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EDITORIALE

What future for cognitive science(s)?

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Abstract In this introduction to the thematic issue on *the future of the cognitive science(s)*, we examine how challenges and uncertainties surrounding the past and present of this discipline make it difficult to chart its future. We focus on two main questions. The first is whether cognitive science is a single unified field or inherently pluralistic. This question can be asked at various levels: First, with respect to the disciplines that should be included in the cognitive hexagon and their reciprocal relationships: should we speak of cognitive science or of the cognitive sciences? Second, with regard to the conceptual and methodological changes (turns or revolutions) that have taken place within the cognitive project from its inception to the present day. Third, it pertains to cognitive psychology as a discipline. Before the emergence of cognitive science psychology was a fragmented discipline characterized by different traditions and approaches: has cognitive science been able to stem this fragmentation? Finally, we can question the unity of the cognitive architecture itself: is cognition produced by homogeneous or heterogenous mechanisms for information processing? We show that the issue of unity is addressed by several of the papers included in this thematic issue. In the second part of this introduction, we query the role that each component discipline should play in the cognitive project and in particular which should lead the project going forward, and why. Again, we show how this issue has been tackled by several articles featured in this collection.
KEYWORDS: Future of Cognitive Science; Cognitive Psychology; Pluralism and Cognitive Science; Philosophy and Cognitive Science; Fragmentation of Psychology

Riassunto *Quale futuro per la scienza cognitiva?* - In questa introduzione al fascicolo tematico dedicato al *futuro della scienza cognitiva* prendiamo in considerazione sfide e incertezze che caratterizzano il passato e il presente di questa disciplina, rendendo difficile prevedere il suo futuro. Due le questioni principali su cui concentriamo l'attenzione. La prima: la scienza cognitiva è un ambito unitario o intrinsecamente pluralistico? Questo problema si manifesta a diversi livelli. In primo luogo, riguarda le discipline che dovrebbero comporre l'esagono cognitivo e le loro relazioni reciproche: dovremmo parlare di scienza cognitiva o di scienze cognitive? In secondo luogo, riguarda le trasformazioni (svolte o rivoluzioni) concettuali e metodologiche avvenute all'interno di questo progetto dalla sua nascita fino ai giorni nostri. In terzo luogo, riguarda la psicologia cognitiva. Prima della nascita della scienza cognitiva la psicologia era una disciplina frammentaria caratterizzata da diverse tradizioni e approcci: possiamo dire che la scienza cognitiva abbia posto rimedio a tale frammentazione? Infine, il problema dell'unità sorge anche in relazione all'architettura cognitiva stessa, considerando che la cognizione potrebbe o potrebbe non essere prodotta da meccanismi omogenei di elaborazione delle informazioni. Nella presentazione che segue si cerca di mostrare come l'unità, in tutte queste varianti, sia una questione affrontata da diversi articoli presenti in questo fascicolo tematico. Nella seconda parte di questa introduzione prendiamo in considerazione il problema del ruolo che ciascuna disciplina componente dovrebbe svolgere nel progetto cognitivo e, in particolare, quale dovrebbe guidare il progetto e perché, ponendo in evidenza come anche questa sia una questione centrale, tematizzata da diversi lavori presentati in questo fascicolo.
PAROLE CHIAVE: Futuro della scienza cognitiva; Psicologia cognitiva; Pluralismo e scienza cognitiva; Filosofia e scienza cognitiva; Frammentazione della psicologia

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WHAT FUTURE FOR COGNITIVE SCIENCE(S)? Charting the future is a complex task that requires a clear and detailed understanding of the present and the past. When it comes to cognitive science the challenge is made even more complex by the many uncertainties that surround its present and past. First and foremost, we can question the identity of cognitive science as a scientific discipline. Should we speak of cognitive science in the singular, or are we dealing with an inherently and irreducibly plural field of study? How many and which disciplines can rightfully be considered integral parts of cognitive science? Has cognitive science as a discipline developed in a unified and coherent manner, or one characterized by fractures and discontinuities?

Even today, when we think about cognitive science, it is difficult not to conjure up that classic image: the cognitive hexagon, proposed in 1978 in a report presented by Samuel Keiser, George A. Miller, and Edward Walker to the Sloan Foundation.[1] Undoubtedly, for many professionals in the field, as well as non-specialists, this is the most common and widely shared representation of cognitive science; it shows a unified and transdisciplinary field of research fueled by contributions from different disciplines. The image of the cognitive hexagon has a twofold effect. From a descriptive standpoint, the vertices define the disciplines included in the project: anthropology, philosophy, artificial intelligence, linguistics, psychology, and neuroscience. From a normative perspective, the connections between these vertices indicate the roles attributed to certain disciplines – and reveal that some (particularly anthropology and philosophy) are less "central" than others.

The image of the cognitive hexagon was the result of a process of systematization that unfolded over a couple of decades. It was the outcome of a complex journey accomplished in several stages that affected the number and structure of the fields of inquiry involved in research on cognition. Interrogating the identity of cognitive science thus involves reflecting on this long and intricate process and wondering whether cognitive science has finally stabilized or instead continues to evolve.

