RICERCHE

What philosophy, if any, is needed for cognitive science?

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█ **Abstract** The question posed in the title serves as a springboard to examine the interdisciplinary nature of cognitive science and the role philosophy should play. I will argue that philosophy has a clearly defined role to play over and above the contributions made by philosophies specific to the various disciplines engaged in cognitive science. I also point out that by engaging with cognitive science – an endeavor defined by a clear scientific goal – philosophy itself will have to change in ways that are bound to affect the future of philosophizing. In the first part of this paper, I play devil's advocate, arguing that philosophy should not be amongst the disciplines engaged in cognitive science. In the second part, I discuss how the relationship between philosophy and psychology has been changed by their common participation in cognitive science: psychology is now admittedly philosophical and philosophy has become naturalized. In the third part, I suggest that philosophy is better equipped than psychology to handle the thorny question of representation in cognitive science. In the fourth part and conclusion, I argue that cognitive science will influence both the theory and practice of philosophy: the futures of cognitive science and philosophy are tied together.
KEYWORDS: Philosophy; Cognitive Science; Cognitive Psychology; Naturalism; Epistemology

█ **Riassunto** *Quale filosofia – se una ce ne vuole – per la scienza cognitiva?* – L'interrogativo posto nel titolo funge da punto di partenza per analizzare la natura interdisciplinare della scienza cognitiva e il ruolo che la filosofia dovrebbe avere al suo interno. Sosterrò che alla filosofia spetti un ruolo ben definito, al di là dei contributi forniti dai particolari indirizzi filosofici coinvolti nella scienza cognitiva. Sottolineerò anche che, confrontandosi con la scienza cognitiva – un ambito caratterizzato da un chiaro obiettivo scientifico – la filosofia stessa dovrà cambiare, assumendo modalità che influenzeranno il futuro del filosofare. Nella prima parte di questo articolo metterò le vesti dell'avvocato del diavolo, sostenendo come la filosofia non dovrebbe essere tra le discipline coinvolte nella scienza cognitiva. Nella seconda parte discuterò come il rapporto tra filosofia e psicologia sia mutato per effetto della comune partecipazione al progetto della scienza cognitiva: ora la psicologia è apertamente filosofica e la filosofia è filosofia naturalizzata. Nella terza parte mostrerò come la filosofia sia meglio equipaggiata della psicologia per fronteggiare l'ostico problema della rappresentazione nella scienza cognitiva. Nella quarta parte e nelle conclusioni sosterrò che la scienza cognitiva potrà influenzare la teoria e la pratica del filosofare: il futuro della scienza cognitiva e della filosofia sono reciprocamente legati.
PAROLE CHIAVE: Filosofia; Scienza cognitiva; Psicologia cognitiva; Naturalismo; Epistemologia

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PHILOSOPHERS ARE ALWAYS BOUND TO meta-philosophize because philosophy is both a "reflective" and a "reflexive" enterprise: "reflective" like any theory-seeking discipline; "reflexive" in that it applies to itself whatever it detects in the reality which it professes to study. Moreover, in spite of academically imposed specializations, the various branches of philosophy, with the exception of most subfields of logic (which have escaped into the mature formal sciences), cannot afford to be overspecialized into watertight compartments, either at its ontological center or along its value-infused periphery. How can we do ethics, aesthetics, and political theory without taking into account human nature and the problems involved in studying it? By the same token, how can we do ontology (a theory of what it is to be) without taking into account the powers, conditions, and limitations of those who attempt it?

The problem has become sharper since philosophy (traditionally a discipline within the Humanities) joined forces with four sciences in an interdisciplinary attempt to solve one of the last enigmas in our worldview, that of the human mind. Cognitive science makes a bold promise: to provide a final theory that explains mentality, with extensions into applications to be tested on a constant and, hopefully, progressive basis. As a result, philosophy, when involved in cognitive science, cannot be limited to some high-handed "criticism-from-above" (i.e., some kind of "armchair cognitive science"), but has to demonstrate serious contributions to this endeavor. What then can we expect of philosophy as a partner in this interdisciplinary campaign?

1 Is philosophy an unsuitable or superfluous partner in cognitive science?

Let us begin with the provocative claim that philosophy is not needed in cognitive science. We can classify the arguments for leaving philosophy out of cognitive science into two camps: In the first are those who might claim that philosophy as a discipline is not a science (with a core of commonly accepted doctrine) but rather an intellectual activity (i.e. philosophizing) that does not fit into a purely scientific joint venture. The second contains those who might claim that whatever philosophy could offer in this endeavor is already provided by the other four sciences involved (psychology, computer science, neuroscience, linguistics) or by their respective philosophies making philosophy superfluous in cognitive science. Let us begin with the first case and drum up the strongest defense for its radical claim.

In the first place, there is a serious dispute as to what kind of knowledge philosophy is supposed to offer. Some think it should be the Socratic tradition of critical enquiry aimed at conceptual analysis and clarification. This would even include philosophical attempts to employ ordinary language analysis to dispel the problems (in fact, puzzles) generated by language in the first place. Others look to the Aristotelian tradition for a final and complete theory of reality with all its neatly fitted components, more recently represented by various types of endorsement of reductionism and scientific realism. Between these two approaches, a series of other combinations may be advanced (in accordance with what is considered fundamental and what is considered derivative), but the widely accepted common ground is that philosophy traditionally deals with problems and puzzles that cannot just be solved by looking more carefully into nature and that philosophers should be ready to tolerate pluralism in their proposed solutions to such problems. At this point, the aims of cognitive science seem to diverge from philosophy. Cognitive science is an inter-scientific endeavor promising a testable and applicable theory of mentality. It cannot tolerate endless discussion about what "the mind" is, or what methods are appropriate for investigating it.

In the second place, it is hard to imagine what methodological contribution philosophy might contribute to cognitive science. The main benefit of an interdisciplinary approach to the mind is that the different sciences provide different methods for studying the mind. Psychology is an empirical experimental science that studies cognitive and behavioral phenomena. Linguistics is a formal science of symbolic systems that investigates the rules that govern the use of these symbols to convey information. It tests its theories on the basis of empirical intuitions as to what native speakers of the various languages would accept as grammatically correct and cognitively significant. Neuroscience is a biological science that deals with the physiology and anatomy of central nervous systems and their relations to animal and human behavior. Computer Science is a technological science (i.e., a kind of engineering), which leads to the construction and successful testing of artifacts (such as software programs). Given the above, what role could philosophy take on from a methodological viewpoint? What part of the mental remains to be systematically examined and how could philosophy provide a method for conducting this analysis?

But even assuming that philosophy does become involved in a dispute that has arisen within cognitive science and is prepared to advance a general thesis, like Fodor's *modularity architecture*[1] or a specific hypothesis, like Fodor's *language of thought*,[2] what kind of experiments or research projects could philosophy propose and successfully complete, in the way that the other cognitive sciences can? In general, what does philosophy have to propose that would advance the work of its partners?

It has to be admitted that although some of philosophy's celebrated negative philosophical arguments, such as Searle's *Chinese room thought experiment*,[3] inspired considerable discussion, they did not significantly affect cognitive science research nor contribute much in terms of significant shifts in cognitive scientific theorizing or research programs.

A final point to consider is that to understand a philosopher's proposal, one has to come to terms with the whole or a large part of his/her theory and often engage in complex tasks of interpretation. Let us keep in mind that philosophy is traditionally classified as a field within the humanities, where the individual perspectives which give rise to a position matters for a proper understanding of that position. Such activities are not in the interests of working scientists and rightfully so. Science divides and conquers, allowing work to be carried out by different teams and individuals who recognize common problems and accept background knowledge that unifies their efforts. Philosophy traditionally does not operate in this manner, except within some narrowly defined schools of thought. Should we only allow that such schools of philosophy work on cognitive science, and if so, what would be their basic tenets?

