Hogarth who are interested in pantomime, pantomimic performance—again, it's a way of engaging the beholder to internalize and understand action. I guess one of the things I hope we talk about, because I know you've thought about this is intention. In other words, it's Aristotle's problem. There is a difference between a first order imitation—the child sees the world, we see the world, the monkey sees the glass of water, and repeats that gesture—and then the question of understanding how that comes about through re-performance. I'm just going to throw those issues out and say that there is quite a bit here. If there is anybody interested in distributed or extended cognition, which interests me a great deal, and the revival of some of the people—if we think of that great period that has sort of been forgotten, from the 1960s and 1970s, we think of work by people like Gyorgy Kepes or of the great J.J. Gibson and the environmental theory of affordances, or looking ahead to our own Gerald Edelman, who has a very sophisticated theory of reentry, that is, how is it that the world comes into us as an individual and things get processed and get put out in the world? It seems to me mirror systems are really at the heart of that kind of extended cognition. So I'll just throw that out for the group.

Nersessian: I can see a little bit why this is of interest to art historians. But why is it of interest to an artist?

Anker: Well, I'm not only an artist. It's one of the hats that I wear. I'm the Chair of the Fine Arts Department at the School of Visual Arts. Before that I was Chair of the Art History Department at the School of Visual Arts. My book, *The Molecular Gaze: Art in the Genetic Age*, addresses the ways in which visual knowledge is a field that essentially is opened up by the use of diverse disciplines. So at a time in contemporary art when things are, one can say, not going as well as they should, the biological sciences are in a golden age. And artists have always been attracted to and have always employed the ideas of their times in terms of the ways in which new frontiers of visualization techniques really change the way we think about things. I think that when one talks about pictures one talks not only about the history of pictures, but a certain contemporary authority of picture, and that all visual interpretations are not equal. Whether they're culturally coded, whether they're learned responses, whether they can be manipulated or under surveillance, any ways in which perception can be altered is something that visual artists are interested in, because we are in the business of communication and response is one of the aspects of that.

Nersessian: It seems to me when you talk about mirror neurons and you say, if I go to take this glass your mirror neurons are going to go through the same set of firing as my neurons have done, you're talking about a relatively straightforward response. But when you're talking about art and looking at art, you're talking about a much more complex response, where people's own fantasies, knowledge, education, comes into play. And so how does that get dealt with?

Baudry: Well, first of all, an experience from my own life, where I suddenly understood something I hadn't understood in myself before—I play the recorder, Baroque music, and I take lessons with one of my teachers, who is obviously much more experienced. Sometimes I'll have the experience that she will play a phrase very differently from the way I've played it. I listen to it, but without realizing it, I will play it exactly the same way. So it's without understanding what I'm doing, there's something that seems to happen automatically, completely outside of my own awareness. Here's the difference between imitation and understanding—I may first imitate exactly the way she's doing the phrase without really having internalized it, and without having made it mine. So I think that would be a little example, maybe, of mirror neurons. Another one that appeals to me is thinking about advertising on TV—what people do to lead children to buy toys or to want foods. I suspect that there's some of that phenomenon that's that. But now to turn to more serious things—I happened to be reading recently Fraud's paper *Moses and Monotheism*, and I thought I'd just read one little phrase, because it's relevant to tonight's discussion. He talks about artistic intentions, and he says, "In my opinion, what grips us so powerfully can only be the artist's intention. I realize that this cannot be merely a matter of intellectual comprehension. What he aims at as the artist is to awaken in us the same emotional attitude, the same mental constellation, as that which in him produced the impetus to create." Isn't that an interesting idea, that in a sense presages what we're talking about?

Anker: I think it's interesting, but I don't think it's correct. I don't think that one can ever get to the nitty-gritty of an artist's intention. The intentions may not even be conscious to the artist, and I think one of the bifurcations between the humanities and the sciences is a kind of false

categorization about cognition and emotion. I think that's what happens in a work of art and why one has a gestalt experience with it, because it happens all at once, and it requires both intellect and emotion in order for one to respond to the fullest capacity. Intentionality in art is a very fuzzy area, particularly as I've seen my students proceed with different projects and then explain to me what they're doing and I wonder whether they're on Mars or something like that, because there is no correlation between what they think they're doing and what they're doing. The other thing is artists lie. Okay? One of our jobs is to lie. Pictures are illusions, they're deceptions, they are intended to create somatic affect, but they don't necessarily have to do so for the good. I think that the question here of the myth of the artist, or using the artist as this signature for neuroscience, which has been done recently, is, again, bifurcating the experience of reacting to and making a work of art. I mean Marcel Duchamp said he stopped making art. Did he stop making art? No. So if you read artist's diaries and you read the different kinds of attributions, you will find all sorts of things that are sort of untrue.

Nersessian: Do you want to respond to the criticism of Freudianism?

Baudry: Yes. The issue of intentionality—I couldn't agree with you more—is complicated. It's very easy to make wild interpretations and statements about intentionality, and that's something that I've been particularly interested in as a methodological issue. I think there are ways I can approach it where, by creating a number of contexts, I couldn't agree with you more that a great writer or a great artist trying to explain his work may not have the fuzziest idea of what he was up to. That's a real problem. But I want to get back to the issue of the mirror neurons and ask Dave something. I felt a little bit, when I was asked to participate in this, that I might be like the fox asked to come into the hen's coop, because I have real concerns and questions about the applicability of mirror neurons to something as complicated as aesthetic products. How I would frame my concern would be the following: If you look, let's say, at a very poor photograph of a man throwing a ball, and then if you look at a great photograph of a man throwing a ball, then if you look at a poor painting of a man throwing a ball, and then at a very good painting of a man throwing a ball, I don't think, unless I'm mistaken, that in terms of how far you've gotten with your theory of mirror neurons, that you could help explicate. You could talk about a mechanism that is involved, but when you talk about the reaction of the person to those four different things I've laid out, I haven't read, in the literature on mirror neurons at least, anything that would help me sort it out in a way that is as subtle and as complicated as a viewer response is to, let's say, these four products.