The idea that cognitive science can be understood as a unified field of research and conceived as a singular scientific discipline can be traced back to a five-year period before the preparation of the report for the Sloan Foundation.[2] More specifically, to 1973 when Hugh C. Longuet-Higgins, a physicist and chemist by training and a scholar actively engaged in creating artificial models for the study of intelligence and perception, wondered, «what science or sciences are likely to be enriched by artificial intelligence studies?». Longuet-Higgins' answer is still relevant: «*all those sciences which are directly relevant to human thought and perception.* These *cognitive sciences* may be roughly grouped under four main headings: *Mathematical* – including formal logic, the theory of programs and programming languages, the mathematical theory of classification and of complex data structures; *Linguistic* – including semantics, syntax, phonology and phonetics; *Psychological* – including the psychology of vision, hearing and touch; and *Physiological* – including sensory physiology and the detailed study of the various organs of the brain».[3]

According to Longuet-Higgins, cognitive science cannot be conceived as a set of well-defined disciplines and their relations, but rather as a field of research formed by the overlap of various domains which are so closely interconnected as to form a unique whole. This is the reason why he suggests using the term *cognitive science*: «perhaps *cognitive science* in the singular would be preferable to the plural form, in the view of the ultimate impossibility of viewing any of these subjects in isolation».[4]

Longuet-Higgins' reflections have foundational value for understanding the construction of the theoretical and methodological identity that cognitive science assumed between its birth and the late 1970s, a period in which it found a more precise definition, culminating in the adoption of the cognitive hexagon as its institutionalized representation. The unity that emerged from Longuet-Higgins' reflection was of a theoretical, methodological, and linguistic nature: those disciplines that make up cognitive science must somehow benefit from the theoretical and methodological developments in artificial intelligence. Computer science and cybernetics were research programs capable of providing the theory, methodology, and language that would produce unity and, therefore, a seminal form of disciplinary identity in an emerging field of study. How? Perception, attention, competent language use, memory, problem-solving, decision-making and other aspects of intelligent behavior were theorized and described as types of information processing: they result from the way in which an organism detects processes and transforms available information, thereby giving rise to organism internal entities such as symbols and representations; the latter can be used to provide a causal explanation of human intelligence and behavior.

As the name suggests, *cognitive science* specifically investigates *cognition*. This term has a long and very important history in the philosophical and psychological lexicon; but took on a changed meaning within the lemma *cognitive* science.[5] As highlighted by Thomas Sturm and Hans Gundlach, the word *cognition* came to us via the Latin translation *cognitio* of older Greek terms (*gnosis*, *gignosko*) for human knowledge and the human ability to acquire knowledge. So, *cognition* originally referred to the acquisition, preservation, and (theoretical and practical) use of knowledge by the human

mind. This idea was emphatically summarized in 1732 in Christian Wolff's *Psychologia empirica methodo scientifica pertractata*: «cognitio est actio animae, qua notionem vel ideam rei sibi acquirit».[6] An echo of this definition can still be found a couple of centuries later in the entry for "*cognition*" in George F. Stout and James M. Baldwin's *Dictionary of philosophy and psychology* (1918): «cognition is an ultimate mode of consciousness coordinate with conation and affection».[7] Traditionally, the word cognition indicates the acquisition and use of knowledge and was intrinsically linked to consciousness, volition, and emotion.

And yet, this is not the sense in which the term cognition is used in the lexicon of cognitive science. The word *cognition* still designates an investigation of the processes by which individuals acquire, retain, and utilize knowledge, but from a very different perspective. *Cognition* is no longer used to indicate the *contents* (ideas) or *processes* (intellectual capacities or psychological faculties) of knowledge acquisition accessible from the first-person perspective but rather to describe the acquisition and use of mainly abstract knowledge separate from the *emotional* and *conative* spheres. The use of terms such as *cognition* or *cognitive* are strictly related to notions and concepts such as *information*, *information processing*, *computation*, *representation*, *symbol*, and *manipulation of symbols*.[8] As Ulric Neisser wrote in his *Cognitive psychology*: «the term "cognition" refers to all the processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used. It is concerned with these processes even when they operate in the absence of relevant stimulation, as in images and hallucinations. Such terms as *sensation*, *perception*, *imagery*, *retention*, *recall*, *problem-solving*, and *thinking*, among many others, refer to hypothetical stages or aspects of cognition. Given such a sweeping definition, it is apparent that cognition is involved in everything a human being might possibly do; that every psychological phenomenon is a cognitive phenomenon».[9]

As Neisser's quotation shows, by 1967 the transformation of the meaning "cognition" was already complete, especially if we consider "sensory input" and "information" to be synonymous terms. Cognition as a process of continuous acquisition and transformation of information gradually became *a foundational conceptual metaphor that offered a new metatheoretical framework for investigating human intelligence and behavior, one* that quickly captured general interest, especially in the field of empirical and experimental psychology.[10] The lexicon of computer science and cybernetics offered linguistic conventions, theoretical models, and conceptual metaphors which allowed psychology to go back to studying the mind. It could finally renew itself, breaking with the dominant theoretical models of the time, namely those provided by behaviorism.