In response to the above claims, let us begin by abandoning two philosophical illusions. The fact that the term "mind" was introduced by philosophers does not endorse philosophy's candidacy for inclusion in cognitive science. All sciences started as parts of philosophy, but then matured away from philosophy. Even terms like "energy" and "matter" originally appeared in Aristotle's *Physics*. Yet these terms are now of little philosophical interest, while any philosophers who would like to speak about energy and matter are well-advised to know their physics well or at least better than their philosophy. Other terms, like "memory" or "learning", instead began their career in ordinary parlance, initially had a small place in philosophy, fared well in psychology, and now form part of cognitive science. Still, other terms, like "consciousness" or "intentionality" began their career in philosophy and (finally) reached a respectable position in cognitive science. It is clear that philosophy's claim to be included in cognitive science as an equal partner cannot be based solely on its history of involvement with the mind. This means that by including philosophy in cognitive science, we move away from a traditional conception of philosophy as a discipline of the humanities, which has to focus on texts in a historical and hermeneutic way that involves understanding individual perspectives. It is of little value to cognitive science to investigate in what sense Hobbes was an early computationalist. Worrying about courting Cartesian solipsism does not call for the exegesis of "cogito", but rather involves recognizing a grounding problem.

The second philosophical illusion is the old Aristotelian idea that philosophy, in general, and metaphysics (i.e., "first philosophy" or ontology), in particular, is the "most architectonic" of the theoretical sciences, as other sciences deal with more specific kinds of being, while philosophy deals with being-in-itself and in its totality, or what is called "the deep picture" (underlying picture) and "the big picture" (complete picture) respectively. In cognitive science, this illusion could lead to the idea that philosophy is needed to provide the ontology of the endeavor and to ensure some ontological orthodoxy or some methodological or other kind of correctness and oversight.

In response to this idea, one can see from its history so far that cognitive science needs no commissars for ideology or clergy for orthodoxy. As far as the ontology of cognitive science is concerned, it is formed by the leading working hypotheses that originated in the sciences involved. In the first stage of cognitive science, it was AI that provided the ontology of the mental as computations on formal symbolic representations, while the appropriate methodology[4] rested on reverse engineering, which led to some simulation tests, initially proposed by the first computational logician, Alan Turing.[5] At the same time, the arbitrary *multiple realization principle*, which made good technological sense, placed AI at the center of cognitive science and neuroscience at the periphery. Paradigm shifts in cognitive science are not normally caused by philosophical arguments critical of the existing paradigm, but by anomalies accumulated from normal research, which lead to the adoption of a new ontology and a new accompanying methodology. The shift from the computational to the connectionist paradigm was ushered in by problems encountered in real-time calculations for simple perceptual judgments, in degraded input problems, in the non-plasticity of hardware and software architecture as compared with the plasticity of the brain, and a nagging feeling that human and animal rationality is more connected to inductive rather than deductive practices. The next step, that of neural nets and PDP, came as promising solutions to the aforementioned anomalies, not as a response to the philosophical critiques of Dreyfus[6] and Searle,[7] who hastily adapted the Chinese Room into the Chinese Gym Argument in order to cover connectionist alternatives endorsed by Patricia and Paul Churchland.[8] As we are in the middle of a new paradigm in cognitive science that insists on "embodied" and "situated" mind, we witness a complete reversal, with neuroscience at the center of cognitive science proposing ontologies and methodologies and traditional AI at the periphery. Philosophical ideas, like Fodor's *Modularity* and *LOT*, and disputes, such as the dispute between Kosslyn[9] and Pylyshyn[10] concerning mental imag-

es, have contributed to the design of research in cognitive science. But shifts in the paradigm of cognitive science involve more than shifts in philosophical credo. Philosophy comes to the support of a cognitive science shift, normally after that shift happens, while at the same time, philosophers already involved in cognitive science often hold on to their old philosophical positions, even when cognitive science has moved away from them. On the one hand, one wonders if a philosopher working in cognitive science has to declare allegiance to eliminative materialism, identity theory, or epiphenomenalism. On the other hand, holding on to previously proposed approaches is understandable as older paradigms in cognitive science are not fully abandoned but continue to be employed and have special roles to fulfill. We may be far from the initial computationalism of the 60s and 70s, but we still hold on to principles advanced by computationalism, not just out of gratitude or nostalgia. We meaningfully remind ourselves, philosophers included, that "AI keeps us honest" and that unless we show the mental to be physicalistically constructible in principle, our work is not yet finished.

Another set of arguments against including philosophy in cognitive science is the idea that each of the other involved sciences already has its own philosophy (of AI, of linguistics, of psychology, even of neuroscience), so that a separate and equal philosophical partner would be superfluous. On the other hand, there are two ways in which this argument could be used to support the opposite conclusion. In the first place, if all the sciences of cognitive science come with their own philosophies in tow, one might argue that philosophy could serve as common ground where the four sciences meet. In this case, however, the metaphor "common ground" must be spelled out. In the second place, it is admitted that the philosophies of specific sciences normally deal with theoretical difficulties concerning principles upon which these sciences rest and philosophy is the rightful place where such principles should be discussed. In this case, the quasi-metaphorical term "principles" must be spelled out. We begin with the second task (principles) and hope to reach a determination of the first task (finding common ground) by the end of the paper.[11]

A science normally turns to its own philosophy on the level of principles which may lead to significant differences in methods or approaches or generate more than one school of accepted scientific doctrine. We can divide these philosophical problems concerning the principles of sciences into two general kinds. Those that pertain to the truth of the theories (and thus to the reference of theoretical and "bridge" terms, to rules of inference, and in general to whatever affects the objectivity of the science involved) and those that pertain to the ex-

planation and adequacy of the proposed theories. In psychology, for example, behaviorism challenged not only the objectivity of mentalistic approaches, which have to rely on what cannot be intersubjectively observed and measured, but also their explanatory adequacy, since mentalistic explanations, according to Skinner,[12] simply repeat the description of the behavior of the animal on another mental "homuncular" level, thus leading to circular, rather than real, explanations.

In the most traditional axiomatic setting of theory, principles include definitions or lists of primitive terms, axioms or postulates, and rules of inference. These sciences refer primarily to abstract forms, which are ideal objects and thus carry with them a sense of absolute certainty as to truth which seems coextensive with proof. Yet even here, philosophical questions of principle arise out of difficulties generated by the problematic status of the entities referred to and paradoxical notions like infinity or self-reference. An archetypical example in that score is the most axiomatic of sciences, mathematics, where to doubt fundamental axioms involving infinity, like Euclid's fifth postulate or Peano's mathematical induction axiom, or the law of the excluded middle, leads to different theorems and radically different approaches resting on restrictions that affect even rules of inference.

Moving on from the formal sciences of proof to the sciences of confirmation and explanation, which have natural kinds as their objects, their principles include fundamental conceptions of space, time, and causation, which allow for a plurality of philosophical approaches. Next to these fundamental conceptions there are, in each science, explicitly stated or implicitly assumed, some fundamental guiding principles which often deserve philosophical scrutiny. Examples of these are the "No Action at a Distance" principle, the "Conservation of Mass" and the "Conservation of Energy", "Least Action Principle", "Entropy", "Homeostasis" and even in psychology the well-known "Law of Effect". Moreover, a similar guiding role is fulfilled by certain proposed models and metaphors, like the planetary model for the atom, the "trial and error" model of learning, the tripartite division of our inner world (from Plato's appetite, sentiment and reason, to Freud's id, ego, superego, or the subconscious-preconscious-conscious division, to reptilian, mammalian, rational brain). It made good sense to retain a questioning, philosophical attitude in the early stages of modern medicine when Claude Bernard proposed a revolutionary conception of illness as continuous with (and not antithetical to) the normal healthy state. In the present time, however, when most of the science of medicine is secured by way of biochemical and micromolecular explanations, there is no task for philosophy to perform in theoretical matters of mainstream medicine, except in areas of medicine still

trapped in immaturity, like psychiatry.[13] Finally, and most importantly, in many sciences, principles include fundamental theoretical entities proposed to serve as the ontological basis of explanations. When the existence of such entities is established by experimental means, the need for keeping philosophical guard over that science is gradually eliminated and it proceeds to a mature stage.