Freedberg: Well, as we would say in Italian, and I regard myself as an honorary Italian, *pazienza*. I mean after all, the mirror neurons—the discovery was in 1991. Of course to scientists this seems like an age ago. To those of us who work in the humanities it seems like yesterday. There's work to be done. In fact, one of the reasons that I've been happy to have this dialogue with Vittorio and to be here this evening is precisely because of the fact that people involved with art have not, I think, seen the potential of this discovery for the understanding of aesthetic issues. Now, there are several things to be said here. I don't think anyone has claimed that mirror neurons are going to provide the secrets to art. There are some neuroscientists and some people who call themselves neuro-aestheticians who try to give the seven or eight principles of art.

Gallese: There's a lot of neuroscientific hubris out there.

Freedberg: But all I would like to say—and then I want to come back to Suzanne’s abandoned critique if I may—is that I don’t think we can proceed with our aesthetic investigations without understanding some of the basic responses that actually may form a component of the aesthetic response. We are not suggesting that mirror neurons give the whole aesthetic story. But to deny the matter of inward imitation that may precede what you are calling understanding seems to me to create a lacuna, which can now be filled.

Stafford: I want to leap in here, because I think a very important distinction has to be made. One has to make a distinction between autonomous mechanisms and really understanding them. It’s something I think that we don’t like to do. We don’t like to think that at least 80% of our responses are somehow driven by spontaneous, intrinsic mechanisms. I think that’s extremely important to make a distinction, because there’s a lot of art that plays on that. Duchamp, for example, plays on that. Surrealists play on that. One has to understand that not all artwork does the same thing.

What I think is maybe the next level, because there’s not just one mirror neuron system—there are many mirror neuron systems—one has to talk about coordination of those systems, and also the work of higher-level consciousness that is actively engaged in coordination. So there are all these mechanisms that are predicated on our automatic responses, and then there are these others, and different kinds of art really appeal to these different things. I think that really would get things moving along in a very exciting way. I think that it would get biology and culture deeply back together again.

Nersessian: Yes.

Gallese: I think here it should be made very clear that we are not dealing with a sort of Skinnerian mechanism with a fixed, permanent, inalterable coupling between stimulus and response. There is already plenty of evidence showing that the degree and intensity to which such mirroring mechanisms can be evoked during, for example, observation of different actions, emotions or sensations, is potently driven by the personal experiential history of the individual displaying these responses. There are beautiful studies done on professional dancers, for example, which clearly exemplify that if you’re a classical ballet dancer and if you watch classical ballet, as opposed to Capoeira, your mirror neuron system is more driven by the observation of classical ballet than when you observe Capoeira, and the other way around.

Further, there are studies showing that only professional piano players are capable of activating a motor representation of a scale played on a keyboard without any sound. Non-professional piano players don’t. They simply recall what they see on their visual system. There is not an activation of the motor system. So this implies that these mechanisms are highly plastic and are highly influenced by the personal history of the person bearing them, which also implies that a naïve eye or an expert eye, an artist’s eye or a naïve eye, when looking at the same artwork, will probably display different responses. To a certain extent, we believe that we are in a position to measure those differences and this is one of the things that we are planning to put on our research agenda for the coming years.

Freedberg: I think what Vittorio said is very important, but I just want to get back to what I said at the beginning about patience, because we are at the beginning of this research. You raised the question of is there any difference between—let us broadly call them mirror responses—to a photograph and a painting and so on. You say you're intuitive feeling is that there would be no difference, but in fact I've been doing some experiments with another neuroscientist, not Vittorio, in which we've been using trans-cranial magnetic stimulation, and we found that the motor evoked potentials for muscles—this is the realm of automaticity—when you observe a Michelangelo are greater than when you observe a photograph. And we don't know why, but science proceeds at a slow process. There are issues of color and, to bring the discussion round back to your initial passage from Freud, it also probably has to do with a conscious or unconscious ability of the artist to convey that particular movement successfully. So in that sense, to awaken in the beholder the same mental constellation is rather a nice way of putting it, as Freud did.

Baudry: First of all, we would have to define what people mean by aesthetic response, because it's a term that's so broad. We may each know what we think we know, but it's something so complicated and it involves so many layers that I'm concerned that there would be a reductive attempt to explain away something. Let me read one little paragraph from Delacroix: he says, "The main source of interest comes from the soul of the artist and flows into the soul of the beholder in an irresistible way. Not that every interesting work strikes all its beholders with equal force, merely because each of them is supposed to possess a soul. Only people gifted with feeling and imagination are capable of being moved. These two faculties are equally indispensable to the beholder and the artist, although in different proportions." Now why did I read this passage? Because the word soul, which of course is something that a great artist might want to think about, is terribly difficult to break down into something that we can talk about.

Stafford: But the Delacroix passage also makes something very clear: that we in a way respond to what we notice.

Baudry: Yes.

Stafford: And attention, I'd really like to stress the importance of attention. That is, Delacroix, in a way, is suggesting saliency. Certain things are salient to different people. But what's interesting is that the mechanism of saliency is something that's shared. Maybe this deeper significance of mirror neurons work, that the body—I mean if I go back to the Greek concept of aesthetics, it means sensory knowing. It's knowledge in the body, that the body thinks, which is, of course, the Merleau-Ponty connection as well—the phenomenological connection, which I think fits rather nicely as well. I just wanted to point that out. It seems to me that there is something in that passage about attention and noticing that is both particular to an individual, but it also speaks to a more general habit of the way in which we seize things from the perceptual stream, that's being Gibsonian here.

