What Movies Say about the Mind: Neuroscience, Intentional Action and Rotoscopy

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Cognitive science, especially neuroscience, has shown more and more interest in art and aesthetics issues in recent years. This interest has manifested itself in a range of topics ordinarily thought of as belonging to human sciences, such as imagination, creativity or aesthetic emotions. The growing body of research in cognitive neuroscience of art aims at providing knowledge about how the brain responds to art techniques. The experience of listening to music or watching movies could then be described in terms of information processing systems, and not just in terms of personal experience, cultural influence or social constraints.

Within cognitive neuroscience, aesthetics is still not considered as a proper domain of research, except in the field of communication research where cognitive psychology is meant to provide empirical resources regarding audiovisual media, including movies. Although much work remains to be done, the investment of cognitive neuroscience in art, even secondarily, contributes significantly to our understanding of the aesthetic mind, by emphasizing what precisely cannot be subject to control. Cognitive science and cinema are, among other things, fantastic ways to recall to us that we see and heard, first of all, with our body.

My aim in this contribution is to examine neuroaesthetics' contribution in the domain of movie studies. Experiencing a film is a true challenge for cognition, given the wide variety of stimuli we have to respond to when watching a film.

Seeing intention through the movies

The essential and the most challenging way in which cognitive neuroscience contributes to the understanding of the mind is to provide explanatory frameworks or, at a minimum, empirically justifiable hypotheses that account for both explicit/controlled mental states and unconscious/tacit ones that are represented in the brain. Yet when watching movies, we are not always aware of what and how we feel. An important part of our aesthetic responses to mediated information are, in some essential way, tacit and uncontrolled responses. In this case, the purpose of cognitive science is roughly to provide information about key aspects of the aesthetic mind, contributing secondarily to improving our understanding of cinema. Conversely, it may appear that cinema – as well as painting, music or dance – can be used as a tool by psychologists and neuroscientists to understand the body's way of experiencing reality.

Research in cognitive psychology has collected interesting data from experiments using moving images to better understand what are the neural and psychological mechanisms that enable us to perform complex social-cognitive tasks, such as mental state attribution. Using techniques such as positron emission tomography (PET), and functional magnetic resonance imaging (fMRI), Mar and colleagues began to visualise brain activities of spectators in response to moving image using partial rotoscopy.[1]

[1] Raymond A. Mar and Neil Macrae, "Triggering the intentional stance," in *Empathy and Fairness,* ed. Gregory Bock and Jamie Goode, Novartis Symposium no. 278, (2006):199-205; Mar et al., "Detecting agency from the biological motion of veridical *vs* animated agents," *Social Cognitive and Affective Neuroscience*, 2 (3) (2007): 110-119.

Picture 1. Example of rotoscoping animation portraying Donna Hawthorne (Winona Ryder) in *A Skanner Darkly* (Linklater, 2006) (© Warner Independent Pictures)

Invented by Max Fleischer around 1914, rotoscoping is an animation technique using digital video or traditional hand drawing: animators trace over each frame of a live-action movie projected onto a frosted glass surface so as to re-create animation that imitates the live action. Movies such as *Renaissance* (Christian Volckman, 2006), *2001: Space Odyssey* (Stanley Kubrick, 1968) and *Star Wars* (George Lucas, 1977) include some sequences in rotoscopy. Now, as far as I know, *Waking Life* (2001) and *A Scanner Darkly* (2006), both directed by Richard Linklater, are the only movies based wholly on rotoscoping. But the greater part of their aesthetic interest comes from the special rotoscoping technique they utilise: *Waking Life* and *A Scanner Darkly* (Figure 1) are indeed based upon partial rotoscoping, so that live action shots and animation partially overlap.

Partial rotoscoped movies, just as *Waking Life*, is a combination with digital images and photographs of real persons and objects. Interestingly enough, the ratio of that combination is not 50/50; the movie consists of a balanced mix between real footage and animation, which slighly varies between frames. Among other advantages, this technique preserves many of the cues from real footage, notably motion kinematics such as velocity, and biological features such as self-propelled movements and facial mimics. Howether, while real footage is incorporated, as it was, in the frames, *Waking Life* remains a cartoon.