Two points must be borne in mind. In the first place, as sciences mature and the reference of theoretical terms is established, there is less need for a philosophy of this science. Psychiatry and some parts of neurology still need philosophy, while the rest of the medical sciences can depend philosophically on the philosophy of biology and the philosophy of neuroscience. In the second place, a science that is reduced to another more basic science needs no philosophy, as the latter now carries the full weight of explanatory principles. There is no need for a philosophy of chemistry; there is a need for the philosophy of physics.

Sciences that are concerned with human beings, their activities, and their historically developing institutions, necessarily have an accompanying philosophy, even when they explicitly deny it. Depending on the definition of human nature they employ, and the place they assign to humans in the order of things, they avail themselves of different methods and principles. Like all sciences, the sciences of humans strive to be rigorous. Faced with the complexity of human phenomena, they often have easy recourse to truths by way of statistics, yet statistics will never provide the sought-after explanation. Even the ones that contain mathematized sets of laws that allow for predictions, like economics, offer explanations that rely on assumptions, such as rationality, whose nature is further investigated by sciences like psychology. Kahneman (who worked with Tversky) was awarded the 2002 Nobel prize in Economics for what was in fact a psychological investigation of reasoning practices, biases and errors.[14] Indeed, most, if not all, of the social sciences (following Thucydides as our first master) end up relying on psychology for the ultimate explanation of their principles. Psychology is in a position to undertake this role as it shares common ground with the natural sciences (specifically the biological ones) and borders on the social sciences (the branch of social psychology) as well as the humanities, in that, unlike most sciences, it focuses on the individual or personal element (rather than the universal) but, like a genuine science, feels obliged to attempt general theories that can handle the individual (the psychometry of individual differences and theories of personality).

From the above, it is clear why cognitive science cannot include any of the social sciences (not even anthropology), even though they all involve human mentality (with its normal rationality and occasional irrationality – or is it the other way round?), because these sciences depend for their explanations on psychology, which provides them with the only available means for reduction. They too are somehow "about the human mind" but make no attempt to explain it. At best they assume it in the way that psychology describes it in its best, worst, and in-between moments. If the sciences of the mind that are included in cognitive science could be reduced to psychology, the only philosophy needed in cognitive science would be the philosophy of psychology. But it was not destined to be so.

2 Psychology and philosophy (naturalized) cohabiting in cognitive science

In cognitive science there is yet no accepted final order of reduction; if there were, it would not be an interdisciplinary endeavor. Psychology in particular, which serves as the basis of reduction in the human-focused sciences is by no means the basis for reduction in cognitive science. Indeed, historically speaking, it is just the opposite, because cognitive science in general, with AI at its forefront, has provided a way for psychology to bypass its main foundational problem, that of psychophysical causation. Psychophysical interaction is primarily a problem of explanation that has precluded the successful reduction of psychology to the already mature natural sciences.[15] The model of the computer provided the idea (or the hope) that such a solution was possible and ushered in a new approach in psychology, that of cognitivism. Later, another approach, using inductive machine learning by parallel distributed processes, ushered in another approach in psychology and cognitive science, that of connectionism. However, this mentalistic courting of associationism did not eliminate cognitivism, which survived in the basic tenet that the mental is composed of representations that carry syntactic structure as a prerequisite of the compositionality of the mental.

We are now running through a period of embodied and situated intelligence, which at times questions even the very basic concept of representation,[16] and proposes a subsumption architecture of controlling and controlled mechanisms promising a very long road that starts with basic animal intelligence (the one that enables the fulfillment of the 4Fs) and reaches all the way up to rational animals of the homo sapiens species with their symbolic linguistic representations coming at the very end. It is clear that the obvious path forward, reducing psychology, to neuroscience, would not be an easy task.

Given the above limitations on psychological theorizing, what kind of role is psychology entitled to play within cognitive science, especially given the real possibility of its reduction to neuroscience

in some distant future? Psychology is the science that has dealt with the mind in an experimental way for over 140 years, while no other science has dared to investigate it systematically. Not only has it collected myriads of established major and minor truths concerning the mental, but in order to do so, it has divided up and organized the field in detailed ways: it has found, proposed, and diligently investigated many parts and kinds of attention, sensation, perception, memory, learning, thinking, knowing, reasoning, deciding, controlling, acting. Psychology is the meeting point for all the sciences in cognitive science because it provides the *explanandum* for all of them. In addition to psycholinguistics, which is the accepted common ground of psychology and linguistics, two sciences that have occupied guiding roles in cognitive science, AI and neuroscience rely on psychology in order to investigate their subject matter. Artificial Intelligence has to start with what is, or what constitutes intelligence, what are its kinds, and what psychologists have found in their attempts to detect, test, and measure it. Neuroscience (which has become cognitive) investigates the structure and functions of the brain using as a preliminary guide the rough and, very likely, erroneous maps of areas of the mind that psychologists have drawn. It is equally important that what psychology has to offer is not just a list of investigated items, but also some significant preliminary organization of these finds, including by way of explanatory schemes that psychology has put forward in its premature theorizing. In fact, the ground on which the edifice of cognitive science is built was provided by psychology. This real estate comes with a lot of solid ground but has entailed some false and perhaps wrong or questionable starts, which have nevertheless contributed many valuable insights.

It would appear then, that as far as theory and explanation are concerned, one could argue that whatever philosophy is to be practiced in Cognitive Science should be adequately and systematically covered by psychology, and if there is a philosophical residue not covered by psychology, this could be covered by the philosophy of psychology.

Without wishing to enter into a turf dispute between philosophy of psychology, philosophy of mind, philosophy of action, philosophy of language, we can agree on the fact that psychology, admittedly from the start a decided science, still carries an undeniable philosophical component that is broader than that found in other philosophies of specific sciences. If the term did not have an air of paradox in it, one could claim that psychology, in addition to being a biological science,[17] is also a science of the mental,[18] a social science,[19] a humanistic discipline,[20] and, yes, a "philosophical science" in that a philosophical perspective is necessary to handle all aspects of psychology, all three

levels of psychological explanation (behavioral, cognitive, neuroscientific), as well as the many recognized approaches to (or schools of) psychology that have produced valuable insights, research, or knowledge.[21]

Even though it has remained in many ways philosophical, psychology has been divorced from philosophy since 1879, and this was a much needed and very successful divorce for psychology, as it allowed it to proceed as a rigorous experimental science which has produced a significant number of truths. Still, the progress of psychology in amassing truths has not led to an undisputed theoretical synthesis and, as a result, philosophical concerns still accompany all facets of the field, including its practical applications. Although one can be a good mathematician, physicist, biologist or medical doctor, even if he or she has no inkling of the philosophy of mathematics, physics, biology or medicine respectively, the same cannot be said of psychology. It is not only the fact that "un-philosophical" psychologists will not have fully understood the articles and the books they have studied if they ignore the kind of philosophy that underlies these different texts that informed their education. It is also a matter of day-to-day use of psychological knowledge: even the practitioners of clinical psychology have to deal with problems of causal determination, control, freedom of choice, and rationality. They have to live and work on a day-to-day basis in a philosophical, all-too-human puzzle.