In its attempt to make psychology part of the natural sciences, behaviorism reduced its object of inquiry to directly observable behavior, excluding any causal reference to entities and processes not directly observable. While this theoretical move had safeguarded psychology against the methodological and theoretical dangers of introspectionism, it also generated irreducible fractures and fragmentations in psychological knowledge. These fractures impacted, for instance, the relationship between experimental psychology and clinical practice, with implications for the identification, diagnosis, and treatment of psychopathologies, and led to an increasing diversity of opinions regarding the existence and role of "unconscious" processes in shaping individual overt behaviors.

According to George Mandler, psychologists enthusiastically embraced the "new" *cognitive* movement (which he believes emerged in the five-year period between 1955 and 1960) because of «the various tensions and inadequacies [of the psychology] of the first half of the twentieth century».[11]

The new language of cognitive science *promised* to overcome the *fragmentation* Mandler was referring to.[12] Describing human mental activity as continuous information processing and transformation seemed to provide a rigorous and scientific framework for psychology. Conceived in this manner, all mental activity could be thought of and described as a sequence of rules and a set of mechanisms operating at different levels, most of them under the threshold of consciousness and therefore below the level of awareness. Indeed, this new approach could account for unconscious dimensions of human thought in terms of subpersonal information processing: not all the information available to individuals is known to them; they are not aware of how this information is processed before they use it; and not all uses of available information are consciously and deliberately controlled. Mentalistic elements were reincorporated in the lexicon of psychology and mental activities could be considered to play a causal role in the production of intelligent thought and behavior.

Nearly seventy years after the birth of this new discipline, we can take stock and consider what may lie ahead. In particular, we can assess the current status of the project and consider whether cognitive science has actually helped us overcome the tensions and inadequacies of past theories of mind. And we can make predictions regarding future developments, asking in what direction this project will or should progress.

When the cognitive science project launched its new methodological and theoretical approaches to the investigation of mind, these were considered to constitute a (cognitive) "*revolution*".[13] Some authors believe there have been other revolutions or – at the very least – *turns* and *shifts* that have radically modi-

fied the original project. More precisely, they point out that the original project was never fully abandoned, but continued to coexist alongside new lines of research, leading to the development of multiple school of thoughts within cognitive science.

Typically, the (first) cognitive revolution is linked to the *brain as computer* analogy, a functionalist conception of the relationship between mind and brain, and the idea that information processing systems can be analyzed at three levels:[14] first, by describing the *computational* problems they must solve, i.e. the tasks it must accomplish; second, by identifying the *algorithms* that can solve these problems, i.e., the way in which system tasks can be accomplished; third, by determining how such algorithms can be *implemented* by the hardware, i.e., by the biological substrate. Two essential tenets of traditional cognitive science related to this idea are *internalism* and *representationalism*. As well summarized, for instance, by Mario Villalobos and David Silverman: «internalism, roughly, is the idea that the material realisers (or vehicles) of cognitive states and processes reside, always and entirely, inside the organism's boundaries (paradigmatically inside the head). Representationalism, on the other hand, is the idea that the intelligent behaviour of organisms is the result, at least partially, of the manipulation of content-bearing representations».[15]

Some authors argue that a second cognitive revolution, shift or turn occurred when this functional model of the mind was challenged by the development of *cognitive neuroscience*. Roughly speaking, the *cognitive neuroscience revolution* meant there could be no complete explanation of the mind independent of the brain; any psychological theory at the level of description begs investigation of its brain-level implementation. As Worth Boone and Gualtiero Piccinini state: «current neuroscience is empirically well grounded and should constrain our cognitive explanations».[16]

Other authors are inclined to consider the shift in attitudes towards culture and society as a second cognitive revolution, turn, or shift In his seminal book on the history of the cognitive revolution, Howard Gardner notes that the classical version of the cognitive project included among its assumptions a «de-emphasis on affect, context, culture, and history»: «though mainstream cognitive scientists do not necessarily bear any animus against the affective realm, against the context that surrounds any action or thought, or against historical or cultural analyses, in practice they attempt to factor out these elements to the maximum extent possible».[17] Over time, this attitude has changed to a greater or lesser extent.

In some cases, this change in attitude has led to the (relatively modest) acknowledgement that «culture and society constitute new functional systems and develop new human cognitive abilities and functions».[18] In other cases, however, developments of this idea have taken a more radical course. This is the case with so-called *4E cognition* (i.e., Embodied, Embedded, Extended, and Enactive cognition),[19] an approach which highlights the importance of considering interactions between the body, environment, tools, and actions in understanding cognitive processes and even suggests that cognition *emerges* from these complex interactions. At least some forms of *4E cognition* also challenge the very tenets of traditional cognitive science, i.e., internalism and representationalism, instead embracing externalism and antirepresentationalism. These more radical forms of 4E cognition propose a description of the mind that appear to offer a genuine alternative to classic cognition, and thus can be considered to constitute a real "revolution".[20]

The issue of cognitive revolutions/turns is tied the previously mentioned issue of disciplinary fragmentation in psychological models, a fragmentation that the cognitive project had promised to overcome/address/resolve. In fact, in the first half of the twentieth century, psychology was characterized by different traditions or schools. According to Ardila these included structuralism, functionalism, reflexology, behaviourism, gestalt, topology, psychoanalysis, and existential psychology: «the creators of these schools considered that they had the explanation for all psychological phenomena, that they had adequate methodology, and that they could also ignore all that was done by other schools».[21]

At least originally, the cognitive project might have provided an opportunity to consolidate and improve a solid and integrated evidence-based cognitive psychology over other psychological traditions or schools.