Anker: I think there's also another aspect of this, which may go back to something about the difference between a photograph and the Michelangelo, is the kinesthetic experience of sculpture in space, and the way the body reacts to installation, formatting, et cetera. And there are many studies being done now with neuro-architecture as a way to create a dynamic kind of special

arrangement. But I want to mention two contemporary artists' works. One is Thomas Struth, the photographer, who photographs people standing in front of famous paintings in famous museums. And they mimic, the persons mimic what is being represented. I'm sure that Thomas would be very surprised to hear about a mirror neuron. That's number one.

Number two is Christian Boltanski, who has been able to elicit viewer response to the point of tears just about, by collecting photographs in old thrift shops, et cetera, and installing them as memorials that make them appear as if this is a memorial to a Holocaust survivor. None of this is true. These are random photographs that are just gleaned out of thrift shops.

I think this sort of question of determining—over-determining in a way—the kinds of actions that are still so subtle with us is a great, exciting, fabulous space to be in. And I think that many artists would be more involved in this if you took the neurology part away.

Stafford: Suzanne, I actually use Thomas Struth in my *Echo Objects* book, because it seems to me it speaks to the intuitive level of the mirror neuron. I want to put something else on the table: that despised word “formalism.” If one thinks of morphology, if one thinks of D'Arcy Thompson—the ways in which not only the natural world, but also individuals intuitively mimic formats. In other words, where larger compositions even speak to us—again, it's a process of internalization, the way in which, for example, the people in Struth's photograph looking at Gericault's *Raft of the Medusa* actually fan out and instinctively order themselves vis a vis an aesthetic order. There's a kind of mimicking system. And that isn't the whole story, but it seems to me it's a really deep bodily intelligence whereby, as Dr. Freedberg and Vittorio just said, one does it before one understands it. In other words, intuitively you shape yourself to that, and then you interpret it afterwards, so it rises to consciousness afterwards. So I just want to say that Thomas Struth is actually dear to my heart.

Gallese: I would like to briefly bring up the issue of reductionism. Because I think there's a sort of paradox here. Who are the real reductionists? I mean, do we really want to reduce human nature, human experiences, and therefore art experiences, to a cognitive enterprise solely mediated by our most highly sophisticated cognitive endowments? It is only something to do with language. That's what they told us during the last 50 years. Thus cognitive science has produced a dramatic divergence between the domain of experience and the domain of knowledge. I think that neuroscience today—or at least a certain kind of neuroscience, because there are many options out there—can provide new ways of bringing back experience into the debate, not only in aesthetics but also on the larger issue of social cognition, interpersonal relations.

So we are not just pure representations of systems. We are embodied creatures, and we should give to the body what pertains to a body, which in my humble opinion plays an enormous role in social cognition and therefore in aesthetics as well.

Baudry: Could you define aesthetics a little bit more when you use it, because it's a word that is very slippery.

Freedberg: Right. I couldn't begin to define aesthetics, and I don't want to define aesthetics. Whatever it is that we call aesthetic responses must surely have a component that relates to the matter of embodied simulation, as Vittorio has rightly called it and as he has just pointed out. This must be a component of our responses to all works that we regard as art, but none of us now know exactly what art is, so I would step back. I mean this is a historical question. This is not a question for neuroscience.

Gallese: May I quote a very old author, Georg Christoph Lichtenberg? So we are in the second half of the 18th century: "Our body stands in between our soul and the external world, mirroring the effects of both." I think we are trying to investigate this particular aspect here.

Stafford: One can think of physiognomic theory, which Lichtenberg, of course, challenged. He said you can tell more by the way a person wears his or her hat than you can by facial analysis, and yet it seems to me both are wonderful. He brings action into it.

But I was very struck by what you said about 50 years of linguistic work, because to me, as an imagist, I'm kind of an Ezra Poundian imagist is what I think I am. Anyway, I'm going to identify myself as that. Because what's so exciting to me is all this work that's been done on cognitive linguistics, and it seems to me mirror neurons really open up the gestural—it opens up mantic, not hermeneutic, experience. That is, experience that goes to the level of ritual, performance, that is really body based.

We were speaking a few moments before we joined the roundtable about work by my colleagues in psychology, David McNeil and Susan Golden Meadow, on gesture and speech. That is, the ways in which gesture is not simply an embroidery on speech but is actually—experiments have been done that if you tie a person's hands down or you don't permit them to move their hands when they're speaking, the thought is not formed. So in that way this inactive process is really central, and it seems to me that it's also central to your work. There is a performative dimension, which puts mantics rather than hermeneutics back in the foreground.

Baudry: And you see that when people talk on the telephone.

Stafford: Yes.

Baudry: They gesture—

Stafford: Yes, even on the cell phone walking in the street. It's quite dangerous to navigate New York streets I discovered this afternoon.

Nersessian: If you have somebody throwing a ball—

Gallese: Right.

Nersessian: You're looking at it.

Gallese: Yes.

Nersessian: And the person who's looking at this person throwing the ball is told to do the opposite, how do the two systems work then?

Gallese: There is an interfering effect, because you have two competing motor representations, which get activated simultaneously. We carried out several studies to explore the extent to which our capacity to process and understand the meaning of a sentence—an action related sentence, a sentence which describes an action—can benefit of the activation of this mechanism. For example, it's a very simple task, a go/no-go task. You're listening to sentences. Your instructions are that if it is an action related sentence you have to press a button. If it is an abstract sentence you have to refrain from responding. And sentences can describe actions performed by a hand or by a foot. You might be required to emit the response either by the hand or by pressing a pedal with your foot. So when you are processing an action related sentence describing an action performed by a foot, your foot response is slower with respect to your hand response. Why? Because while you are processing the sentence you are simulating the action described by the sentence, and that motor simulation process interferes with the activation of the motor program required to effectively set into motion the very same effect described in the sentence. The same holds true if you do the experiment by employing trans-cranial magnetic stimulation. So even our processing of concrete words or sentences that describe action implies an activation of the motor system. To what extent this activation is required to understand the meaning of the sentence is something we need to investigate more. So we are not in a position to say that we understand by purely stimulating. But certainly it's striking, this systematic activation, which, by the way, occurs about 20 milliseconds after the word has been processed by the auditory part of the brain. So it's not that you listen to the sentence and understand by activating a putative linguistic specialized module, and then after the understanding process has been achieved you indulge in a kind of motor imagery. This activation of the motor system is almost immediate. We believe it plays a role in the understanding process. But we need to do more studies to back up this hypothesis.