In the same light though, philosophy itself, even before the official birth of cognitive science, and prior to any commitment to cognitivism, had turned towards psychology, as philosophers realized that the justificatory foundational approach to epistemology (Cartesian doubt initiated modern philosophy and reached all the way into the 1950s) had no rational possibility of grounding knowledge on a secure self-evident foundation. As a first step, philosophy turned to language to investigate the limits of its ability to handle its problems. It then quickly realized that an integral part of its investigation would involve focusing on psychological results. A first naturalistic Darwinian step brought philosophy and psychology closer, by way of early functionalism, in the works of James and Dewey, but the idea of the mind as an organ that supports adaptation by way of learning led to behaviorism (influenced also by positivist restrictions on method). The love affair between analytic philosophy and behaviorism began with Russell's endorsement of its methodology[22] and continued with Wittgenstein's private language argument[23] and Ryle's explaining away of the mental as dispositions to behavior,[24] a line followed by Logical Behaviorism. The most systematic of the analytic philosophers, W. V. O. Quine, not only proposed and defended a naturalized epistemology[25] but even took many steps forward in that di-

rection, applying behavioristic approaches to the handling of meaning[26] and reference[27] in the philosophy of language. Philosophers who take the task of searching after truth seriously cannot ignore science on the basis of some all-purpose scepticist argument positing that science needs an epistemological/philosophical foundation if its results are to be accepted. In the same way that philosophers who want to find out about space and time have to take physics into account, philosophers investigating anything that involves human perception, thought, language, memory, or action, have to consult the sciences that have been systematically investigating these faculties for many decades. Since psychology provides the meeting point for all the cognitive sciences, as philosophy again mixed with psychology, it too became a part of cognitive science.

It appears then that, after a successful divorce, the two partners have come together but in a new arrangement for cohabitation. Serious philosophy and thoughtful, theoretically oriented psychology live under the same roof of cognitive science, collaborating on almost all problems, yet maintaining some independence where one of the two has some comparative advantage in handling certain problems. What are some of the rules that govern this new cohabitation and what specific role is philosophy to play in this new living arrangement under the roof of cognitive science?

3 Psychology and mental representations

We have argued that psychology provides the ground on which the edifice of cognitive science is built and that this contribution is primarily on the side of the *explanandum*: it has searched, found, and organized a vast number of truths (most minor, some major) concerning mental faculties. The search for these truths rested on grounds that invited philosophical scrutiny and had already generated philosophical controversy among psychologists themselves (even in the very beginnings of psychology, e.g., imageless thought, unconscious inference). Most of the truths uncovered by psychological research are not only of a statistical nature but also rely on ideas about the divisions of the inner world that are arbitrary or are based on what is called "folk psychology". Most of these classifications took place without neuroscientific or neuropsychological knowledge and were influenced in many ways by old-fashioned metaphors: in the best case, the tripartite nature of the soul, in other cases acknowledged myths, such as the well-known association of feeling love with the heart and body temperature. Some even rested on bits of universal human experience, like the peculiar connection between smell and memory, celebrated by Proust.

Phenomena associated with universal human experience that can also be observed or detected in the animal kingdom, such as attention, sensation, and perception, were thought to be sufficiently straightforward to be examined using experimental methods without recourse to serious philosophical scrutiny. But higher faculties such as sentiments and thoughts generate puzzles. It is difficult to identify sentiments beyond the most basic (whose expression is detectable in animal and infant reactions), especially when it comes to questions regarding their relations to thought and motivation. This indeterminacy even affects the experiencers themselves. Moreover, by focusing on the defense mechanisms of the Ego, the psychodynamic influence on psychology made even introspective examination of sentiments appear susceptible to bias and systematic distortion. Even beyond psychodynamic doubts, as emotions are subject to development and cultivation in the developing human, private edifices of emotional makeup, coupled with what is considered socially appropriate to feel or express, lead to an extremely confused picture, and the associated research has remained inconclusive. Nostalgia, to give just one example, made its official debut as a pathological disturbance that led to aberrant behaviors in persons forced to permanently live and work away from home, but was later recognized and even encouraged as a normal mature human feeling and even as a sought-after characteristic of artistic expression.

Moving from sentiments to thought, in the passage from sensations to higher cognitive functions memory (normally associated with learning) was an intermediate step considered accessible to psychological research. Here, with Thorndike showing the way, psychologists began by investigating learning in animals. They placed them in escape mazes and measured memory in terms of speed and errors in subsequent performances. Leaving aside the many kinds and aspects of memory, the field is an easily accessible experimental ground in which psychology reigns supreme. Still, it did introduce a fundamental notion that will remain a key source of philosophical puzzlement and involvement, the idea of representation (in the absence of any initial stimulus), which in spite of ontological and methodological doubts, remains with us to the present. This characteristic is readily extendable to the mental in its entirety. As Brentano has argued, intentionality specifically characterizes the mental, since it comprises acts that are aimed at objects which do not have to exist or exist in the same way as the actual intended object. The difficulties surrounding this notion usher philosophy into psychological theorizing in ways that cannot be ignored unless one decides to arbitrarily ban or ignore mental representations *tout court*. Even the Behaviorists' daring decision to study learning as the observable change of behavior in response to environmental stimuli, with no recourse to what is going on inside the skin or

"inside" the mind, finally led serious Behaviorists[28] to introduce representations by way of cognitive maps, readiness, pre-conditionings, predictions. Further violations of the *Classical and Operant Conditioning* models, in phenomena like "learned helplessness", show that learning cannot be divorced from sentiments or replaced simply by a neutral (or neutralized), observable reinforcement concept.

Representation is the key notion that all the disciplines in cognitive science have employed explicitly or implicitly in all research or theorizing. Given the enormous complexity of this Ur-notion, philosophy has to be constantly on call (and on guard) to handle the specifics of its employment and the implications and limitations of any experimental findings or theoretical proposals. Philosophy needs to make multiple contributions here to handle the many aspects, facets, kinds, characteristics, levels, and dimensions of representation.

4 Causal and formal aspects of representation in cognitive science

Philosophy's encounter and dealings with representation run all the way back to Plato's cave parable and Aristotle's brilliant insight that the mind, in its various cognitive functions, handles abstracted forms (not the actual matter) of things. Today, we see how cognitive science struggles with and employs the idea of representation or may explicitly call for assistance from philosophy as in the case of *Knowledge Representation*[29], which resurrected the old problem of categories. Our past and present philosophical involvement with representation not only runs deep but also wide, as wide as Nelson Goodman's[30] masterful treatment in *Languages of Art*, where depiction, description, exemplification, and expression are examined as types of symbolic representation in the arts (and not only in the arts, but also in other "*ways of worldmaking*").

From an ontological point of view, representation must be classified with relations. All the puzzling relations (causality and similarity are the *par excellence* examples) that hold between real things (not ideal or artificial or conventional ones) encounter the difficulty of determining how many *relata* are involved. At the outset we may stipulate that it has to involve at the very least two *relata*, the representing and the represented, something which is easily discernible in the case of the conventional "symbol-object symbolized" relation. In the case of natural (not conventional) representation relations, what often makes the relation problematic is the well-known "process-product" ambiguity: the process of representation becomes the product representing, a difficulty that can be extended in the opposite direction as well, given the multiple stages of representation involved from stimulus to mental image and, even further, to the word describing the mental experience. This problem also holds for conventional representations, although these are easier to disentangle.[31] Another dimension of complication arises for the conventional employment of symbols from the pragmatics of representation, when we take into account the one who introduces the representing symbol and those to whom the representation is addressed (even those that are to be excluded from understanding the symbolism) and the conventions that are taken for granted in this situation.[32] As we live in a world of mentality, surrounded mainly and often solely, by objects and symbols that presuppose intelligence of various kinds, learning the ways in which representations are to be interpreted, understood, and adopted, becomes the basis of our education and enculturation into responsible adulthood. Both difficulties outlined above require philosophy's assistance in the ways explored below.

