ISOMORPHISM AND MIRROR NEURON SYSTEM

Commentary Article on Eagle M.N. & Wakefield J.C., Gestalt Psychology and the Mirror Neuron Discovery[1]

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Eagle & Wakefield contend that Köhler's and Koffka's scientific speculations anticipate recent empirical and theoretical accounts of the so-called mind-reading ability (those skills that make up the cognitive capacity of ascribing some mental states to others in such a way to understand the meaning of their behavior) having it to be seen as intentionally driven and goal directed. The authors maintain that the Gestaltist explanation of it might be taken as an early formulation of some crucial features of mind-reading accounts based on the mirror neurons discovery and the embodied simulation theory, that is, the stress on a sort of direct accessibility to other's intentions, motivations and emotions, and the claim that this phenomenology is likely to be grounded on a neural mechanism shared by the observer and the agent.

This paper serves to give a constructive contribution to this contention by trying to specify the extent at which the Gestalt Psychology be consistent under certain respects with the mirror neurons system theory and the embodied simulation theory. Hence, I will split my arguments, dealing first with the mirror neurons discovery and then with the embodied simulation theory in order to spot those points that seem to leave still room for further discussion.

Rizzolatti & Gallese (2006) deem mirror neurons to be part of a broader motor system whose anatomical organisation and functions calls into question the received view about a merely executive motor system, which receives information from the associative and sensory areas resulting from a purely perceptual system as much as such attempts at clear cut separating distinct streams for perception and action. This system is supposedly composed by:

(1) some motor control circuits with motor, somatosensory and visual neurons;

(2) some circuits that transform spatial locations into motor terms defined as a function of head or arm movements with reference to either retinotopic or manifold somatotopic coordinates thanks to motor and somatosensory visual, tactile, auditive neurons whose receptive fields are kept in register in such a way to specify a peripersonal space;

[1] *Gestalt Theory 29* (1), 59-64.

(3) some circuits that transform visual information about the shape and dimension of objects in motor schemes as to the type of such action as grasping, tearing, holding, and to the way the particular grip is to be realized as well, thanks to visuomotor neurons that fire at the observation of an object while acting or at the mere presentation of graspable objects;

(4) some circuits that recognize others' actions, made possible by so-called mirror neurons that fire when both the agent acts on objects and sees another agent performing the same action; they show selectivity as to the type of action and the way it is realized, ranging from strict congruence, if an observed action must match the executed action as to its type and way of being performed to activate the neurons, to broad congruence, if only a type match between observed and executed action is required to trigger the neurons firing when the action is merely observed.

From this picture the motor system appears to coordinate motor control activities, different perceptual abilities related to space and object perception, recognition skills related to one's own and others action, in such a complex way to integrate them all with the function of the organization of actions, after receiving visual and kinematic information of objects and events processed by the ventral stream (V1, V2, ventral V3, V4).

Within this picture the great importance of the mirror neuron system becomes apparent. It helps in giving the world in which the organism lives a meaning along its perceptual and action dimensions, being the neurobiological basis for the phenomeology made up of agency, common ontological ground, interpersonal relationship, which set out the framework of ordinary life (Gallese 2000; 2003; 2005).

What can be said about the consistency of this picture with the phenomenology and the explanatory view of the Gestalt Psychology? An answer might be given at different theoretical levels.

Eagle & Wakefield's tenet that the isomorphism hypothesis could be given the same role played by the mirror neuron system in explaining the mind reading ability and, as I tried to sketch above, in building the framework of our ordinary phenomeology seems to purport the right answer at a general theoretical level. Indeed, the invariance of structural properties across neurophysiological processes, individual experience and overt behavior within one and the same agent allows for an observer and an agent to share and directly recognize the same meaning pattern in actions and behavior as much as being in the same neuronal state by the agent, thanks to the firing of the same mirror neurons when she observes and performs the same type of action, allows for him to match the intended meaning or mental state of another agent directly with the one she would be having were she performing the same action. Therefore, it is reasonable to say that the treatment Koffka (1935) gave to this issue, the analysis Köhler (1939; 1947) proposed about the direct phenomenological access to other's emotions, feelings, intentions and interests, or maybe even the theory of expression Arnheim (1949) worked out resemble very much the general explanation suggested by the mirror neurons theorists.