(*Figure* 2) Julie Delpy and Ethan Hawke (*Waking Life,* Linklater, 2001) replaying one scene from *Before Sunrise,* directed by Linklater in 1995. In Mar et al.'s experiment, the scene is recreated using alternatively live-action footage and animated footage (© Mar et al. 2007).

The experiment is presented as follows: participants are shown the sequence in which Julie Delpy and Ethan Hawke, seated on a bed, engage in talk. Presented without sound, the video is made from 29 scenes that are each composed of between 1 and 15 shots which alternates between cartoon and real footage.[2] The video furnishes two sorts of perceptual stimuli for social interaction, depending on the specific frame, which keeps changing, althought the representational content remains the same (*Figure 2*). Interinstingly enough, the pictorial variations between the two existing data sets – the animated one and the photographic one – corelates with a change in neural pathways. The posterior superior temporal sulcus (STS) and the bilateral temporal parietal junction (TPJ), which are selectively involved in the attribution of intentions for behavior and detection of biological motion,[3] show a greater increase when participants watched live-action scenes compared to cartoon scenes. Moreover, the right middle frontal gyrus (MFG), another region implicated in social cognitive processing, is also more active during scenes using real footage.[4] By contrast, another area in the brain, the bilateral orbitofrontal cortex, shows a greater response in viewers when they viewed the animated footage. Why? How can we interpret these data?

Animated objects are generated mechanically with hand drawing or digitally with computer graphics. The representations that photography gives us are, in some respect, very different from those we get from hand drawing and these differences depend on the ways photography and hand-drawn animation are produced. As opposed to objects in photographs, they don't have ecological counterparts, since there are no causal relations between them and what it is out there, in the real world. Nevetheless, cartoons can be more realistic than photographs. The aliens of the *Alien* film series are highly realistic, even if *Alien* movies don't resemble what they represent, since Alien does not exist. The production of good realistic pictures cannot be reduced to a physical recording – mechanical or digital. To be sure, it becomes harder to distinguish between a living character in a movie and an animated one. But digital images in *Waking Life* have been specifically designed to imitate less realistic traditional hand-drawn animation.

How can using art works, in particular movies, inform interdisciplinary research on human cognition, including a central feature of human consciousness; that is, intentional action?

1. Understanding intentionality with motion perception

Mental states, such as beliefs, thoughts, desires, hopes, wishes, etc. are intentional in the sense that they are always directed on, or at, something. In philosophical literature, intentionality has long been regarded as constitutive of the mental.

Intentionality is a specific feature of propositional attitudes, that of being directed upon a object or being about something,[5] and it is currently understood as the causal source of actions. As such, intentionality plays a significant role in so-called "folk psychology" as the basic capacity to attribute intentions and other mental contentful states to others, and is also commonly thought of as the psychological explanation of what they do.[6] Since this aptitude is so deeply anchored in our

[2] Mar and Macrae, "Triggering the intentional stance," 115; Mar et al., "Detecting agency from the biological motion of veridical *vs* animated agents," 202.
[3] Michael S. Beauchamp et al., "Role ambiguity, role efficacy, and role performance: Multidimensional and mediational relationships within interdependent sport teams," *Group Dynamics, Theory, Research, and Practice* 6 (3) (2002): 229-242.
[4] Mar and Macrae, "Triggering the intentional stance," 116; Mar, R. et al., "Detecting agency from the biological motion of veridical *vs* animated agents," 202.
[5] Franz Brentano (1973 [1874]). *Psychology from an Empirical Standpoint*. L. McAlister (ed.), (A. Rancurello, D. B. Terrell, & L. McAlister, Trans.). New York: Humanities Press, p. 88.
[6] Alvin Goldman, "The psychology of folk-psychology," *Behavioral and Brain Sciences* 16 (1993): 15-28; Stephen Stich & Shaun Nichols, "Folk Psychology," in *The*

lives, it is easily extended to targets other than conspecifics. In fact, human beings attribute intentionality to almost anything, be it cars, shadows, geometrical objects or characters in animated films.[7]