In a preliminary stage, philosophy is needed to avoid or accordingly clarify the process-product ambiguity contained in representation. This is not a once-for-all task; it has to be repeated in steps as previous processes become products in the next step or vice versa. The task is not a pedantic distinction concerning nuances of meaning, as processes and products differ in terms of the kind of intentionality they involve. In the second place with respect to conventional representations, we begin, following Searle,[33] by distinguishing real intentionality (what any cognitive function has as its object/content) with the "as-if intentionality" of the employed symbol which is parasitic on the real intentionality of the user and intended receiver of the symbolic representation. This "as-if intentionality" is not limited to the arts and discourses that are properly the objects of hermeneutic disciplines of interpretation (i.e., the Humanities), since it relates to a central system of conventional representation that has acquired natural status and directly affects mental and brain processes. I am talking here about language which is learned in conventional social settings that employ different languages, all of which are nevertheless grounded in specific biological structures and exhibit universal characteristics, such as universal grammar and, perhaps, emerge from the language of thought. There is evidence that once language is engaged, even simple pain alarm functions in the brain are altered.[34]

There are two main aspects (or sides, if you prefer) of representation which are often intertwined so that careful philosophical work is needed to distinguish which part of which is involved in which part of the other. These two aspects of representation are the formal and the causal. The formal refers mainly to correspondences between various "representings" and "represented" (and parts thereof) and it mainly detects similarities. It reaches deeper into questions of abstraction, ref-

erence, isomorphism, truth, and categoricity, but its main advantage is that it becomes the ground that allows for compositionality, which is one of the characteristics of the mental, at least in its human language-infected instantiation. The causal aspect of representation refers to processes by which elements and parts of the represented object or event and its inner representing counterpart are connected in actual temporal sequences that lead from the world "out there" to the brain inside the skull, and to the mind that has emerged and is experienced in the brain. This causal aspect is connected to objectivity, grounding, reference, and necessity but its greatest significance for cognitive science is that it allows for causal intervention and interference which, in turn, yield experimental, or at least observable, facts. These two aspects, the formal and the causal, are intimately connected in our search for the mental, so that even straightforward laboratory research needs philosophical assistance to disentangle them and propose further even crucial experiments. To mention just a few examples, consider Pylyshyn's[35] cognitive penetrability experiments in mental imagery, Libet's experiments on conscious decision,[36] or McKoon and Ratcliff's experiments in the language of thought.[37]

The causal aspect of representation has two roles to play here. The first is that it allows for experimental approaches adding, subtracting or modifying factors in the represented or the representing factors at each of the many stages in a process or processes. Ever since Fechner noted the existence of an afterimage when the stimulus was absent, there has clearly been space for the added dimension of the mental (an 'in the mind' in addition to what is "outside the skin" and "in the brain"). The renewal of solid cognitive research in the work of Sheppard[38] and Kosslyn[39] relied on the absence and recall of the absent stimulus as a mental image. But the converse was also employed in Logothetis' experiments on binocular rivalry, where the stimulus is still present, but the final representation is absent from consciousness.[40] Neurological evidence for serious modifications to representations of the world due to lesions and disturbances of intermediate steps in processing abound in the work of O. Sacks.

The second important role of the causal aspect of representation is that it promises to be the way in which a reductive explanation of the mind could finally be achieved. There are good arguments in favor of the impossibility of a final and complete reduction of at least one important aspect of the mental, that is, the first-person subjective experience to the objectively third-person observable neurobiological substrate: T. Nagel's bats,[41] S. Kripke's (and D. Chalmers') zombies,[42] the induced color blindness of F. Jackson's Mary,[43] D. Chalmers' hard problem,[44] all of which can be neatly subsumed under J. Levine's explanatory gap argument.[45] As is the case with other scientific endeavors which leave fundamental problems unsolved, there is good reason for cognitive science to be happy that the explanatory gap is constantly narrowing and will continue to do so. Even if we have to live with a small, albeit diminishing, explanatory gap, this is a gap that "runs through us", it is 'our' explanatory gap, a devil we know and live with.

The two aspects of representation, together with their attending concepts and relations, have peculiar relations to logic. Even though they are foundational presuppositions of logic, they turn out to be recalcitrant to a full logical analysis. The formal aspect, resting on similarity, abstraction, and analysis, is a *sine qua non* presupposition for doing logic. At the same time, abstraction is a vague operation yielding different results regarding different aspects of form. Similarity is an equally, if not more, vague relation that any object has to itself and to anything else with some qualification, forcing us to always specify the respect in which something is similar to something else. When we compare it to other "logically tame" relations, like identity or equality, it is clear that it is not an equivalence relation: it lacks symmetry and transitivity, except in restricted mathematically defined contexts, like similar triangles.

In a similar manner, causality lacks a clear truth-functional profile and is also not an equivalence relation as it lacks both reflexivity (there is no "causa sui") and symmetry (indeed it has to be asymmetrical to allow for the temporal succession element of causality), while its transitivity holds only in restricted contexts. On the other hand, however, though causality seems too temporal to be analyzed by our atemporal first-order logic, still the key logical connective of the conditional (which spells out the key logical relation of implication, tested by the tautology of the conditional) is surely related to what the organism causes to happen and what it predicts will happen, or not happen, as a result of its actions. An ontologically parsimonious characterization of the mind/brain as "doer and predicter" surely needs an "if-then" construction as a quasi-logical basis that straddles the present and the immediate future or the immediate past.

The problems of logically analyzing causality spills over to the problem mentioned at the outset, the indeterminacy in the number of the *relata* involved in causal attributions. The point is obvious: how many factors are to be considered as having influenced an event? How far back should the search go, and how wide should this search be?

Hume had shown that the attribution of causality requires an inductive leap from "constant conjunction in the past" to an "always" to be provided not by logic but by psychology. Yet even in the case of singular attribution of causality in the past ("a caused b"), what is called for is a strong

condition of necessity stating that the result "b" would not have happened, had the cause "a" not happened. This appeal to counterfactual conditionals is not only logically suspect but generates further hopeless indeterminacy when counterfactuals are connected to further counterfactuals. To cut through this *conundrum*, law courts appeal to common sense to measure, attribute and allocate blame.[46] In addition, even in the case of attributing causality in normal scientific (not legal) contexts, Hume's third condition leads to lawlike generalizations. When we try to determine "lawlike", we need recourse to counterfactuals, and when we try to establish counterfactuals, we need recourse to lawlike-ness. The indeterminacy this time turns out to be of the "chicken and egg" type.