Even if Luchins & Luchins (1999) claims about the different forms the isomorphism has taken in Gestalt theory, the research on the mirror neuron system might prove a noteworthy candidate to satisfy the need to reformulate empirically the iso-

morphism hypothesis in the light of recent empirical findings about the anatomical and functional brain organization beyond the mere "neurophysicalism" displayed by the original proposal.

Much empirical research and very deep theoretical interpretation are obviously required to prove this suggestion right.

Moving from this general level to a more detailed one, it can be said that the mirror neurons show extremely interesting properties for a gestaltist point of view. Umiltà et al. (2001) and Rizzolatti et al. (2002) emphasize that mirror neurons are tuned not to the single movements that can eventually build up an action but to the whole action itself, that they respond to the interaction between an object and an agent, that some of them generalize the action goal across different various instances of it. Furthermore, it is an interesting property of mirror neurons to fire when an actual action (vs. a mere mimicry) is performed notwithstanding its last and more crucial feature (e.g., the grip of an object) is not visible to the observer. After excluding that this firing could be caused by a delayed neuronal response triggered by the initial phases of the observed action, by attention processes or memory storage, Umiltà et al. (2001) noticed that it is crucial that the observer sees the agent hand disappear behind the screen that makes the action end invisible. Though these Authors' explanation would not likely be consonant with a gestaltist approach since it refers to a form of knowledge over the inferred presence of the object that is the action target, it seems a point where gestaltist analyses of the phenomenological conditions at which for something being out of sight without not being phenomenally present could be trying to give a contribute, provided that the neural correlates to them be distinctly individuated and empirically tested as precursor or integrative mechanisms of the mirror system.

Leaving this speculation aside, I will take now into account the embodied simulation theory. First of all, it is worth noticing which is the concrete working proposed for the function of mirror neurons to be realised. Fadiga et al. (2000) conceive the mirror neurons together with the other visuomotor ones that transform space locations or object properties into motor properties as a map of potential actions that would be independent of their actual executions. The neuronal activity would be neither due merely to the intention to do something or to the attention paid to something nor to the motor preparation to act. These neurons' responses would be an automatic evocation of the action needed to interact with 3D objects, which then may guide its realisation or remain merely represented and available for the semantic knowledge, or the internal representation of the observed action. This neuronal system is therefore thought of as a motor repertoire of ideas of how to act to which the brain has an automatic access. This representational working is deemed the main trait of the mind-reading ability, since the representations or ideas would constitute the state an observer happens to be in at which the observed action goal should be matched in order to have direct access to an idea of other's mental state. This is likely the background that led Gallese & Goldman (1998) to take the mirror neurons mechanism as the neurobiological necessary condition for the mind-reading ability to obtain and to give an account of it in term of an embodied simulation theory. This theory dictates that there is no need of knowledge of law like rules or causal correlation among one's own or other's stimuli, internal states and external outputs to predict or ascribe mental states, as theory theory

would have it, because it is sufficient that there be a homology between the states of the observer and the agent as much as it is the case between an orrery and an actual situation to be modeled. But unlike the traditional simulation theory (Gordon 1986), the embodied simulation theory requires that the observer must generate a state that would be functionally equivalent to that triggering the observed action in the agent. This qualitative resemblance must be directly accessible via an off-line motor plan, that is an action plan tagged as other's and hence as one not to be actually executed. The mirror neurons are thought of as providing the pretending motor activity over which to match other's mental state.

To be sure, this theory is couched in such concepts as functional equivalence or similarity and predicts a direct (and not knowledge-dependent) access to shared phenomenal content of behavior (Gallese 2005), and that prompts to take it as being consistent with claims about internal relationship between meaning and apparent behavior and direct access to phenomenal properties made throughout the Gestalt Psychology. Nevertheless, there are some points that might need further discussion.