Yet, the idea that cognitive science could lead to the development of a unitary scientific picture of cognition does not come without problems. First of all, as previously mentioned, the cognitive project consists in a constellation of disciplines and it is not obvious what we should expect from this plurality of perspectives and in particular how/whether this can produce a unitary science of mind. The classic question that has been raised since the beginning of this project is whether these disciplines will or should develop into a unitary field of study, i.e., a cognitive science (in the singular) or whether they will or should remain a multidisciplinary domain described by the term cognitive sciences (in the plural). No final answer has been found to this question, even though at the moment, after almost 70 years of cognitive research, *de facto* the cognitive sciences have not reached any unity yet. Secondly, the goal of unifying cognitive psychology has traditionally been considered an extremely difficult if not impossible to achieve project – at least within such a short

time.[22] In fact, the multiple turns in the cognitive research that characterizes the history of this project confirm that we have certainly not reached the stage of unified psychological description. As cognitive research has continued to evolve, psychological theories may have become even more fragmented, and the project of a unified description even more elusive.

Finally, the problem of unity might also be raised at the level of the cognitive system and its processes. In this respect, one might ask whether cognition is produced by homogeneous mechanisms of information processing or whether different capacities or forms of knowledge are realized through different mechanisms and processes. If cognition is produced by a homogeneous set of mechanisms, we can at least strive to develop a unitary model of cognition and cognitive architecture. But this effort is futile if cognition is produced by different mechanisms and processes: in this case, some level of fragmentation or inhomogeneity would be an intrinsic characteristic of cognition.

Unity across all these variations is a question addressed by several of the papers included in this thematic issue. In this thematic issue on *The future of the cognitive science(s)*, Lisa Osbeck and Saulo de Freitas Araujo trace the radical transformation of cognitive science from its inception to the present day. In their paper, *The future of cognitive science is pluralistic, but what does that mean?*, they illustrate how the original project of cognitive science has undergone several quite radical, if little debated transformations. Osbeck and Araujo ask how we should conceptualize such transformations: do these new views still form part of cognitive science; are they still scientific approaches to the mind; has cognitive science become pluralistic? They argue that cognitive science already includes a range of different perspectives as well as different scientific approaches and methods and will continue to be pluralistic in the future. Pluralism, they point out, is not the same as interdisciplinarity: conducting interdisciplinary research has always been part of the cognitive project and yet, in its original instantiation, interdisciplinary approaches shared common assumptions. Neither does pluralism is entail relativism; in the authors' view, pluralism does not make it impossible to establish whether one perspective is better than another. The point is rather that our knowledge is necessarily limited and always in progress; only a multi-method approach can help us grasp this complexity.

This issue is also addressed – at least from a certain perspective – in Aurora Alegiani, Massimo Marraffa, and Tiziana Vistarini's paper entitled *Two open questions in the reformist agenda of the philosophy of cognitive science* and in Daniel C. Burnston and Antonella Tramacere's work, *Distributed loci of control: Overcoming stale dichotomies in biology and cognitive science*. Both of these works consider seemingly irreconcilable positions within the cognitive science and show that/how it is possible to find coherent syntheses that mend fractures by identifying new forms of unity.

Alegiani, Marraffa and Vistarini put forward a reformist agenda for cognitive science and argue that the classic computational-representational framework must be integrated with the 4E approach to cognition (i.e., with the idea that cognition is embodied, embedded, enacted, and/or extended) to achieve the twofold aim: ending the anti-biologism and radical internalism of classical cognitive science and preserving the notions of representation and computation which still appear crucial for an explanation of the mind. Burnston and Tramacere consider the seemingly irreconcilable dichotomy between the radically internalist perspective of classical cognitive science and the radically externalist perspective of 4E cognition: «"internalists" argue that the causal source of the phenomenon of interest is internal to the organism, and "externalists" that it is external to it» (cf. this issue, *infra*, p. 104). The authors suggest that we need to reach a minimal agreement on a distributed causal source (they call it "locus of control"). This would allow us to keep (working on) the notion of mental representation even though it would have to be radically revisited. Moreover, from a methodological point of view, we would move away from the idea of a holistic system (in which individual components do not play any causal role, but only the relationships among the parts can be causally relevant) and we would be encouraged to decompose the system into internal and external factors to investigate how their separate contributions and their interactions combine to bring about fine-grained changes in behavior.