Baudry: When I was raising questions, before, David said have patience. Well now I'm going to ask him the opposite, because I was asking two complicated questions. How do you imagine further study of mirror neurons? What additional light, or what aspects about the complex aesthetic response—this is in your fantasy now—it could help illuminate in the future?

Freedberg: I think there's one interesting way in which it might, and it relates to a point that Vittorio made earlier on. I've often thought most of us hold out the dream that some works of art will be accessible to everybody, or to more than those from our own culture. We know from our own experience that we can respond to works of art from other cultures, and we know that we can respond to works of art within our own culture. I think that perhaps—and I think Vittorio would agree with me—mirror neurons are not going to provide the solution to every aesthetic problem out there. It reinstates a dimension of aesthetic response, which has been absent largely from Western thinking about the arts—Barbara will know there are exceptions—but most of us, as I said earlier, are brought up in the shadow of Kant, who detached the emotions from art. To some extent, Freud also did this, because of the need for detaching too direct an engagement with the central aspects of the work of art, and it calls for reflection, as you know. I mean this is the idea in the West.

So what are the prospects, to get back to your question? I think one interesting prospect would be simply to alert viewers to the possibilities of understanding gestures, movements, within works of art. I think you could, in a way, sensitize less adept beholders to the possibilities inherent in works of art by suggesting not only what are the kinds of physical gestures that you respond to, but what kinds of emotions do you associate with those gestures? I should say that what is so interesting is that many of these ideas, of course, have antecedents. There was this great period of German empathy theory at the end of the 19th century, out of which, for example, came Aby Warburg and Aby Warburg with this notion that somehow the agitated drapery that swirled around dancing figures in Renaissance art was the outward expression of inner emotion. These are issues that I think we need to attend to more, and that are to some extent illuminated by the discoveries around mirror neurons. I think there is a step that needs to be made between the study of movement and the emotions that issue from them. I mean this is a question that William James, of course, raised and people have worried about ever since.

Baudry: I would have less of a problem if you spoke of response to images rather than response to art. Because I think there's a big difference. You're talking about responding to certain images, some of which might be art. But if you're going to bring in the word aesthetic, then you're going to have to show me how it relates to something, a work of art, rather than just an image. That would be very helpful.

Gallese: Well, certainly in aesthetic experience, when we contemplate a work of art, there has to be a very powerful framing effect. So in a sense, we are not involved in the stream of life. We suspend our immersion in the stream of life and we delimit within our attentional focus to a very specific spot on which we concentrate all of our personal attentional involvement. So that already should provide an amplifying factor. So, for example, I would expect that if we look at some apples or bottles, take a Cézanne or a Moran, for example, and we show them to participants and we contrast the activation induced by this observation with the observation of equivalent objects portrayed in a non-artistic—

Baudry: Or a bowl of apples on the table.

Gallese: Exactly. The expected outcome would be to have an increased activation of the motor system coupled with an enhancement of emotion related circuits in the case of the work of art with respect to the trivial rendition of the object as such, possibly with a very strong inference played by the degree to which the eye of the beholder is naïve or not. So what can be expected is a strong modulation of the personal expertise and personal history of the person contemplating that. So we should segregate different categories of viewers and different renditions of the same object. And by doing that, I think we'll probably be in a position to move a little step forward.

Stafford: I'd like to take a crack at your question as well and say that there may be two areas. One would be the role of ambiguity. It seems to me that one of the things that you were describing is the problem of whether one has, as it were, two competing systems. I mean I don't want to go the route of V.S. Ramachandran, who has of course studied this with considerable, one can say, too narrow a fashion. But it seems to me that what is interesting about cultural

productions of these sorts is this problem, which is a great problem, of uncertainty and ambiguity.

The other thing that I think mirror-neuron systems would shed light on is the ways in which certain kinds of art forms defy the system. I think of montage work, for example, work that refuses to mirror neatly, which means that at some level you have to understand the system. In other words you have to understand the way in which that system works in order to defy it. It seems to me that that one can have a great deal of historical specificity, but there's also a great stretch. One can think of emblem construction, for example. Again, in my book I talk a lot about compound images and composites. That kind of construction obviously plays with an intuitive understanding that it is, as it were, thwarting that mirror process so that you have both. So, I would like to add those two and say that paradoxically I think great things can be expected from the other side as well, by looking at it in terms of how it gets thwarted.

Anker: I have a question that was recently raised in a conversation with a curator who was here from London, who was actually doing a *Líneas* exhibition in London this summer in the Museum of Natural History. We were talking about film, and we were talking about the Luis Buñuel film in which there is the slice of the eye, and I said, "Every time I see that I have the same reaction." And she said to me, "You didn't see that, that it was the filmic cut that caused that reaction?" And that fits very much into what you're talking about in terms of montage.

Stafford: Yes.

Nersessian: But this system must not be that strong a system, because it has to be possible to constantly override it and have the opposite feelings—in other words, you could see somebody have disgust and you not have disgust, or more commonly you see somebody eating something that you find disgusting and they're eating it with great relish.

Gallese: Or I can be happy to see a person I dislike be in pain.

Nersessian: If what you are saying in terms of the emotions is accurate, because I can see the motor part. I'm not so clear yet about the emotional part. If that were accurate—if it weren't possible to overcome that—one couldn't be a psychoanalyst, because you would be constantly going from one emotion to the other not knowing where you are.