Talk of internal representation seems to be not a mere façon de parler. Gallese (2003a) makes explicitly the point from both a neurofunctional and a theoretical point of view, because every explanation must allow for error to obtain and prevent omniscience from being the case. However, the isomorphism hypothesis and all the Gestaltists' analyses of the phenomenal properties of objects, events or behavior were meant to dispense us with inner representations. Koffka and Köhler maintained that the perceptual world was provided by various sort of orderings that constituted the framework for other meaningful segmentations of it in functions of agency or social behavior. They tried to study the phenomenal relations in order to map them backwards to brain processes deemed to display the same properties as to their structural manifold. Indeed, Koffka (1935) stresses the inner relationship between neurophysiological states and physiognomic properties of experience and overt behavior, preserving for the latter a treatment in terms of phenomenal content of perceptual field. But his aim was to explain the meaning of the individual or interpersonal states not to the extent that they were mental rather as qualities to be treated as genuine phenomenal properties or facts. This phenomenological stance does not reject the epistemic request that justifies reference to representations not only as mappings but also in ontologically or epistemically substantive terms as internal states or representations. Koffka (1935) distinguished among real, phenomenal and apparent behavior in function of the difference between the geographical and behavioral environment but also of the difference between the various behavioral fields of the different agents and of the incomplete stance of every point of view. Therefore, the consistency of internal pretending states with the Gestaltists' phenomenology and explanatory stance seems to need to be further debated.

In conclusion, I think Gestalt theory might suggest a very interesting framework for the theories of mind-reading that reject the features of theory theory (Gordon 1986; Gordon & Cruz 2004), assuming the common access to a shared perceptual world is a strong central point around which to build empirical and theoretical explanations of mind-reading that will be also phenomenologically plausible.

Zusammenfassung

Der vorliegende Kommentar möchte einen konstruktiven Beitrag zu Eagle & Wakefields Behauptung (in deren Artikel in *Gestalt Theory 29,* 59-64) leisten, dass die Isomorphie-Annahme sowie die Hypothesen der Gestalttheoretiker über den unmittelbaren phänomenologischen Zugang zur mentalen Welt einer anderen Person neuere Forschungsbefunde über diese Vorgänge des „Gedankenlesens“ vorwegnehmen. Der Autor versucht herauszuarbeiten, in welchem Maß und in welcher Hinsicht die Gestaltpsychologie mit der Systemtheorie der Spiegelneuronen und der Theorie der „Embodied Simulation“, die die Grundlagen für diese Vorgänge zu erklären beanspruchen, tatsächlich übereinstimmt.

Dazu werden kurz verschiedene empirische und theoretische Fragestellungen angesprochen - die neurobiologischen Eigenschaften des Systems der Spiegelneuronen, die psychologische Erklärung seiner Funktionsweise sowie die Grundzüge der Theorie der „Embodied Simulation“. Davon ausgehend werden Übereinstimmungen dieses Erklärungsansatzes mit einigen gestalttheoretischen Grundannahmen diskutiert. Dabei werden Zweifel daran angemeldet, ob die in diesen neueren Ansätzen verschiedentlich formulierte Annahme einer Handlungsplanung im „Off-line-Zustand“ in Form innerer „Als-ob“-Zustände tatsächlich mit Koffkas Erklärungsansatz vereinbart werden kann, der das Erfassen des mentalen Geschehens bei einer anderen Person auf eine besondere Klasse phänomenaler Qualitäten zurückführt.

Summary

This paper aims to give a constructive contribution to Eagle & Wakefield’s contention (in their article in *Gestalt Theory 29*, 59-64) that the Gestaltists’ hypotheses regarding isomorphism and phenomenological direct access to other’s mind anticipate recent accounts of mind-reading ability. I attempt to specify the extent to which Gestalt psychology might be seen to be consistent under certain respects with mirror neurons system theory and embodied simulation theory, claimed to be founding the aforementioned ability.

Therefore, empirical and theoretical issues such as the neurobiological features of the mirror neuron system, the psychological explanation of its functions, and the features of the embodied simulation theory are briefly addressed. Further, some points about the consistence of this explanatory view with some key Gestaltist notions are made. It is argued that talk of off-line action planning as internal pretending states might not be consonant with Koffka’s attempt to explaining other’s mental states as a special class of phenomenal qualities.

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ACTION POTENTIALS AND REPRESENTATIONALITY: REPLY TO DR. CALÌ'S COMMENTARY

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We thank Dr. Calì for his very useful and rich commentary. Indeed, one could write a separate paper devoted to taking up the different topics covered by Dr. Calì's comments. However, we will limit our response to two issues.

First, Calì writes that according to Fadiga et al. (2000), mirror neurons along with other visual-motor neurons "transform space locations or object properties into motor properties as a map of *potential actions*" and automatically evoke "the action needed to interact with 3D objects". As Calì notes earlier, the mirror neuron discovery "puts seriously into question the received view about a merely executive motor system, which receives information from the associative and sensory areas resulting from a purely perceptual system….." In other words, there is no clear-cut distinction between the perceptual and the motor. Or, to put it another way, to perceive an object is not merely to register it passively, but to activate motor or action schemas regarding how one can interact with it.