Other papers address the question of unity from the point of view of cognitive architecture and the mechanisms of information processing. Frank van der Velde's work, *From unified to specific theories of cognition,* considers whether we should expect future cognitive theories to reveal a single set of mechanisms for the explanation of different cognitive capacities or whether we should presume that different capacities will be explained on the basis of different mechanisms. The classic computational architecture theorized primarily by Newell, Fodor and Pylyshyn who aimed to guarantee the main features of human level cognition – i.e., productivity, compositionally and systematicity – was meant to describe any aspect of cognition. All cognitive processes were considered to be a form of symbol manipulation and thus to be explicable by a computational theory of cognition. Yet, in van der Velde's view «the aim for unified theories of cognition may be out of reach» (cf. this issue, *infra*, p. 75). Apparently, different kinds of cognition are possible and this opens the door to the idea that cognitive mecha-

nisms might not be unitary (or homogeneous) either: «certain forms of implementation could be selective for certain forms of information processing» (cf. this issue, *infra*, p. 79). In the paper, van der Velde examines the example of the connection structures between nouns and verbs suggested by Hebb. These are alternative to the von Neuman architecture (information is not stored by symbols) and yet they can still ensure full combinatorial productivity. This offers further corroboration for the view that «a "single set of mechanisms" might not exist» (cf. this issue, *infra*, p. 83). From this point of view, the future of cognitive science might be naturally fragmented: if our cognitive capacities are implemented by several mechanisms, we should search for distinct domain-specific cognitive architectures and their unique implementations.

William Bechtel's *Rethinking cognitive architecture: A heterarchical network of different types of information processors* goes in an analogous direction. Bechtel challenges the classic view developed in cognitive science that cognitive architecture is characterized by a homogeneous set of capacities and is organized hierarchically. The idea of a homogeneous set of capacities was suggested with enthusiastic tones and as a possibly great achievement of psychological research, e.g., by Allan Newell in 1990: «psychology has arrived at the possibility of unified theories of cognition – theories that gain their power by posing a single system of mechanisms that operate together to produce the full range of human cognition».[23]

Moreover, a hierarchical design presupposes that «multiple lower-level units report to a single higher-level unit, and ultimately one top-level unit oversees the whole system. The different units are organized into a pyramid» (this issue, *infra*, p. 98). That's the way the brain is commonly described. The idea is basically that input information is processed first and then transmitted to higher processing centers to reach its ultimate destination: centralized executive control, located in the prefrontal cortex. Bechtel defends a different perspective in which the vertebrate brain is characterized by several different information processing systems. These are integrated with each other but not on the basis of a hierarchical structure. Their organization is rather heterarchical: «heterarchical organization can differ from hierarchy in multiple ways – there can be more units at higher levels than at lower levels, inverting the pyramid, and when units exercise control over others, multiple ones may control the same component and controlled components can, in some respects, exercise control over those taken to be in control» (cf. this issue, *infra*, p. 100, footnote 42). In this structure, the components are organized in a network and they can influence each other. The behavior of the organism does not result from commands from a higher processing center which controls and coordinates all the information provided by lower-level systems but is rather the product of complex coordination between the components of the network. The aim of future research carried out by cognitive science should be to investigate the different types of information processed by the brain of the vertebrates as well as the diverse processing architectures they exhibit and the way in which their components coordinate to generate a coherent behavior. Thus, in Bechtel's view, the cognitive science of the future should overcome instead of pursuing the ideal that we might develop unified theories of human cognition based on homogeneous mechanisms and guided ultimately by high-level abstract cognition.

An analogous issue is discussed by Aurora Alegiani, Massimo Marraffa, and Tiziana Vistarini. They focus on Clark's active externalism, in particular, on the idea that the classical notion of mental representation must be replaced with a continuum of representational genera. In their view, this implies that we cannot adopt a single explanatory strategy but– depending on the specifics of the case – «must respectively appeal to the dynamical non-representational or the representational explanation» (cf. this issue, *infra*, p. 62). Organisms are constantly generating and updating internal models that predict incoming sensory information based on prior knowledge and expectations. These predictions are compared with actual sensory inputs, and the discrepancies (i.e., the prediction errors) are used to update and refine internal models. The authors discuss PP and compare Clark's "radical predictive processing" (rPP) in to the "conservative" view (cPP). Both cPP and rPP are reformist proposals that aim to reconcile the pragmatic turn in cognitive science with the desire to preserve a representational approach to cognition. However, while cPP is entirely representational (even though it does not conceive of representations in the traditional, "linguaformal" way), Clark's rPP describes a hybrid model. In Clark's view, cognition operates on the basis of both representational and nonrepresentational processes: low level processing is nonrepresentational and model free while high level processing is representational. Yet, Alegiani, Marraffa and Vistarini question this hybrid architecture: «why resort to a hybrid notion if we do have a well-grounded notion of representation (that of cPP) that does not neglect the role of action, but rather emphasizes its prominence in our cognitive processes?» (cf. this issue, *infra*, p. 69). Of course, in the light of the previous works in this volume, we might wonder whether hybrid architectures should still be considered epistemologically weaker than homologous architectures.

