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Received: 8 February 2006 / Revised: 28 February 2006 / Accepted: 1 March 2006 / Published online: 21 March 2006
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Research at the CSC

Work at the Torino Inter-University Center for Cognitive Science (henceforth, CSC) reflects the complexities of today's cognitive science. The very history of the Center testifies to the changes which the area is undergoing in these years. The CSC was established in 1992 as a joint initiative of the Department of Psychology of the University of Torino, the Department of Computer Science of the same university, and the Department of Control and Computer Engineering of the Polytechnic of Torino. More recently, the Department of Biology of the University of Torino and the Department of Philosophy of the Amedeo Avogadro University of Eastern Piedmont joined the endeavour. Thus, the CSC has traversed the whole recent history of the cognitive sciences, from the classical information-processing approach to the opening to biology—particularly, of course, neuropsychology and the neurosciences in general as well as evolutionary and evo/devo biology.

The main research areas of the CSC are:

- action and communication in human beings and in AI systems,
- ontogeny and impairments of human action and communication,
- mindreading, collective intentionality and social cognition,
- reasoning and decision making,
- metacognition,
- theoretical psychology and foundations of the cognitive sciences,
- neuropsychology,
- artificial intelligence,
- philosophy,

- psychopathology and clinical psychology,
- learning and education, and
- computer science.

Because of the width of these interests, and of the range of theoretical and empirical strategies with which they are fostered, it would be impossible to provide a thorough description of the research carried on in each of these areas. Therefore, only a few hints will be given. The comprehensive list of references provided in the [Appendix](#) will hopefully give a more detailed picture of what has been done at the CSC during these years.

Further information, including the complete list of the affiliates with their physical and digital addresses, as well as other personal and collective information, can be found on the CSC web site at < <http://www.psych.unito.it/csc> > .

Theories of communication and social cognition

Communication is a major research area of the CSC. Theoretical and experimental studies in this area focus on the nature, the development, and the decay of this crucial human competence.

Theoretical research has focused in particular on the mental processes involved in communication and dialogue. Such processes are generally described as sequences of mental states, that is in terms of what are called belief–desire–intention (BDI) architectures.

While, historically, this has allowed the various philosophical perspectives that can be taken on the mind and on communication (whether computational, biologically inspired, and even reductionist) to use a common jargon and thus to cross-fertilize, much still remains to be understood as to what precisely these terms mean, and as to whether their meaning is the same in all these different perspectives. Similar considerations hold for the particular dynamics with which the various mental states postulated to take part in dialogue follow each other.

Thus, working on communication has led several researchers to also engage in the current debate on the nature of representations and, in general, on the foundations of the cognitive sciences (see below).

Most researchers at the CSC would agree on a view of communication as a process of cooperative meaning-making between the interactants. Cooperation is only possible on the background provided by the knowledge that the interactants have of each other and of the common (shared) ground on which they are moving. Suitable theories of what sharedness is, when and how it may be taken for granted prior to communication or reached during (and via) dialogue, and of the phylogeny and ontogeny of the capability for sharedness in the human species, have therefore had to be proposed.

Further work on the structure and functioning of social interactions

Mindreading

These views of communication and cooperation have also required gaining an understanding of the ability to “read into” a partner’s mind. This, commonly known as *mindreading* or *Theory of Mind*, is therefore a related focus of research at the CSC.

In an AI perspective, this amounts to a theory of how the interlocutor (often, the human user of a computer interface) can be modelled in computational terms. This consists in a sort of nesting of BDI architectures within each other; or in the system’s capability to explicitly or implicitly reason upon (a specific token of) such architecture.

In a psychological perspective, mindreading has instead been mostly (but not exclusively) investigated in a developmental perspective, both because this is an interesting strategy in itself and because mindreading in the (non-impaired) adult is a highly sophisticated and culture-laden activity.

It is also interesting to remark that a failed ontogeny or a later breakdown in the capability of mindreading has been viewed as (part of) what causes the symptomatology of at least two diseases of neuropsychological interest, namely autism and schizophrenia. These pathologies have also been investigated by researchers working at the CSC.

Communicative actions

The mental activities involved in communication find their visible counterpart in the actions that are actually performed. Therefore, studies of linguistic and extralinguistic dialogue acts (including their theoretical, cerebral and pragmatic differences, their patterns of development and decay, and so on) are still another focus of research in this area.

This has mostly been accomplished by researchers belonging to artificial intelligence. In this area, AI research at the CSC includes the computational modelling of cognitive agents and of their interaction at different levels.

Computational studies of language have focused on syntactic analysis and robust methods for NLP and the development of linguistic resources and software systems and resources for the Italian language (in particular two parsers based on dependency theory and the TUT—Turin University Treebank).

Other AI studies of agent interaction

Beside what has been already said, AI studies of agent interaction have also focused on modelling cooperative versus non-cooperative contexts and of the relevant differences in obligation management, decision making, and planning.

Still another direction of research has been the investigation of the general features of social interaction between simple rational agents in a closed world, such as the stock market and other legal and economical contexts.

Empirical studies of communication

Finally, different approaches to communication will lead to different theories of how such highly complex competence and its “components” (such as the abilities of reading into the mind of partners, sharing mental states with them, planning appropriate communicate moves, understanding the partners’ moves, and so on) develop in children and of how they may decay following different types of neuropsychologically relevant brain diseases.

Empirical studies of communication have focused, besides the more traditional psychological experimentation (in terms, for example, of story understanding, thinking-aloud protocols, and so on), on neuroscientific and neuropsychological approaches. Knowledge so collected may help to revise the overarching theories, of course, but it also has a clinical value in itself.