Gallese: As I said, we are not dealing with a Skinnerian mechanism. So my question is the following: How do I understand the emotional status of someone else, and then how do I react to that understanding? We should, I think, keep those two issues separate. Mirror neurons provide an answer to the first part of the problem. So how do I realize how it feels to be in a given emotional state? How does it feel to feel pain? How does it feel to be disgusted? How does it feel to feel anger? If we take as a sort of negative evidence what Asperger's patients refer to—what they talk about is the fact that they cannot directly access the meaning of the expression of a given emotion. They have to apply a theory in order to make sense of what other fellows are experiencing at that very moment, which is exactly the opposite of what many people claim, that the autistic dimension is due to a lack of theory. It's just the opposite. You need the theory to compensate for a lack of direct involvement, direct engagement. And disembodied mechanisms

are addressed exactly in this way, in my opinion. So this direct access to the experiential world of the other—

Nersessian: So it's more of a cognitive understanding, not an emotional one, because once you're talking about emotions—when you say I understand how you feel when you are sad, you are sad, but I'm not sad.

Gallese: Exactly. But in order to understand how it feels to be sad, you don't need to apply a hermeneutic strategy. You have a direct link with the emotional state of the other that may further on become the intentional object of your speculation, of your interpretation, of your analysis. So you empathize—well, I shouldn't use this word, which is terrible. It's polysemic. It's always tricky to deal with the word empathy. Nevertheless, you directly, intuitively realize the emotional state experienced by the other by means of this simulation-driven direct access to the experiential world of the other. But you can't, at that point, start with all the interpretation and cognitive elaboration of the outcome of this direct access. It's two different things.

Nersessian: Do you want to say something specific that is on your mind, or shall I go to the audience? Have you said everything you were going to say? Go ahead.

Audience: Well, for me, after this, neurons are here to stay. You mentioned about throwing the ball, and I played some ball. When I started I would imitate whom I watched. Snuffy Stirnweiss. I loved Joe DiMaggio. Even tried to imitate him, which is not right for me. After a period of time, I wasn't just imitating. My own style developed and became my style, which was pretty good. Now, I think everybody does that. Everybody who has anything to do with sports, for example, which is an art in a sense. They imitate. And I love that word intent, that we have the intent toward. You know, as Alex Rodriguez hits that homerun or whatever he does, we have that same intent, and we are feeling the same way. And it doesn't only go for sports. I mean, say poetry, for example. I did a little poetry, and if I hear Hardy, or some of the things I did, I can imitate it or I can, with the mirror neurons or whatever it is, I can understand it, whether I'm as good. Now the only thing is, it takes work with art. Say it's literature. Well, if you're going to understand it and really develop your neurons on it, I mean you have to do a lot of work. I mean *Bleak House* is not easy. And also you have to do a lot of work to get something out of it so that you have new neurons, whatever it might be. But they're here to stay, as far as I'm concerned. There's no doubt about it.

Audience: I'd like to ask David Freedberg to say something more about the trace of a gesture in Pollock and the response of the viewer in the context of mirror neuron systems, the response of the viewer to imageless works of art. I'm thinking in particular of something like the monochromatic works of Yves Klein or Franz Kline or Motherwell, which is not imageless, but is of course a particular kind of image.

Freedberg: Well the experiments are really Vittorio's domain, but our claim is that you have an understanding of the action that produced the cut or the action that produced the—I was going to say the stroke—in the splashes of paint of Jackson Pollock, the directed splashes of paint.

Audience: I can see it with a Pollock, but I'd be less ready to say that it's so evident in a work of somebody like Yves Klein.

Freedberg: Oh, well we were talking about this just last night. You can't see the gesture in Yves Klein, or even in Mark Rothko, for example. Rothko is a very difficult case. So this is one of the possibilities that we are now contemplating, but I think most of us would agree that you don't feel especially agitated when you look at an Yves Klein or especially at the kind of Rothko's you find in the Seagram murals or in the Rothko chapel. Why these pictures have this kind of serene effect on the beholder, there's something that we need to explore. But it may have something to do with the absence of the signs of action on those—

Audience: And the open text, so to speak, that allows one's own fantasies. It's very stimulating to the viewer's fantasy. I don't know whether that—

Freedberg: Well I think there are probably two stages here—on the one hand, we've been interested in the pre-motor cortex and motor cortex and the activation of neurons in the pre-motor and motor cortex, which presumably would be lower. I mean we haven't done these experiments. But you could do these experiments in the case of those large blank fields. One of the interesting things about the mirror research is people say to me, "So what? I knew that all along." But we now have a kind of neural substrata for those feelings that we intuited about pictures. We have neural substrata for our responses to those baseball hitters or the cricket players. I can tell you a story about cricket in a moment. I think we may therefore also have some kind of explanation for those feelings of serenity and calm in the case of the Yves Klein or Ad Reinhardt.

The matter of fantasy is, of course, a whole other question, because this is really a cognitive response, so I think there you would have to do a whole different set of tests, what ideas come into your mind. I mean these are so individualized that I myself would find some difficulty in devising experiments. I think actually to get back to Francis's question, a test for any consideration, a test for any future aesthetic must surely be the ways in which those parts of the brain that are involved in cognitive evaluation of automatic responses come into play when we look at a work of art. I mean that's really going to be the interesting project.

Baudry: One thing. I want to talk for a second about Waelder's principle of multiple functions.

Freedberg: Sorry, can I just say, I don't know whether that was enough, to begin with.

Audience: That was a good beginning.

Freedberg: Okay.