A further major problem with the cognitive project addressed by several papers in the themat-

ic issue regards the reciprocal relationships among its constituent disciplines and their theories; in particular, the role each should play, which should lead the project, and why. Considering that cognitive science is directly engaged in studying *human cognition,* i.e., according to the definition offered by Gardner, «the nature of knowledge, its components, its sources, its development, and its deployment»,[24] cognitive psychology might seem the best qualified discipline to lead this project. Indeed, the title of Gardner's book (*The mind's new science*) presupposes that we already had a science of mind before the cognitive revolution; that old science of mind is empirical psychology.

However, it is not so obvious that guidance of the project necessarily belongs to psychology. As Gardner himself acknowledged, the topics addressed by cognitive science are long-standing epistemological questions that were traditionally investigated by philosophy. For this reason, philosophy could be the discipline to lead the cognitive project, while the latter could itself be seen as an improvement of previous philosophical research. In fact, the relationships between philosophy and psychology in the development of new theories of mind are quite complex and have always been highly debated. The reason why most descriptions of the cognitive science consider psychology instead of philosophy as the discipline appointed to develop new theories on cognition and cognitive processes is that – although not without difficulties or ambiguities – psychology employs the scientific method and this is a precondition for developing a *science* of mind.

And yet there is at least a third candidate that could provide leadership in this project. We might agree that linguistics, anthropology, and artificial intelligence cannot head up the cognitive project because: (i) linguistics focusses uniquely on a very specific aspect of cognition, i.e., language; (ii) anthropology describes the cultural diversity of human beings, and the aim of the cognitive science is exactly to show that this is only apparent or superficial and that it can be explained on the basis of universal mechanisms; and (iii) artificial intelligence serves as a (man-made) model to understand human cognition.

But neuroscience cannot be automatically considered as an ancillary discipline. In fact, one might wonder whether psychology depends on or can be reduced to neuroscience. In this case, the psychological agenda should be set by (cognitive) neuroscience while the study of cognition would be limited to the investigation of how knowledge is implemented by the brain. As a matter of fact, this idea would be perfectly compatible with the cognitive neuroscience revolution proposed by Worth Boone and Gualtiero Piccinini.

Several papers in this thematic issue question what role the various disciplines should play within the cognitive project and which discipline should head up the cognitive project and why.

Philip Kargopoulos' paper, *What philosophy, if any, is needed for cognitive science?*, focusses on the role played by philosophy and on the changes that philosophy and philosophizing have undergone and will necessarily continue to undergo by participating in this project. First of all, Kargopoulos argues that philosophy has no "natural right" to be included in cognitive science just because the term "mind" was introduced by philosophers and because the mind was originally investigated by this discipline. It is also a philosophical illusion «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» (cf. this issue, *infra*, p. 29). In his view, we must justify why philosophy has something to offer for the advancement of the work of the other disciplines belonging to the cognitive project and we must clarify the relationship that philosophy entertains with psychology and their respective roles in cognitive science since both disciplines cultivate the ambition of elaborating theories about the mind. Kargopoulos argues that philosophy revolves around the notion of representation which is a tremendously complex topic that must be addressed by philosophical research. Indeed, this is why philosophy as a discipline has still a major role to play in the cognitive project. Moreover, philosophy has already shown that it is able "to propose small or grand hypotheses and theories" and to collaborate, especially with psychology and linguistics, in evaluating them: the modularity thesis and the language of thought are two prominent examples in this direction. From this perspective, at least some philosophical problems are not ordained to be everlasting, but may find specific solutions through (empirical and theoretical) research.

Max Coltheart's *Psychology is – and should be – central to cognitive science* claims that psychology should take the lead in the cognitive project. In Coltheart's view, the cognitive project has not become a cohesive interdisciplinary field over time, but this is not a failure since unity was never the intention of its founding fathers. To understand the very nature of this multidisciplinary field we must determine when a study conducted by two or more constituent disciplines counts as cognitive science. In fact, several lines of multidisciplinary research in these disciplines are not meant to investigate how the mind works but to solve other kind of problems: e.g., research on face recognition systems is not aimed at comprehending how humans recognize faces but at solving the practical problem of making artificial systems more efficient. Coltheart's thesis is that a multidisciplinary study conducted by two or more constituent disciplines can count as cognitive science only if cogni-

tive psychology is involved and this is the reason why «(cognitive) psychology is central to cognitive science» (cf. this issue, *infra*, p. 43). Ultimately, cognitive science is about mental processes and mental processes are the specific subject of cognitive psychology. One could argue that philosophy – which has not been taken into consideration by Coltheart – is another potential candidate to head such a coalition. The answer to this objection implied in Coltheart's reflection is that the study of mental processes should be based on observations and experiments and driven by the models developed by cognitive psychologists which offer effective explanations for phenomena such as cognitive impairments, recognition, performance of cognitive tasks, reasoning, etc.