Applying the same insight from causality to representation, even in clear-cut cases of conventional symbolic representations, the relation is never a two-place connection between representing and represented, but at least a five-place connection: symbol *s* represents object *o* for user *u* who intends *s* to be understood by receiver *r* under convention *c*. Even in the case of road signs that are to be understood by everybody (illiterates included), there is evidence that what the sign indicates often fails to convey the intended message to the vast majority of users. When we move away from conventions and consider mental representations, there is ample literature to show that meaning is fluid and indeterminate. Even in something as common as memory recall, E. Loftus[47] has shown that recall is not a reproduction of the past but a reconstruction. The plasticity of the brain and the intimate connection between concepts and induction indicate that even for an individual user the meaning of a mental representation remains unstable. This holds not only for "belief-constituted concepts" (to use A. MacIntyre's term), but even for the simplest of qualia as to acceptable taste, which are subject to change, once one tastes something better, or something different, or learns something "distasteful" about what was ingested. Such changes can be radical, as the initial rejection of the taste of beer is replaced by enthusiasm, as in the celebrated example of D. Dennett. Although the notion of representation has generated opposition, for doubling our difficulties instead of helping with them,[48] there is hardly any doubt that it enjoys some kind of objective footing. Even by the most naturalistic and anti-mentalistic reckoning (that of B.F. Skinner), all that must be admitted is that there has to be some kind of entity or process inside the skin of the organism that corresponds or somehow relates to an event outside the skin that acts as a stimulus. Even in this minimal ground for representation, the two aspects of representation (causality and correspondence) come to the surface. The connection between the representation (the product) and

represented is a causal one, i.e., a process with many steps serving as products, or subprocesses, and not necessarily a one-to-one relation. We know, for example, that color perception involves more than one area of the brain. To make matters even more complicated, the direction of causality is never one way (from the represented to the representation), but runs both ways, often involving re-entries, even for something as basic and simple to comprehend as the alarm system of pain, which seems universal in the animal kingdom.

The task of clarifying the relations between the formal and the causal aspects of representation involves a host of concepts all of which are seen as part of philosophy's involvement with our inductive practices and thought, which began as part of philosophical psychology in Hume's thought, became part of epistemology after Kant, and continues to the present as part of the philosophy of science proper. To the extent that inductive practices are a main constituent of human intelligence, extending back to animal intelligence by way of learning, memory, discrimination, generalization, association, prediction, much of inductive thought has come under investigation by psychological research which has yielded important finds regarding confirmation bias (and other types of bias), in truths about concepts, and even theories of concepts (neatly separable into theories of similar features and theories of theory),[49] and even led Oaksford and Chater[50] to adopt a Bayesian interpretation of probability employed by the Personalist school of inductive logic, in the direction of a general approach to the mind as a predictor system[51] in which truth, falsity, and uncertainty have an intimate connection to sentiment.[52] We said earlier that psychology provides the ground (by way of providing the *explanandum*) on which the edifice of cognitive science is to be built, but it is the philosophy of science that offers the next step of evaluating and charting the ground and providing in this way a forum where cognitive scientific thinking can meet.

5 Conclusion: On the future of philosophy in cognitive science

Philosophy, then, has a major role to fulfill in cognitive science and will continue to do so as long as representation occupies center stage in cognitive scientific thinking. Specifically, philosophy allows for careful work clarifying the complex relations between the causal and the formal aspects of representation which are pertinent to both experimental and theoretical work. Its role however is not limited to providing ancillary distinctions for others to keep in mind while experimenting or theorizing.

Philosophy as part of cognitive science is in a position to propose small or grand hypotheses and theories, so it should have a part in testing and establishing such theoretical leaps in cooperation with the

other sciences, most often but not only psychology and linguistics. Fodor proposed at least two grand hypotheses: *Modularity Architecture* and *Language of Thought*. In his arguments in defense of his proposals, it is difficult to separate the philosopher, the linguist, and the psychologist. In an equally inspired way, Patricia Churchland coins the neologism "neuro-philosophy"[53] to characterize the attempt to solve problems in the philosophy of mind that are informed by new developments in neurobiological research. We expect that as the neurosciences uncover many new truths in the context of cognitive science, even common language is bound to change as a result of newer more accurate classifications of what is happening in our inner world.[54]

When it collaborates on cognitive science, philosophy is no longer part of the history of ideas (offered for the appreciation and enrichment of life). Though philosophical problems appear to be eternal, certain advances in the sciences can and do solve such problems, not as an all-or-nothing triumph of one "-ism" over all other "-isms", but as a piecemeal solution to parts or aspects of the problem.

The solution to Molyneux's Problem provided by later scientific discoveries, should not be seen as a victory of nativism over empiricism or vice versa, but as a careful account of what can be considered innate in the relevant cognitive functions and what is the product of learning or development, at what stages and under what conditions and in which animals.[55] In the same light, the problem of free will does not lead to a resolution of the three-way combat between libertarianism, soft determinism, and hard determinism, but is resolved by understanding the many ways in which the nervous system exercises control over bodily function, behavior and even thought itself. There is no one Grand Riddle to be solved differently by the many grand "-isms" but many smaller riddles that can be solved with adequate empirical support. Such solutions can be provisionally accepted by most of those concerned.

In December 1879, Wilhelm Wundt lifted himself up from his philosophical armchair, rolled up his sleeves and entered his newly founded laboratory at the University of Leipzig. Before becoming, in this way, the first experimental psychologist to initiate the divorce of psychology from philosophy, he had been occupying the chair of Inductive Philosophy at various European academic institutions. Could some inductive philosophy be the kind of philosophy needed by cognitive science?

Notes

[1] Cf. J.A. FODOR, *The modularity of mind*.
[2] Cf. J.A. FODOR, *The language of thought*; J.A. FODOR, *LOT 2*.
[3] Cf. J. SEARLE, *Minds, brains and programs*.
[4] Cf. D. MARR, *Vision*; M. MINSKY, *The society of mind*.
[5] Cf. A.M. TURING, *Computing machinery and intelli-*

gence.
[6] Cf. H. DREYFUS, *What computers can't do*; H. DREYFUS, *What computers still can't do*.
[7] Cf. J. SEARLE, *Could a machine think?*.
[8] Cf. P.M. CHURCHLAND, *The engine of reason the seat of the soul*; P. SMITH CHURCHLAND, P.M. CHURCHLAND, *Could a machine think?*.
[9] Cf. S.M. KOSSLYN, J.M. BALL, B.J. REISER, *Visual images preserve metric spatial information*; S.M. KOSSLYN, *Image and mind*.
[10] Cf. Z.W. PYLYSHYN, *What the mind's eye tells the minds brain*; Z.W. PYLYSHYN, *Imagery and artificial intelligence*; Z.W. PYLYSHYN, *The imagery debate*.
[11] Let us at the outset rule out one kind of philosophical involvement in the application of the sciences, especially those whose aims are more practical than theoretical: questions of moral application. This is not what we mean by "the philosophy of a science", since it only relates to ethics or politics. Medical science has applied aspects as do all the technological sciences. Their philosophical involvement in such aspects have acquired names, such as "medical ethics". Yet for medicine and for the science of AI, there are other theoretical aspects that deserve the name "philosophy of medicine" or "philosophy of AI".
[12] Cf. B.F. SKINNER, *Behaviorism at fifty*.
[13] In psychiatry, Claude Bernard's idea is disputed: some maintain that mental illness is continuous with normal conditions, others insist on sharply distinguishing the disordered from the normal mind, while others opt for eliminating mental disorder altogether on sociological grounds.
[14] Cf. D. KAHNEMAN, A. TVERSKY, *Subjective probability: A judgment of representativeness*; D. KAHNEMAN, A. TVERSKY, *On the psychology of prediction*; D. KAHNEMAN, *Who shall be the arbiter of our intuitions?*.
[15] Surviving even in the present discussion in J. Levine's *Explanatory gap argument* (cf. J. LEVINE, *Materialism and qualia: The explanatory gap*; J. LEVINE, *Purple haze: The puzzle of consciousness*).
[16] Cf. R.A. BROOKS, *Intelligence without representation*.
[17] In three ways: neuroscientific, evolutionary, behaviorist.
[18] A formal syntactic and, hopefully, semantic endeavor.
[19] With a historical and ethnographical component.
[20] Aiming at self-understanding, not prediction or control.
[21] From the most naturalistic to the most anti-naturalistic: neurobiological, evolutionary, behaviorist, psychodynamic, Gestalt, cognitivist, social, humanistic.
[22] Cf. B. RUSSELL, *My philosophical development*.
[23] Cf. L. WITTGENSTEIN, *Philosophical investigations*.
[24] Cf. G. RYLE, *The concept of mind*.
[25] Cf. W.V.O. QUINE, *Ontological relativity and other essays*.
[26] Cf. W.V.O. QUINE, *Word and object*.
[27] Cf. W.V.O. QUINE, *The roots of reference*.
[28] Cf. E. TOLMAN, *Cognitive maps in rats and men*; J. GARCIA, R.A. KOELING, *Relation of cue to consequence in avoidance learning*; R.A. RESCORLA, R.L. SOLOMON, *Two-process learning theory*; N.J. MACINTOSH, *Conditioning and associative learning*.
[29] Cf. J.F. SOWA, *Knowledge representation: Logical, philosophical and computational foundations*; A.B. MARKMAN, *Knowledge representation*.
[30] Cf. N. GOODMAN, *Languages of art*; N. GOODMAN, *Problems and projects*; N. GOODMAN, *Ways of worldmaking*.