Baudry: Waelder talked about the ego as a sort of synthetic part of the person, and that each act solved a number of problems, and that the more the scope of problems is solved the more satisfying it is. And he said in his paper, though some people might disagree, that the act of love is the act that is most perfect in solving many problems. Now, if you look at a work of great art—and I like the idea of ambiguity, because I think it's central—our response to a great work

of art is going to be more complicated because of the role of ambiguity. Now what would be very fascinating from the point of view of the motor neurons is if you could show in some fashion that the response to a great work of art is more complicated neurologically than—now we'll have to agree that there are certain masterpieces, and if we could show some differences then in neuronal response, then we might have at least a point of entry into thinking about the complexity of the human brain and how it responds.

Audience: It seems that the mirror neuron discovery has been a major plank in the simulationist model of the mind and how it works, particularly the perceptual systems. And there have been other battles in other parts of the brain, for instance, with the perception of form and shape and size. Kosslyn at Harvard has made it pretty clear that we have analogical phenomena in our visual cortex. In other words, even if I imagine an elephant 10 feet away or an elephant 50 feet away, it's going to take up a different amount of my visual cortex so that it's, in their view, a depictive model of mind, as opposed to Zenon Pylyshyn, who has a computational coding system of perception. I'm wondering then, does the brain do everything in a simulationist way? And if so, if we think that, then we might push it into other areas. And I was wondering if things like mathematics and color, can that be done in a simulationist way?

Gallese: Well, I'm just starting from the last part of your question, about numbers. We have a paper that just appeared in the *Journal of Cognitive Neuroscience*. It's again a TMS experiment—transcranial magnetic stimulation. Very simple task: participants are looking at the computer screen, where numbers appear, numbers between one and four or between six and nine. And all they have to do is to say odd or even. While they are doing that, we are stimulating the part of the motor cortex that maps the movements of the finger of the hands. And it turned out that when subjects were processing numbers from one to four, but not when processing numbers from six to nine, there was a strong facilitatory affect on the muscle of the right hand. All our participants were right-handed. We haven't done the experiment yet on left-handed participants. So this implies that when you are not solving a math problem, you only have to determine whether three is odd or even. Nevertheless you are engaged in a motor stimulation, which recovers from your past experience most probably the way you learned to count, which in our Western society basically means using the fingers of your right hand. So this is one example. Do we carry out all of our cognitive activities by simply using simulation? I don't think so. This is only one part, probably the part which explains what of our cognitive world is more relevant in building our experiential insight into what it means to be a human being, what it means to experience pain, love, hatred, performing a particular action in order to accomplish particular intention and so on.

The point is that we still know very little. Don't trust the handbook of neuroscience. If you read the handbook of neuroscience, it's okay: form is there, color is there, shape is there. I mean it's an over, over-simplified version. Take for example, color. Many people in this room take for granted that color is analyzed by a modular system, area V4. If you ask people recording neurons from there, they will tell you that barely 20%, no more than 20% of the neuron recorded from area V4 actually codes neurons. Another mystery: our visual system is organized in such a way that the axons of the neurons which receive their input from the rods and cones, ganglion cells—these axons form the optic nerve, the optic tract and then project to the lateral geniculate body, which is the thalamic nucleus specialized to process visual information. The lateral geniculate

body projects in turn to V1, the primary visual cortex. Well, there are far more connections back from V1 to the lateral geniculate body than there are connections from the geniculate body to V1. What is the functional role of this backward connection? We simply don't know. I mean, the decade of the brain was a highly optimistic idea. I don't know if anyone entertained the idea that in ten years people were going to solve the mysteries of the brain. We need a couple of centuries at the very least.

Stafford: May I just say one thing at the macro level, just about the math. There is a very interesting group of mathematicians now who are actually studying the performative dimension of diagrams. That is, the way in which diagrammatic formulas, things like Feynman's diagrams, are actually performatives. And these are operational images, so I just wanted to say at the macro level there is really an instantiation of what you're also saying going on at the neural level. I could say more about color, but I'll park it. Thanks.

Gallese: In a sense, PowerPoint, when giving classes, can be a disaster. When I had to teach for the first time the compliance curve of the chest-lung system, I realized afterward I was perhaps capable of having my students understand what was going on by drawing the function manually with the good old chalk on the blackboard, because you literally construct the function, and you have a motor resonance, which most likely is not so powerful when you simply have this snapshot-like projection of a slide. So Bill Gates probably would be happy to listen to this, but to the extent that we can use our digital tools in an interactive way, so we could have people learning math functions by using their mouse, so we have a digital version of the chalk, this seems to help. And I talk to people who are teaching math at the university, and they are exploring this more interactive way of teaching mathematics to even graduate students.

Audience: That's a good point. I think that there are two things on my mind, and one is grappling with how we even converse with one another and where we're at at any given moment in terms of being able to converse meaningfully with one another. And the level of that in terms of the neurons that was just raised—the experiments haven't been done. The whole thing about mirror neurons and imitation suggests a series of experiments, possibly in which developmentally one would follow infants and children—if that's possible. And in that context, also, one of the neuroscientists who was at a previous panel here, with a lot of agreement, made reference to the *Time* magazine article in January—

Stafford: Who was it?

Audience: I forget which person said it, but it was brought up that one of the problems with that type of media discussion is the tendency to abstract or to over-define. And what gets left out is that all of this is always a dynamic process. So you have on one level a series of experiments having to do with what happens when a child is imitating, and then later on both in individual development and in cultural development, what the interactions with other neurons are that are developed, and the significance of any of that to the kinds of issues we're dealing with, which get very complicated—art, love, truth. You mentioned truth earlier in terms of intention, if you were to ask the artist. But I think we have to somehow take a new step back in relationship to how we approach things, because if we're using an old language that bifurcates everything—mind, body, language—it doesn't seem to map what's happening in terms of what we're talking

about. The artist often speaks about it being a vehicle. Well, we can spiritualize that and say some divine thing is moving through you, or we can maybe look at it in terms of neuroscience and say that there's another level of functioning, and there's an interactive dynamic there that's very complex that the artist has with that. So the artist, if asked, says, "I'm just a vehicle." Is he lying, is he not telling the truth, or if he does the reverse and thinks he knows and gives you a statement of intention is he being dishonest or is he confused? None of that really seems to fit a contemporary view of what we're living through as we discover all this. So it seems one of the problems of all these discussions always is the time frame. You said more than ten years before the experiments could be done to show the complexity. I guess as a question what I'm getting to, at least on one level, is what kinds of possibilities or difficulties are we faced with in bringing this to, on a scientific level, a meaningful discussion in terms of what needs to be found so that our talking about it is equal to the complexity of what we're finding out? Did I make any sense?