Sandro Nannini's paper *The mind-body problem in philosophy and the cognitive sciences* offers an argument supporting the position that neuroscience should lead the cognitive project. In Nannini's view, especially after the so-called "second cognitive turn" in the 1990s – i.e., the cognitive neuroscience revolution we mentioned above – neuroscientific research became crucial for understanding the nature of the mind and cognitive processes, while the mind-body problem turned into a central issue of the cognitive project. In this paper, Nannini reviews the main solutions philosophers have proposed for the mind-body problem throughout history and considers how cognitive scientists have accepted or criticized these solutions. Eliminativism (specifically, "soft physicalistic eliminativism") is presented as the most convincing and suitable ontological-epistemological framework for promoting interdisciplinary and multidisciplinary studies among the various cognitive sciences. This "soft physicalistic eliminativism" builds on the work of the Churchlands and it assumes that folk psychology, cognitive psychology, and cognitive neuroscience operate within distinct "discourse universes" with different ontological commitments: folk psychology speaks of mental states, cognitive psychology describes psycho-functional states, and cognitive neuroscience focusses on neurological states. Psycho-functional states are idealized and partial redescriptions of mental states in the language of scientific psychology. Mental states are supposed to be reducible to psycho-functional states and psycho-functional states are, in turn, considered to be implemented by physico-chemical processes and identical to a higher-order property of brain dynamics. In this approach, «philosophers of mind suggest an ontological-epistemological framework capable of favouring interdisciplinary research in the field of "the science of mind" while the cognitive scientists evaluate whether this philosophical suggestion is of any use to them» (cf. this issue, *infra*, p. 128). Even though this framework reflects a policy of "divide and rule" by recognizing that philosophy, psychology and cognitive neuroscience play a role in the cognitive project, in practice it endorses the absolute primacy of neuroscience in the cognitive project.

At least implicitly/tangentially, other contributions in this issue also take stand on the question of leadership. William Bechtel's *Rethinking cognitive architecture: A heterarchical network of different types of information processors* suggests that we should rely on brain structures to understand how the cognition of vertebrates works and this seems to be in line with the idea that neuroscience should play a central role in the cognitive project. Daniel C. Burnston and Antonella Tramacere's work on *Distributed loci of control: Overcoming stale dichotomies in biology and cognitive science* appears to go in a similar direction to that of Bechtel but to substantiate an even more radical position in which biology forms an integral part of the cognitive project. Biology is the discipline that reveals the deep structures from which we must draw inspiration to understand all levels of cognition.

Up until now, we have taken for granted that – beyond revolutions, plurality, and fragmentation – it still makes sense to speak of cognitive science or at least of the cognitive sciences and that the idea of joining forces for the scientific study of cognition is meaningful and deserves a future. However, even this minimalist view is not unanimous. In the final lines of his 2003 article titled *The cognitive revolution: A historical perspective*, referring to the founders of the cognitive program, Miller himself states that: «some veterans of those days question whether the program was successful, and whether there really is something now that we can call "cognitive science"».[25]

In this thematic issue, in his "*Cognition" – Let's forget it?* Alan Costall takes the skeptical position that cognitive science was a project doomed to failure even before its inception. He challenges the very notion of cognition, claiming it is not only problematic to define but possibly also misleading and unscientific. As we have already seen the term cognition has a long history, reaching back to scholastic philosophy. Yet, until the 60s its use in psychology was «sporadic and selective» (cf. this issue, *infra*, p. 136). By the 80s the term was already widespread in psychological discussions and became essential for defining the very subject of psychological research. In Costall's view, the spread of this notion was not accompanied by any clarification of its meaning, which has remained obscure. In particular, it is not clear whether "cognitive" refers to particular psychological processes or a (meta)theoretical approach. This is one of the reasons why the cognitive revolution has not found unanimous consensus among psychologists. Rather than constituting a revolution, according to Costall, the cognitive turn represents a *re*-turn to the past and, in particular, to a form of a *modified behaviorism*. By the mid-50s it became clear

that «defining psychology as the science of behavior was like defining physics as the science of meter reading». The psychological lexicon could no longer avoid mentalistic terms. However, «we were still reluctant to use such terms as "mentalism" to describe what was needed, so we talked about cognition instead» (cf. this issue, *infra*, p. 139). Thus, according to Costall, the very notion of cognition is ambiguous and *empty*. Researchers in psychology mostly hung on to this notion because this it was at the core of their discipline and to abandon it seemed impossible. As he asks, «is it just possible that we ourselves don't really know what we are talking about when we talk about "cognition". If so, let's forget it and find some better words» (cf. this issue, *infra*, p. 140).

What clearly emerges from the collection of these contributions is that – whatever it may be – the future of cognitive sciences is not easy to decipher or straightforward to predict.

Notes

[1] Cf. S.J. KEYSER, G.A. MILLER, E. WALKER, *Cognitive science – 1978: Report of the state of the art committee to the advisers of the Alfred P. Sloan Foundation*. On Sloan Foundation report(s) and the so-called "cognitive hexagon" cf., i.e., H. GARDNER, *The mind's new science. A history of the cognitive revolution*; W. BECHTEL, A. ABRAHAMSEN, G. GRAHAM, *The life of cognitive science*; M.A. BODEN, *Mind as machine. A history of cognitive science*; C. BAUM, *Stabilizing cognition: An STS approach to the Sloan Foundation report*.