There are many ways to describe an agent's behavior: as a specific type of reaction to stimuli, as a bodily movement, as determined by motives and intentions, etc. Firstly, intentional action does not consist simply in moving one's body, but in entertaining mental states about states of affairs, viewed as intended goals, that the action aims to produce. As developmental psychology puts it, people's ability to distinguish between actions that are performed intentionally and those that are performed unintentionally occurs very early in life. Experiments with new born children and non-human primates, because of their pre-linguistic intelligence, furnish good insights in this respect.[8] Secondly, describing my action as intentional means that I am not the object of external causal forces of my environment but the author of the action, in the sense that this action is the distinctive conscious experience that I am the author of the action when carrying out this performance – the "I" responsible of the action, generating questions, for example, about privilege-access and transparency:[9] Do we enjoy first-person authority about our own actions?

How is intentional action neurally implemented, if at all? What are the brain processes causally involved in the intentional control of behavior? Does the process associated with the identification of other's goals and intentions differ from the process associated with the identification of our own? In recent decades, with the growing interest in the use of brain imaging to study cognitive system, the emergence of understanding intentional actions and behaviors has become as much of a theoretical issue[10] as an empirical issue in cognitive psychology and cognitive neuroscience. According to the bottom-up approach involved in cognitive neuroscience studies, the feeling of producing events, such as actions and thoughts, through one's own intentional behaviour, does not result from higher-order computations of observational judgments, but originates in neural processes responsible for the motor aspects of action.[11]

Blackwell Guide to Philosophy of Mind, eds. Stephen Stich & Ted A. Warfield (Oxford: Basil Blackwell,2003): 235-255.

[7] See for example the classic experiment: Fritz Heider, F. & Marianne Simmel, "An experimental study of apparent behavior," *American Journal of Psychology* 57 (1944): 243-249.

[8] Maria Legerstee, "The role of person and object in eliciting early imitation," *Journal of Experimental Child Psychology* 51 (1999): 423-433; György Gergely et al*.,* "Taking the intentional stance at 12 months of age," *Cognition* 56 (1995): 165-193; Andrew Meltzoff, "Understanding the intentions of others: Re-enactment of intended acts by 18-month-old children," *Developmental Psychology* 31 (1995): 838-850.

[9] Lynn Stephens and George Graham,When Self-Consciousness Breaks: Alien Voices and Inserted Thoughts (Cambridge: MIT Press, 2000); Patrick Haggard et Sam Clark, "Intentional action: Conscious experience and neural prediction," *Conscious and Cognition* 12 (2003): 695-70; Shaun Gallagher, " Philosophical conceptions of the self: Implications for cognitive science," *Trends in Cognitive Science* 4 (1) (2000a): 14-21; " Self-reference and schizophrenia: A cognitive model of immunity to error through misidentification," in *Exploring the Self: Philosophical and Psychopathological Perspectives on Self-experience,* ed. D. Zahavi *(*Amsterdam & Philadelphia: John Benjamins, 2000b): 203-239.

[10] Donald Davidson, (1963), "Actions, Reasons, and Causes," *Essays on Actions and Events* (Oxford: Oxford University Press, reprinted in 1980): 3-20; Stephen Stich, (1981). "Dennett on intentional systems," *Philosophical Topics* 12, 39-62; John Searle, *Intentionality: An Essay in the Philosophy of Mind* (Cambridge: Cambridge University Press, 1981); Daniel Dennett, "Three kinds of intentional psychology," in *Reduction, Time and Reality,* ed. Richard A. Healey (Cambridge: Cambridge University Press, 1981): 37-62; Alvin Goldman, "The psychology of folk-psychology," *Behavioral and Brain Sciences* 16 (1993): 15-28.

[11] Christopher D. Frith et al., "Explaining the symptoms of schizophrenia: Abnormalities in the awareness of action," *Brain Research Reviews* 31(2-3) (2000): 357-363 ; Gallagher, "Philosophical conceptions of the self: Implications for cognitive science," 14-21; Gallagher, " Self-reference and schizophrenia: A cognitive model of immunity to error through misidentification," 203-239; Sarah-Jane Blakemore et al*.,* "Abnormalities in the awareness of action," *Trends in Cognive Science* 6 (6) (2002): 237-242.