Gallese: Well, we think at the very least that we are progressing step by step. So every time we gain some sort of empirical evidence, this empirical evidence triggers new hypotheses. These new hypotheses in turn trigger new experiments. So it's like raising the stakes slowly but steadily every time. So when the evidence is telling you that you are wrong, then you have to revise your hypothesis. That's what we are doing. That's what most scientists do. Our empirical problem is to understand where we are going to stop. I mean not in doing science—that will never end. That's so enjoyable, doing research. So hopefully I will continue for many years. The point is how far can we go? What is the real explanatory role of this mechanism? And when one realizes that these mechanisms are not the key to explaining complex cognitive aspects of behavior, how these more direct, lower level mechanisms do relate to, more cognitively speaking, sophisticated mechanisms. That I think is one of the key issues we are asked, probably not to solve, but to address with the future research.

Levy: Vittorio, one question that relates to something that Barbara had mentioned before, and that was when you brought in the question of mimesis and Auerbach has the famous book on mimesis. You created a timeline. The first experiments were with the macaque monkeys. You discovered the mirror neurons.

Gallese: By the way, the ice cream story in the *Times* is not true.

Levy: But you've got some kind of anomaly here, in fact. The mimesis within the timeline in human development was actually a revolutionary activity. In other words, we start to view this kind of mimetic activity going on in animals. But in human life itself, wasn't the advent of mimesis a revolutionary activity—the ability to embody the human being as an image? Like the significance of the primitive cave painting, for instance.

Stafford: Can I respond? Before you raised this question, I was going to say I think what would help a great deal would be taking a look, as you obviously have, at developmental psychology, but also the enormous amount of work now on prehistory, and enormous amount of work on cognitive archeology, cognitive anthropology. And also—I'm going to mention a rather beleaguered figure—somebody like Bruce Lahn, who speaks of the Paleolithic revolution as well, and one can ask in what ways did this fit really within a revolutionary schema. I mean I think somebody like Edelman, for example, would offer a kind of support to answer that

question I think that you were raising. So the ways in which it really speaks to other areas, I think, gives it context.

Audience: I have an observation and a question. I grew up in the art world. All my family were artists and I've visited most of the great museums of the world. I personally have a tremendous emotional response to art, and I collect it, and when I see something on the wall of my house it just enlivens me with power. I want to talk about Rothko and a number of the other artists you've mentioned who do not have specific form but have strong color, and I want to make the observation that the power of color is not fully understood. My wife is a lawyer—on the wall, I created two pieces of artwork, and one was a very strong red color, and when she feels lackadaisical, non-power, she can look at that and actually it gives a power response to her. But when she's very hyper I have one next to it that is very blue and light greens, and it tends to relax her. The power of the color has a tremendous response. I think that's separate from form and separate from an emotional response we may get from mirror neurons. And therefore, I'm saying this: all the elements are so complicated that they are not easily segmented. Some people are not visually oriented and do not have a strong response to art. Others may have a background in liking one type of thing, and therefore they will mirror what they see, which will give a mirror back to them. Therefore, how we are oriented emotionally and aesthetically reflects how a piece of work can come back to us to a certain extent, and so a lot of people may not be able to respond to a certain form of art because they do not have any education or appreciation for it. My question is: have you done any research in mirror neurons without actually any way of seeing the response—let's say one person who has his eyes closed but the person next to him has a strong emotional response, an anger or fear or sadness? Have you done any experiment to see if the other person picks up without any—no? Because that'd be very interesting to see if that happens too. Because that may be a component we can pick up.

One of my hobbies is martial arts. The ability of one person to be able to pick up on non-visual aspects of what's happening in their environment has been documented many, many times. There's an old story of a famous sword teacher who was once meditating under a tree in Japan. One of his students was observing him and said, "Master is so controlled, his eyes are closed, he's very vulnerable." And he noticed the master stood up and looked around, and closed his eyes again. Later the master said, "It was very interesting. I was meditating and suddenly I felt a threat." And the student said, "Oh, I'm sorry master, that was me, because I had thought you were vulnerable." So the ability sometimes to pick up emotional situations from another person—I don't know if that would be the mechanism, but it may be something that is involved.

Audience: Yes, I'm a painter and I was very interested in the conversation earlier that had to do with gesture, and many of you used the word gesture in relation to painting. Barbara talked about the paintings of Grosz and Hogarth and the recognition on the part of the painter of emotional states and the ability of the painter to express those through the various elements of the painting. It made me think about the work of Giotto in the Scrovegni chapel in Padova, and the fact that so many of the beholders of that work in the 13th and 14th centuries were not what we would think of as literate people in the sense of reading, but were certainly aware of what those images were saying and understood that the gestures of mourning were embodied in those angels in the *Lamentation of Christ* and so forth. But I wondered if Suzanne could talk about the exhibition and talk about her work in particular, vis-à-vis this idea that in the 13th and 14th centuries we're

looking at bodies expressing and embodying gesture. And now we're looking into the brain and into the microscopic world for these kinds of understandings.