[31] Compare, for example: (1) The representation (process) of the Last Supper occupied Da Vinci for 3 years, with (2) The representation (product) of the Last Supper has faded with the years, and with (3) The representation of the Last Supper follows St. John's Gospel (process or product?)

[32] Drawing or gesturing the abstract shape of a fish in the early days of Christianity, for example, was a way for someone to declare their Christian faith to someone they encountered who, if Christian, would have understood that the fish symbol referred (by Greek acronym) to "Jesus Christ God's Son Savior", but if not would think the symbol was vaguely about fish.

[33] Cf. J. SEARLE, *Consciousness and language*.

[34] Cf. P. REINVILLE, G.M. DUNCAN, D.D. PRICE, B. CARRIER, M.C. BUSHNELL, *Pain affect encoded in human anterior cingulate but not somatosensory cortex*.

[35] Cf. Z.W. PYLYSHYN, *What the mind's eye tells the minds brain*; Z.W. PYLYSHYN, *The imagery debate*.

[36] Cf. B. LIBET, *Cortical activation in conscious and unconscious experience*; B. LIBET, *Mind time*.

[37] Cf. R. MCCOON, G. RATCLIFF, *Priming in episodic and semantic memory*; R. MCCOON, G. RATCLIFF, *Spreading activation versus compound cue accounts of priming*.

[38] Cf. R.N. SHEPARD, *The mental image*; R.N. SHEPARD, L.A. COOPER, *Mental images and their transformations*.

[39] Cf. S.M. KOSSLYN, J.M. BALL, B.J. REISER, *Visual images preserve metric spatial information*.

[40] Cf. N. LOGOTHETIS, J.D. SCHALL, *Neuronal correlates of subjective visual perception*.

[41] Cf. T. NAGEL, *What is it like to be a bat?*.

[42] Cf. D. CHALMERS, *The conscious mind*.

[43] Cf. F. JACKSON, *What Mary didn't know*.

[44] Cf. D. CHALMERS, *Facing up to the problem of consciousness*.

[45] Cf. J. LEVINE, *Materialism and qualia*; J. LEVINE, *Purple haze*.

[46] Appropriately enough, as "*cause*" in Greek derives from "*aitia*", i.e., blame.

[47] Cf. E. LOFTUS, *Leading questions and the eyewitness report*.

[48] Cf. R.A. BROOKS, *Intelligence without representation*; R.A. BROOKS, *Flesh and machines*.

[49] Cf. J.S. BRUNER, J.J. GOODNOW, G.A. AUSTIN, *A study of thinking*; M.I. POSNER, S.W. KEELE, *On the genesis of abstract ideas*; D.L. MEDIN, M.M. SHAFFER, *Context theory of classification learning*; E. ROSCH, *Principles of categorization*; S. ARMSTRONG, L. GLEITMAN, N. GLEITMAN, *What some concepts might not be*; L.W. BARSALOU, *Context-independent and context-dependent information in concepts*; L.W. BARSALOU, *Ad hoc categories*; L.W. BARSALOU, *The instability of graded structure*.

[50] Cf. M. OAKSFORD, N. CHATER, *Bayesian rationality*.

[51] Developmental psychologists detect Bayesian inference even in 12-month old infants' cognitive dealings with the world, cf. E. TENGLAS, E. VUL, V. GIROTTO, M. GONZALEZ, J.B. TENEBAUM, L.L. BONATTI, *Pure reasoning in 12-month-old infants as probabilistic inference*.

[52] Cf. S. HARRIS, S.A. SCHETH, M.S. COHEN, *Functional neuroimaging of belief, disbelief and uncertainty*.

[53] Cf. P. SMITH CHURCHLAND, *Neurophilosophy*; P. SMITH CHURCHLAND, *Brain-wise*.

[54] While ordinary parlance has refused to change and replace "The sun rises" with its less poetic, scientifically correct equivalent, changes that affect our views on our 'inner world' are more readily adopted in common par-

lance. For example, most of the terms introduced by psychodynamic theories (repression, displacement, rationalization, oedipal, neurotic, etc.) have been adopted even though they were questioned by many psychologists and philosophers of science.

[55] A contemporary example of this old problem in a modern cognitive science setting in V. OCCELLI, *Molyneux's question: A window on cross-modal interplay in blindness*.

Literature

ARMSTRONG, S., GLEITMAN, L., GLEITMAN, N. (1983). *What some concepts might not be*. In: «Cognition», vol. XIII, n. 3, pp. 263-308.

BARSALOU, L.W. (1982). *Context-independent and context-dependent information in concepts*. In: «Memory and Cognition», vol. X, n. 1, pp. 82-93.

BARSALOU, L.W. (1983). *Ad hoc categories*. In: «Memory and Cognition», vol. XI, n. 3, pp. 211-227.

BARSALOU, L.W. (1987). *The instability of graded structure: Implications for the nature of concepts*. In: U. NEISSER (ed.), *Concepts and conceptual development*, Cambridge University Press, Cambridge, pp. 101-140.

BROOKS, R.A. (1991). *Intelligence without representation*. In: «Artificial Intelligence», vol. XLVII, n. 1-3, pp. 139-159.

BROOKS, R.A. (2002). *Flesh and machines*, Vintage, New York.

BRUNER, J.S., GOODNOW, J.J., AUSTIN, G.A. (1956). *A study of thinking*, Wiley, New York.

CHALMERS, D. (1995). *Facing up to the problem of consciousness*. In: «Journal of Consciousness Studies», vol. II, n. 3, pp. 200-219.

CHALMERS, D. (1996). *The conscious mind*, Oxford University Press, Oxford/New York.

CHURCHLAND, P.M. (1995). *The engine of reason the seat of the soul*, MIT Press, Cambridge (MA).

DREYFUS, H. (1979). *What computers can't do* (1972) Harper & Row, New York.

DREYFUS, H. (1992). *What computers still can't do*, MIT Press, Cambridge (MA).

FODOR, J.A. (1973). *The language of thought*, MIT Pres, Cambridge (MA).

FODOR, J.A. (1983). The modularity of mind, MIT Press, Cambridge (MA).

FODOR, J.A. (2008). *LOT 2*, Oxford University Press, Oxford.

GARCIA, J., KOELING, R.A. (1966). *Relation of cue to consequence in avoidance learning*. In: «Psychonomic Science», vol. IV, n. 3, pp. 121-124.

GOODMAN, N. (1968). *Languages of art*, Bobbs and Merrill, New York.