Previous neuroimaging studies suggest that our brain responds differently to intentional movements when compared to accidental ones, and that intentional action is directly caused and controlled by neural processes.[12]

This emerging integrative approach appears to provide convincing evidence as to the neural correlates of something that is a key aspect of social cognition. Intentional action seems to be sustained by specific neural events in the motor areas of the brain, distinct from those involved in artificial movements. What is at stake behind the specific case of intentional action is the more general issue – and crucial one – of how understanding self and others as intentional agents, and to what extent we can have direct access to other's mind and our own.

Now, grasping intentional action involves another – more basic – ability to detect the presence of animated agents in the environment and to discern that sort of agents from artificially animated devices. In other words, we have to distinguish movements caused biologically from those caused mechanically or by accident.

1.2. Sense of agency and schizophrenia

Because this topic cuts across different disciplinary lines, it doesn't appear to be easy to seek a clear consensus on what "sense of agency" means.[13] Broadly construed, the sense of agency for a given action is the sense that one is the author of one's action. From simple perceptual signals, human beings have the capacity to understand and predict the goal-directed actions of others; that is, the complex motives and intentions which guide others' behavior. The sense of agency differs from the "sense of ownership" (or otherwise called "sense of subjectivity") for bodily movements, which is the sense that I am the one who is undergoing the movement; the sense I have that my arm's moving, whether the movement is voluntary or involuntary, means that the action belongs to myself.[14] In the case of unintended movement, these two modalities are clearly distinguished. If I am falling down on the escalator, I may enjoy ownership of my movement I have the sense that I am the one who is moving but I have no sense of agency for it, since I am not the agent who causes me to fall down. It concerns only my foot bumping solidly into a stair. Thus, the sense of ownership may be consistent with the lack of the sense of agency.[15] There is nothing abnormal in my having a thought or performing an action consciously without feeling to be myself the author of that thought or of that action. Within intentional action, however, the self is experienced immediately and non-representationaly in terms of its agency and its sense of ownership.

1.3. Intentional action and cartoon

Mar and colleagues' experiment is an example of how aesthetic objects – such as movies – can take part in the construction of scientific knowledge, including cognitive neuroscience with regard to embodied cognition and mentalization. Cognitive science provides us in return with fruitful insights about both old and new issues in aesthetics, notably perceptual responses to films.

[12] Benjamin Libet et al., "Time of conscious intention to act in relation to onset of cerebral activities (readiness-potential): The unconscious initiation of a freely voluntary act," *Brain* 106 (1983): 623-642; Christopher Frith and Utah Frith, "Interacting minds - A biological basis," *Science*, 286 (1999): 1692-1695.

[13] Shaun Gallagher, "The natural philosophy of agency," *Philosophy Compass* 2 (2)(2007): 347-357.

[14] See Shaun Gallagher, *How the Body Shapes the Mind* (New York: Oxford University Press, 2005).

[15] As for the sense of agency, neuroscientific studies, especially of brain damages, show that the sense of ownership of a body part depends on a subpersonal mechanism. Patients suffering from asomatognosia due to a lesion in the right posterior parietal cortex generally describe one part of their body as no longer their own. Edoardo Bisiach et al., "Remission of somatoparaphrenic delusion through vestibular stimulatio," *Neuropsychologia* 29 (1991): 1029-1031; Shahar Arzy et al. "Neural mechanisms of embodiment. Asomatognosia due to premotor cortex damage," *Archives of Neurology*, 63 (7) (2006): 1022-1025.

The modularity of vision leads to the related idea that different *types of visual scenes* could be correlated with different areas of the neural system. Intentional action involves a characteristic set of brain processes according to which "I" am causally involved in the production of my thoughts and actions. As Mar and colleagues' experiment shows, this functional difference in visual brain affects the way we respond to movies, especially the formal features of visual objects. Viewing moving images depicting either abstract human beings in cartoon animation or photo-realistic ones in live action footage gives rise to the perception of two sorts of action modalities. Now, it is a matter of degrees: more the stimuli presented are "realistic", more the neural responses associated with intentionality are active.