Anker: Well I think it's just another databank, in the sense that the predominance of images and the bombardment of images in our media culture creates a vast range of possibilities, and what I have found so interesting about scientific images is that they have a cultural dimension to them as well. They don't only function as sort of the residue of an experiment, et cetera. I mean what happens many times in science history is that science eats its own history, whereas in art that doesn't happen. So, for me to go to the scientific iconography and to repurpose it and look at it in terms of its value as a cultural artifact brings new information to the fore. And I'll just use these pieces on the orange wall as an example. Those are scans of Rorschach tests that I converted from two-dimensional inkblots into three-dimensional sculptures. I then took the three-dimensional sculpture and rescanned them back into two-dimensional objects, so that this relationship between two-dimensions and three-dimensions, between what seems to be a random inkblot, what seems to be a projective technique, what seems to have an enormous amount of historical and cultural baggage—everyone knows what a Rorschach test is. In fact, it's become part of the vernacular description of sort of, one can say, "more about you than about what you are saying about someone in that way." So with these new technologies, what was apparently looking like an amorphous kind of form as an inkblot, once they became objects—and I'm sorry I don't have any here, because we didn't have any place we could really put them—but when you can hold an imaginative projective test in your hand and it feels as if it's either a body part or a bone or a sea creature, there is this kind of atavistic response to a kind of primal recognition that something's there that you cannot quite decode, but you can recognize. In reading Peter Galison's book, he talks about the Rorschach as being one of the most studied tests ever. In fact, the printers of the Rorschach test, if it was too humid one day, wouldn't print it, so that there wouldn't be any sort of extra crinkles or wrinkles, et cetera. Now maybe I can ask the psychoanalysts here about the Rorschach test and whether you think that it still has psychological currency, or can in fact anything be used as a Rorschach test?

Nersessian: Well the Rorschach is standardized, so the responses are standardized and tabulated. I don't know enough about them. My wife is the expert on them, but you can't just use anything in their place.

Audience: So far, I've only heard about mirror neurons in responses to perception, but not to misperception. So you've talked about seeing someone throwing a ball and there's no misrecognition there, no misperception. And I'm curious to know what would happen if someone misperceived a subject throwing a ball, if the mirror neuron system would be set off in the same way or a different way or not at all? And also things like the Kuleshov effect, which is something from film theory. It's basically the following: You have someone's face on the screen and then there's a cut and you see a coffin, and then the same actor's face. Usually people think, oh, his expression changed. He looks very sad or pensive. But it's actually a still, so the face doesn't change at all. And then maybe you see a baby, and then the face again. He looks very interested. And then soup, and the face again, and he looks hungry. I'm wondering what kind of reactions the mirror neuron system might have to that.

Gallese: That's a very interesting question, and actually together with psychiatrists in Rome, we are running exactly that experiment. We are interested in combining the personality profile of the viewer with the outcome of his observation of the same action played against different backgrounds—an angry face grasping a spoon, a sad face grasping a spoon, a happy face grasping a spoon. We want to see to which extent the emotional system can modulate the responsiveness of the motor rationales, of the motor simulation mechanism. Dealing with your very interesting of your question about misperception: I felt that it could be somehow related to the topic of ambiguity, and to be honest I have no answer to that question. We don't know.

Baudry: Just one word on this. The role of projection is what we're talking about. Marlowe has written that our perception of outer reality is not just that we perceive outer reality, but outer reality the way we perceive it is conditioned by our inner reality, and this is what has been left out of our discussion so far. That is, the degree to which our perception is not of something out there but is really influenced by something inside here. And that adds another layer of complexity.

Stafford: I would say it the other way around. It's context. In other words, in how much is our perception context-dependent? To answer the philosophy question: coming out of areas like neuroeconomics there are now studies of misperception—faking. That's an interesting question. How do you know that the emotion is real or a false emotion? I mean there are those sorts of experiments—but there are, of course, ambiguous results.

Gallese: They're actually selling kits.

Stafford: Interesting how one detects the real from the false. I mean the 18th century was actually quite good at that. Lichtenberg was actually quite great at that.

Audience: I am a cognitive scientist in training. I wanted to actually use your example of the foot, Dr. Gallese, because that was a great example of how the mirror neurons interfered with the intentional sort of motor program. My question is: how could we relate this to people who have a profound ability to impact other masses and crowds and crowd mentality and sort of mob mentality and the loss of self that is often described by people who commit acts of violence in mobs and then later wake up and sort of have this sense of loss of self and loss of agency. I don't know if you can comment on that.

Gallese: It's a very interesting question, which would by itself serve another roundtable. Of course this is too far away from the current level being addressed by our benchmark.

Audience: I'm a stock trader. My question is: what role, if any, do mirror neurons play in the phenomenon of phantom limbs?

Gallese: Phantom limbs. Well, you create an illusion by seeing in motion the limb that you do not have, because the location at which the limb occurs is compatible with the location it would have if you still had it. So most likely, these activate a motor representation, which is still active. Indeed, there's a group of psychiatrists in Zurich who have been able to show that a lady with congenital limb deficiency, a lady who unfortunately was born without upper and lower limbs,

but still was capable of entertaining phantom limb sensation—they brain scanned her while she was entertaining this phantom limb sensation and, interestingly, what they observed was that during the phantom limb sensation what was active within her motor system was not the primary motor cortex, the part of the motor system which issues the command to the motor spine and neuron, which in turn activates the muscles, but within the pre-motor cortex. Within part of the mirror system. So the idea is that some of this motor representation might be hardwired, though fully plastic and exposed to the role of your own motor skills and personal history, as we were talking about before. The idea is that you don't need to have moveable limbs to have a motor representation of an action that could be in principle entertained. Most likely, the phantom limb effect described by Ramachandran, which, by the way, is a very powerful effect—I did the experiment myself. I'm not, luckily enough, limb deficient, but I have a strange asymmetry in my capability of moving my toes: I can do it with my right foot, but I can't do it with my left. So while on holiday just to relax, I put a couple of mirrors in the way described by Dr. Ramachandran. After some exercise, I was looking at my left foot as if it were my right one, so I could see it moving, and after doing it several times I realized I could begin moving my toes. So it's really powerful.