[2] S. WALTER, A. STEPHAN, *Einleitung*, p. 2.

[3] H.C. LONGUET-HIGGINS, *Comment by professor H.C. Longuet-Higgins on Lighthill report*.

[4] *Ibidem*.

[5] Cf., i.e., C.D. GREEN, *Where did the word "cognitive" come from anyway.*

[6] Wolff's text is quoted according to T. STURM, H. GUNDLACH, *Zur Geschichte und Geschichtsschreibung der >kognitiven Revolution< - eine Reflexion*, p. 8: «cognitio(n) is an action of the soul by which it acquires a notion or idea of a thing for itself» (English translation by S.D. and L.P.).

[7] Stout and Baldwin's entry is quoted according to T. STURM, H. GUNDLACH, *Zur Geschichte und Geschichtsschreibung der >kognitiven Revolution< - eine Reflexion*, p. 8.

[8] Cf. S. WALTER, A STEPHAN, *Einleitung*, pp. 1-2. Cf. also B.J. BAARS, *The cognitive revolution in psychology*, pp. 5-6; U. NEISSER, *Cognitive psychology*, pp. 9-12; H. GARDNER, *The mind's new science*, pp. 41-42; J. BRUNER, *Notes on the cognitive revolution*, p. 7.

[9] U. NEISSER, *Cognitive psychology*, p. 4.

[10] B.J. BAARS, *The cognitive revolution in psychology*, p. 6ff and p. 409ff.

[11] G. MANDLER, *What is cognitive psychology? What isn't?*, p. 9 (quoted according to H. GARDNER, *The mind's new science*, p. 29). Till the mid-1950s, psychology, especially experimental psychology, was still dominated by behaviorism.

[12] On the fragmentation and lack of unity in psychology cf., i.e., L.A.W. STAATS, *Psychology's crisis of disunity: Philosophy and method for a unified science*; L.A.W. STAATS, *Disunity's prisoners, blind to a new approach to unification*. On *cognitive theory* as a new theoretical framework for overcoming the issue of lack of unity in psychology cf. Baars' reply to Staats' criticism.

[13] Whether cognitive theories truly represented scientific revolutions in comparison with previous approaches is still an open issue. In general, cognitive scientists and psychologists view these cognitive theories as radically new compared to past theories, especially the behavioristic approach – cf., i.e., D.S. PALERMO, *Is a scientific revolution taking place in psychology?*). A more cautious, if not outright skeptical, attitude has been adopted by epistemologists and historians of science (cf., i.e., W. O'DONOHUE, K.E. FERGUSON, A.E. NAUGLE, *The structure of the cognitive revolution: An examination from the philosophy of science*; C.D. GREENWOOD, *Understanding the cognitive revolution in psychology*; L.B. BRISKMAN, *Is a Kuhnian analysis applicable to psychology?*).

[14] Cf. D. MARR, *Vision. A computational investigation into the human representation and processing of visual information*. Cf. also A. NEWELL, *The knowledge model*; Z. PYLYSHYN, *Computation and cognition. Toward a foundation for cognitive science*.

[15] M. VILLALOBOS, D. SILVERMAN, *Extended functionalism, radical enactivism, and the autopoietic theory of cognition: prospects for a full revolution in cognitive science*, p. 720. Cf. also C. BUCKNER, E. FRIDLAND, *What is cognition? Angsty monism, permissive pluralism(s), and the future of cognitive science*; D. WILLIAMS, L. COLLING, *From symbols to icons: The return of resemblance in the cognitive neuroscience revolution*.

[16] W. BOONE, G. PICCININI, *The cognitive neuroscience revolution*, p. 1510.

[17] H. GARDNER, *The mind's new science*, p. 41.

[18] J. BOBRYK, *The social construction of mind and the future of cognitive sci*ence, p. 494.

[19] Cf., i.e., A.M. GLEMBERG, J.K. WITT, J. METCALFE, *From revolution to embodiment: 25 years of cognitive psychology*.

[20] M. VILLALOBOS, D. SILVERMAN, *Extended functionalism, radical enactivism, and the autopoietic theory of cognition: Prospects for a full revolution in cognitive science*; M. VILLALOBOS, *Enactive cognitive science: Revisionism or revolution?*.

[21] R. ARDILA, *Toward unity in psychology*, p. 302.

[22] Cf. K. STANOVICH, *How to think straight about psychology*; G. HENRIQUES, *The tree of knowledge system and the theoretical unification in psychology*; M.R. ROSENZWEIG, *Unity and diversity of psychology*; F.J. WERTZ, *Multiple methods in psychology: Epistemological grounding and the possibility of unity*; G. HENRIQUES, *Psychology defined*; D.L. KRANTZ, *Psychology's search for the unity.*

[23] A. NEWELL, *Unified theories of cognition*, p. 1.

[24] H. GARDNER, *The mind's new science*, p. 6.

[25] G.A. MILLER, *The cognitive revolution: A historical perspective*, p. 144.

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