This dichotomous neural categorization of apparent motion and the correlated actions associated with the visual signals in the sequences, either biological intentional ones or abstract non-intentional ones, are consistent with previous studies according to which the neural encoding of motion perception depends on the observer's own body representation.[16]

2. Direct perception and ecological similarity

Mar's study provides clues about how perceivers interact with the outside world. Vision has evolved largely for controlling actions rather than creating internal representations. Implicit in the neuroaesthetic approach, as articulated by Mar and colleagues, is an epistemology which emphasizes the activity of the mind *in the immediate environment*. Following Gibson's ecological theory of perception, vision is conceived as a dyadic relation between the whole perceiving organism, moving around in its environment, and a physical object.[17] Many approaches along these lines have been proposed according to which neither conscious inference, nor internal representation is required for perception but only "invariants": evolutionary law-like patterns and repeated schemes of regular interactions between creatures and physical world.[18]

From that point of view, the intrinsic properties of the scene conforms to what we might called "the principle of ecological similarity". Emphasizing the evolutionary importance of detecting biological motion, Mar's results confirm that there are specific neural mechanisms for distinguishing between people and objects. It follows that the brain perceives others as having a mind, including fictional characters in animated films, if they are similar enough to the original biological pattern.[19]

It might be objected that cinematic motion is not real.[20] In Mar's experiment, as in other experiments using videos, the biomechanically plausible properties of apparent human action are *simulated* properties. Apparent human action is created by displaying a series of static images at temporal rates consistent with the amount of time normally required to perform a "true"

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[16] Maggie Shiffrar and Jennifer Freyd, "Apparent motion of the human body," *Psychological Science*, 1 (1990): 257-264; Jennifer A. Stevens et al., "New aspects of motion perception: Selective neural encoding of apparent human movements," *Neuroreport*, 11 (1) (2002): 109-115.

[17] James Gibson J., *The ecological approach to visual perception* (Boston, MA: Houghton Mifflin, 1979).

[18] For example, Kevin O'Regan and Alva Noë's theory of "change blindness' or the "indiscrimminability hypothesis" of James Cutting. Kevin O'Regan and Alva Noë, "What it is like to see: A sensorimotor theory of perceptual experience," *Synthese* 129 (1) (2001): 79-103; James Cutting, "Rigidity in cinema seen from the front row, side aisle," *Journal of Experimental Psychology* 13 (1987): 323-334.

[19] As I conceive it, similarity results from an internal process of recognition, akin to Schier's concept of "natural generativity". Flint Schier, *Deeper into Pictures: an essay on pictorial representation* (Cambridge: Cambridge University Press, 1986).

[20] See the debate between Trevor Ponech and Gregory Currie: Trevor Ponech, "External realism about cinematic motion," *British Journal of Aesthetics* 4 (6) (2006): 349-368; Gregory Currie, "Film, realism and illusion," in *Post-Theory: Reconstructing film studies*, ed. David Bordwell and Noel Carroll (Madison: University of Wisconsin Press, 1996): 325-344.

human action.[21] Still, it is about representation of motion, not physical motion in the first place. The central issue is whether or not we should limit the ontology of space to physical objects. If we don't, apparent motion can be a tool for explaining perception of intentional action, as much as physical motion does.[22]

As Christoph Hoerl puts it, apparent motion does not involve necessarily "the visual presentation of something that is moving."[23] Illusory motion is a kind of optical illusion that deceives our mind into seeing motion in a static image. But cinematic motion is not apparent – that is, illusionary – in that sense, "it is part of the phenomenology of our experience that we are visually presented with something that is moving."[24] If we accept that depiction of moving shapes – in cases where there is no moving physical object present – can be actually classed as a genuine instance of motion, than the fact that human motion perception can be studied with devices devoid of physical object becomes understandable.

[21] For an overview, see Randolph Blake and Mary Shiffrar, "Perception of human motion," *Annual Review of Psychology* 58 (2007): 49.

[22] Conversely, it might be objected that there is something physical in the cinematic motion, for, after all, the surface of the picture is a physical component which may interfere with information from the depictive content and thus invalidate the results. However, the surface properties should not be causally effective in cases where that surface is completely transparent.

[23] Christoph Hoerl, "Seeing motion and apparent motion," *European Journal of Philosophy* (2012):19 accessed December 31, 2013 http://philpapers.org/archive/HOESMA.pdf

[24] Hoerl, "Seeing motion and apparent motion," 19.

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