GOODMAN, N. (1973). *Problems and projects*, Bobbs and Merrill, New York.

GOODMAN, N. (1978). *Ways of worldmaking*, Bobbs and Merrill, New York.

HARRIS, S., SCHETH, S.A., COHEN, M.S. (2008). *Functional neuroimaging of belief, disbelief and uncertainty*. In: «Annals of Neurology», vol. LXIII, pp. 141-147.

JACKSON, F. (1986). *What Mary didn't know*. In: «The Journal of Philosophy», vol. LXXXIII, n. 5, pp. 291-295.

KAHNEMAN, D. (1981). *Who shall be the arbiter of our intuitions?*. In: «Behavioral and Brain Sciences», vol. IV, n. 3, pp. 339-340.

KAHNEMAN, D., TVERSKY, A. (1972). *Subjective proba-*

bility: A judgment of representativeness. In: «Cognitive Psychology», vol. III, n. 3, pp. 430-454.

KAHNEMAN, D., TVERSKY, A. (1973). *On the psychology of prediction*. In: «Psychological Review», vol. LXXX, n. 4, pp. 237-251.

KOSSLYN, S.M. (1980). *Image and mind*, Harvard University Press, Cambridge (MA).

KOSSLYN, S.M., BALL, J.M., REISER, B.J. (1978). *Visual images preserve metric spatial information*. In: «Journal of Experimental Psychology: Human Perception», vol. IV, n. 1, pp. 47-60.

LEVINE, J. (1983). *Materialism and qualia: The explanatory gap*. In: «Pacific Philosophical Quarterly», vol. LXIV, n. 4, 1983, pp. 354-361.

LEVINE, J. (2001). *Purple haze: The puzzle of consciousness*, Oxford University Press, Oxford.

LIBET, B. (1965). *Cortical activation in conscious and unconscious experience*. In: «Perspectives in Biology and Medicine», vol. IX, n. 1, pp. 77-86.

LIBET, B. (2004). *Mind time*, Harvard University Press, Cambridge (MA).

LOFTUS, E. (1975). *Leading questions and the eyewitness report*. In: «Cognitive Psychology», vol. VII, n. 4, pp. 560-572.

LOGOTHETIS, N., SCHALL, J.D. (1989). *Neuronal correlates of subjective visual perception*. In: «Science», vol. CCXLV, n. 4919, pp. 761-763.

MACINTOSH, N.J. (1983). *Conditioning and associative learning*, Oxford University Press, Oxford.

MARKMAN, A.B. (1999). *Knowledge representation*, LEA, London.

MARR, D. (1982). *Vision*, MIT Press, Cambridge (MA).

MCCOON, R., RATCLIFF, G. (1979). *Priming in episodic and semantic memory*. In: «Journal of Verbal Learning and Verbal Behavior», vol. XVIII, n. 4, pp. 463-480.

MCCOON, R., RATCLIFF, G. (1992). *Spreading activation versus compound cue accounts of priming*. In: «Journal of Experimental Psychology – Learning, Memory, and Cognition», vol. XVIII, n. 6, pp. 1155-1172.

MEDIN, D.L., SHAFFER, M.M. (1978). *Context theory of classification learning*. In: «Psychological Review», vol. LXXXV, n. 3, pp. 207-238.

MINSKY, M. (1987). *The society of mind*, Touchstone, New York.

NAGEL, T. (1974). *What is it like to be a bat?*. In: «Philosophical Review», vol. LXXXIII, n. 4, pp. 435-450.

OAKSFORD, M., CHATER, N. (2007). *Bayesian rationality*, Oxford University Press, Oxford.

OCCELLI, V. (2014). *Molyneux's question: A window on cross-modal interplay in blindness*. In: «Rivista internazionale di Filosofia e di Psicologia», vol. V, n. 1, pp. 72-101.

POSNER, M.I., KEELE, S.W. (1968). *On the genesis of abstract ideas*. In: «Journal of Experimental Psychology», vol. LXXVII, n. 3, pp. 353-363.

PYLYSHYN, Z.W. (1973). *What the mind's eye tells the minds brain*. In: «Psychological Bulletin», vol. LXXX, n. 1, pp. 1-24.

PYLYSHYN, Z.W. (1978). *Imagery and artificial intelligence*. In: C. SAVAGE (ed.), *Perception and Cognition*, Minnesota University Press, Minneapolis, pp. 19-55.

PYLYSHYN, Z.W. (1981). *The imagery debate*. In: «Psychological Review», vol. LXXXVIII, n. 1, pp. 16-45.

QUINE, W.V.O. (1960). *Word and object*, MIT Press, Cambridge (MA).

QUINE, W.V.O. (1969). *Ontological relativity and other essays*, Columbia University Press, New York.

QUINE, W.V.O. (1974). *The roots of reference*, Open Court, La Salle.

REINVILLE, P., DUNCAN, G.M., PRICE, D.D., CARRIER, B., BUSHNELL, M.C. (1997). *Pain affect encoded in human anterior cingulate but not somatosensory cortex*. In: «Science», vol. CCLXXVII, n. 5328, pp. 968-971.

RESCORLA, R.A., SOLOMON, R.L. (1967). *Two-process learning theory: Relationships between Pavlovian and instrumental learning*. In: «Psychological Review», vol. LXXIV, n. 3, pp. 151-182.

ROSCH, E. (1978). *Principles of categorization*. In: E. ROSCH, B.B. LLOYD (eds.), *Cognition and categorization*, Lawrence Erlbaum, Hillsdale (NJ), pp. 27-48.

RUSSELL, B. (1959). *My philosophical development*, Allen and Unwinn, London.

RYLE, G. (1949). *The concept of mind*, Hutchinson House, London.

SEARLE, J. (1980). *Minds, brains and programs*. In: «Behavioral and Brain Sciences», vol. III, n. 3, pp. 417-424.

SEARLE, J. (1990). *Could a machine think?*. In: «Scientific American», vol. CCLXII, n. 1, pp. 20-25.

SEARLE, J. (2002). *Consciousness and language*, Cambridge University Press, Cambridge.

SHEPARD, R.N. (1968). *The mental image*. In: «American Psychologist», vol. XXXIII, n. 2, pp. 125-137.

SHEPARD, R.N., COOPER, L.A. (1986). *Mental images and their transformations*, MIT Press, Cambridge (MA).

SKINNER, B.F. (1963). *Behaviorism at fifty*. In: «Science», vol. CXL, n. 3570, pp. 951-958.

SMITH CHURCHLAND, P. (1986). *Neurophilosophy*, MIT Press, Cambridge (MA).

SMITH CHURCHLAND, P. (2002). *Brain-wise*, MIT Press, Cambridge (MA).

SMITH CHURCHLAND, P., CHURCHLAND, P.M. (1990). *Could a machine think?*. In: «Scientific American», vol. CCLXII, n. 1, pp. 26-31.

SOWA, J.F. (2000). *Knowledge representation: Logical, philosophical and computational foundations*, Brooks and Cole, Boston.

TENGLAS, E., VUL, E., GIROTTO, V., GONZALEZ, M., TENEBAUM, J.B., BONATTI, L.L. (2011). *Pure reasoning in 12-month-old infants as probabilistic inference*. In: «Science», vol. CCCXXXII, n. 6033, pp. 1054-1059.

TOLMAN, E. (1948). *Cognitive maps in rats and men*. In: «Psychological Review», vol. LV, n. 4, pp. 189-208.

TURING, A.M. (1950). *Computing machinery and intelligence*. In: «Mind», vol. LIX, n. 236, pp. 433-460.

WITTGENSTEIN, L. (1953). *Philosophical investigations*, Routledge, London.