Multimodal Abduction
External Semiotic Anchors and Hybrid Representations

Lorenzo Magnani (lmagnani@unipv.it)
Department of Philosophy and Computational Philosophy Laboratory, Piazza Botta 6
27100 Pavia, Italy, and Department of Philosophy, Sun Yat-sen University,
510275, Guangzhou, P. R. China,

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Our brains make up a series of signs and are engaged in making or manifesting or reacting to a series of signs: through this semiotic activity they are at the same time engaged in "being minds" and so in thinking intelligently. An important effect of this semiotic activity of brains is a continuous process of "externalization of the mind" that exhibits a new cognitive perspective on the mechanisms underlying the emergence of abductive processes of meaning formation. To illustrate this process I have taken advantage of the analysis of some aspects of the cognitive interplay between internal and external representations. I consider this interplay critical in analyzing the relation between meaningful semiotic internal resources and devices and their dynamical interactions with the externalized semiotic materiality suitably stocked in the environment. Hence, minds are material, "extended" and artificial in themselves. I have recently provided concrete examples relating my philosophical points to neuroanatomy and neuropsychology taking advantage of an analysis of some aspects of *animal cognition* (Magnani, 2007b) and of the concept of direct and indirect *affordance* (Magnani, 2007c).

A considerable part of human *abductive thinking* is occurring through an activity consisting in a kind of reification in the external environment (that originates what I call semiotic anchors) and a subsequent re–projection and reinterpretation through new configurations of neural networks and chemical processes. In my recent research I have illustrated how this activity takes advantage of *hybrid representations* and how it can nicely account for various processes of creative and selective abduction, bringing up the question of how "multimodal" aspects involving a full range of sensory modalities are important in hypothetical reasoning.

I maintain that abduction is the process of "inferring" certain facts and/or laws and hypotheses that render some sentences plausible, that "explain" or "discover" some (eventually new) phenomenon or observation; it is the process of reasoning in which explanatory hypotheses are formed and evaluated. In (Magnani, 2001) I have introduced the concept of theoretical abduction, as a form of internal processing. There are two kinds of theoretical abduction, "sentential", related to logic and to verbal/symbolic inferences, and "model-based", related to the exploitation of internalized models of diagrams, pictures, etc.

Theoretical abduction illustrates and cognitively integrates much of what is important in creative reasoning in science, in humans and in computational programs, but fails to account for many cases of explanations (for example occurring in science) when the exploitation of environment is crucial. The concept of *manipulative abduction* (Magnani, 2001) aims at capturing a large part of agent's thinking where the role of action (and, in science, of what I call epistemic mediators) is central, and where the features of this action are implicit and hard to be elicited: action can provide otherwise unavailable information that enables the agent to solve problems by starting and by performing a suitable abductive process of generation or selection of hypotheses. The role of manipulative abduction and mediators in moral reasoning is illustrated in the recent Magnani (2007a).

Many commentators criticized the Peircian ambiguity in treating abduction in the same time as inference and perception. It is important to clarify this problem – also considering some perspectives that derive from the field of animal cognition – because perception and imagery are kinds of that model-based cognition which we are exploiting to explain abduction: in (Magnani, 2006 and 2007b) I conclude we can render consistent the two views, beyond Peirce, but perhaps also within the Peircian texts, taking advantage of the concept of *multimodal abduction*, which depicts hybrid aspects of abductive reasoning. Abduction is fully multimodal, in that both data and hypotheses can have a full range of verbal and sensory representations. In my recent research I have illustrated some aspects of this constitutive hybrid nature of abduction – involving words, sights, images, smells, etc. but also kinesthetic experiences and other feelings.

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