Neuroscientific studies of communication have focused on the decay of communicative skills after cerebral damage; furthermore, we have devised studies of normal subjects with neuroimaging techniques.

Impairments of communication can be found in a wide range of diseases, including cerebrovascular diseases (stroke) of either the left or the right hemisphere (albeit with different consequences on communication), head trauma, schizophrenia, Alzheimer’s disease, and other types of dementia; furthermore, several childhood diseases of neuropsychological interest may also yield abnormalities of communication, including autism and related syndromes, deafness, and traumatic brain injuries.

A major aim here has been to understand what specific disturbances of communication may occur in each specific disease (trivially, an impairment in planning, as it often occurs after head trauma, will have a different impact on the dialogue between the affected persons and their partners than an impairment of language, as it often occurs after stroke); this may help the clinician in understanding the symptomatology of different diseases as well as, as said above, help the theoretician in return to better understand the different components of communicative competence.

A further aim has been to collect the specific profiles of communication malfunctions in the various diseases and assemble them within a larger picture that can then be used to design specific assessment tests and strategies for the rehabilitation of communicative deficits.

Thinking and reasoning

Another major stream of research at CSC has been on thinking and reasoning. This includes studies of deduction, induction, and learning. Beside providing the core of our capabilities for formal reasoning, these kinds of inferential activities are constantly entangled in other everyday activities like understanding situations, formulating hypotheses, solving problems, or making decisions.

A first aim of this area is to develop unitary theories of the cognitive processes involved in different types of deductive reasoning. The assumptions underlying are that humans build representations of reality as mental models and that the construction and manipulation of models is driven by a mixture of general (context-free) and local (task-driven) strategies. The same research strategy has been applied to induction, generalization, and categorization. The work on deduction has yielded a computational model which simulates the performance of human subjects at syllogistic reasoning tasks.

Research on deductive and inductive reasoning has also been applied to the domain of education, and particularly to human learning and teaching. The aim here is to provide valid theoretical and empirical criteria for effective educational planning, where both contents and methods are related to the student's competences and resources.

An additional area is the investigation of how psychological techniques and multimedia technologies may help to improve learning and education.

Neuropsychology

Apart from what has been said about the study of impairments in communication, other research in neuropsychology at the CSC has been based on the use of neuroimaging (mostly fMRI—functional magnetic resonance imaging) techniques.

Functional magnetic resonance imaging studies are conducted at the Ospedale Koelliker of Turin as well as in collaboration with several research centres in Europe. Such studies are aimed at the assessment and rehabilitation of motor and cognitive diseases due to cerebral pathologies.

Examples of research projects in this area are the study of how the areas involved in movement execution and control may reorganize in patients with central paresis; the construction of fMRI protocols for the early evaluation of fronto-temporal dementia; and the study of the brain areas and centres involved in shared intentionality and other manifestations of social cognition.

Psychopathology

Exchanges and cross-fertilization between cognitive science and clinical psychology have lately become another focus of interest at the CSC; indeed, many of us perceive this as a major area of future development. Clinical psychology offers an interesting test bed for the validation or falsification of theories and results from within cognitive science; even more important, it can provide a crucial field of application.

Research conducted at the CSC within this area has included studies of the development and the evolution of the self, of attachment and its dysfunctions, of metacognition and mindreading. Studies of how to assess the effectiveness of psychotherapy have also been conducted.

The development of the self has been studied by focusing on the representations that individuals have of their attachment relation with their caregivers. The latter, of course, is most typically their father and mother; a more thorough consideration of the former than used to be in the past is a recent acquisition of clinical psychology.

The evaluation of psychotherapy has been conducted by studying the joint relation-building and meaning-making activities in which the psychologist and the patient/client are together involved. The underlying consideration is that psychotherapy consists mainly in knowledge- and interaction-based social practice, which means that the mental activities that are involved in other forms of communication play a crucial role in this process as well, together, of course, with specific clinical knowledge.

Mindreading and “metacognition” in general are also heavily involved in psychotherapy and related processes and activities, including the self-reflection in which the patient typically indulges both within, outside, before and after the specific psychotherapeutic setting.

These mental activities, which were more typically studied in laboratory settings, are often dysfunctional in cognitive and emotional disturbances, and are an important part of the patient's mental processes on

which a psychotherapist will focus. Since the classical laboratory tests of mindreading are too oversimplified to yield interesting results in this context, we have devised new and different methods for the investigation of metacognition and mindreading.

Foundations of cognitive science

Cognitive science has lately undergone a process of epistemological fragmentation into different, and possibly mutually exclusive, paradigms.

The old-fashioned information-processing or computational paradigm is still the most sound and complete approach to the study of the mind, and most researchers still subscribe to it, at least for want of a better one.

Yet, many others reject it; the grounds on which this happens, and the alternatives that are envisaged in its place, may lead to the development of different, sometimes radically so, paradigms.

All researchers take part in this debate, if only with their ontological, epistemological, and methodological choices; some, of course, make explicit attempts at developing, unfolding, and discussing landscapes within which to frame the study of the mind.

Researchers at the CSC make no exception. Thus, while most of them subscribe to one version or another of the classical cognitivist paradigm, others reject it in favour of some alternative. Among the various possibilities, those that have been most widely pursued are situated cognition (that is the idea that the mind only exists in the here-and-now of its conscious interactions with the world or, better still, with itself-in-the-world) and the loose version of anti-Cartesianism which is implicit in neuropsychological research; still others researchers work at some interaction between them.

Acknowledgements I am grateful to the researchers of the CSC for being kind enough to discuss their activities with me, for providing me with the relevant bibliographic references and, even more important, for being tolerant enough to understand and accept the oversimplifications of their work that needed to be made to make this document (hopefully) readable for the widest possible audience.

Appendix

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