Since our paper on which Calì comments is an historical one, it is worth noting some historical antecedents of this idea. We begin with Koffka's rejection of a dichotomy between the perceptual and the motor. He writes: "The point of view from which we have found it desirable to consider this connection between sensory and motor behavior, is that of regarding the whole procedure as an interconnected system in which the motor and sensory processes are not independent, as they would be were they connected by external bonds" (Koffka 1928, 163).

Of course, this is quite general. More directly germane are (1) Peirce's (1966) idea that the percept of an object is not simply a wholly sensory affair, but includes the repertoire of actions evoked by that object; and (2) James' "ideo-motor" theory of perception. (See contemporary versions in, for example, Prinz's [1987] concept of "ideo-motor actions" and Preston & de Waal's [2002] "Perception-Action Model.") The idea that the perception of an object is actually in part an experience of the potential actions one might take with or in regard to the object was also developed at length in the work of the Gestalt-inspired French philosopher Maurice Merleau-Ponty (Ref: Phenomenology of perception).

Second, Calì's comments raise a number of questions regarding how one conceptualizes the nature of representations and their role in understanding another. Can Gallese's embodied simulation and Gestalt isomorphism be understood in terms of sensori-motor representations or is that stretching the concept of representation too far? Calì makes the point that the Gestaltists believed that their isomorphism hypothesis and their analysis of phenomenal properties permitted one to dispense with inner representations in some mental processes. (This is also surely the intent of Merleau-Ponty.)

Calì appears to suggest that the explanation of error may require representationality, the idea being that only if one represents a situation can one have a false representation and thus be in error. However, it is not clear that one cannot also construct a different kind of theory of error in terms of a mismatch of projected action potentials within a nonrepresentational theory. Both philosophical and psychological work is needed here.

Also, Calì suggests that if one includes "internal pretending states" as an aspect of embodied simulation theory, one runs the risk of re-introducing a representational state that mediates between the perception and understanding of the other – a move that gets uncomfortably close to positing some kind of inferential process. In any case, as Calì observes, the relationship between embodied simulation theory, particularly the concept of internal pretending states, and Gestaltist phenomenology, merits further thought and investigation.

The question of representational mediation of perceptual processes, and of "unconscious inference" in perception, goes back to the dawn of psychology and remains one of its most contentious issues even in today's cognitive science. As Calì's commentary suggests, the mirror neuron discovery, and its resonance with the earlier Gestaltist theories that minimize the role of explicit representations in certain psychological processes (while not denying their existence entirely, as Calì cautions), will inevitably revise this profound controversy about the scope and limits of the role of representations in mental life.

Zusammenfassung

Die Autoren nehmen in ihrer Replik auf Cali´s Kommentar auf zwei Punkte Bezug: (1) Sie stellen fest, dass auch Koffka eine Dichotomie zwischen sensorischem und motorischem System zurückwies; sie verweisen weiters auf die Beziehung von Cali´s Feststellungen zu verschiedenen anderen Ansätzen: Peirces Konzept der Wahrnehmung als einer Folge von Vorgängen, die durch ein Objekt hervorgerufen werden; die „Ideo-motor theory" von James; die ideomotorische Handlungstheorie von Prinz; das Perception-Action-Modell von Preston und de Waal sowie die Arbeiten von Merleau-Ponty. Sie gehen (2) kurz auf Calìs Feststellung ein, dass es den Gestalttheoretikern ein Anliegen war, mit den Vorstellungen von innerer Repräsentation Schluss zu machen, und dass die neueren Versuche, Fehler in der Wahrnehmung des mentalen Zustands einer anderen Person zu erklären, auch zur Wiederauferstehung dieser alten Repräsentationsansätze führen könnten.

Summary

We take note in our reply to Dr. Calì's useful and rich commentary of two issues: (1) We note that Koffka also rejected a dichotomy between the sensory and the motor systems; and relate Dr. Calì's observations to Peirce's conception of perception in terms of a repertoire of actions evoked by an object; James' ideo-motor theory; Prinz's ideo-motor action, Preston & de Waal's perception-action model; and Merleau-Ponty's work. (2) We also comment briefly on Dr. Calì's observations that the Gestaltists wanted to dispense with inner representations; and that an account of error may require a concept of representations (i.e., false representations).

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