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The Quarterly Newsletter for the Center for Cognitive and Social Neuroscience | Fall 2010

The University of Chicago

Affiliate Lab Interview Alfonso Caramazza

Alfonso Caramazza, an affiliate of the CCSN, studies the neural architecture of language and cognition at the Cognitive Neuropsychology Lab at Harvard University. He is also the director of the Center for Mind/Brain Sciences, an interdisciplinary center for brain research at the University of Trento, Italy.



Above: Alfonso Caramazza and the faculty and staff of the Center for Mind/Brain Sciences, Trento, Italy.

Which broad questions drive your research?

I research the ways in which word knowledge, word meanings and the grammatical properties of language are represented in the brain. In my laboratory, we also research some aspects of object cognition, object processing, and how people perceive and execute different actions.

How has the study of language changed over time?

For most of my career, the main research methodology was the study of patients who had developed language impairments as the result of incurring some type of brain damage. The strategy was to learn how the normal language system works by looking at the patterns of language breakdown in these

patients. More recently, there has been a major shift in research methods. My students and I employ many different research methods. We continue to do behavioral research, which I still think is perhaps the most beautiful and exciting kind of research. We also continue to work with patients, but now also use imaging methods: MRI and EEG techniques. We also use transcranial magnetic stimulation (TMS) to study how stimulation of the brain affects performance. It has been a fantastic journey, and great to see new insights emerge from the use of these methodologies.

The Center for Mind/Brain Sciences is composed of six different research labs and thirty full-time researchers, as well as sixty-seven students and fellows. How does interdisciplinary work proceed at the Center? Why is this work important?

I founded the Center in 2006 because I

INTERDISCIPLINARY WORK CAN BE MORE THAN SCIENTIFIC COLLABORATION

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saw the need for a structure to bring together researchers with different areas of expertise to tackle problems together. This interdisciplinary approach provides the opportunity to employ multiple methods of study and analysis. For example, there are researchers who have focused their study of the mind entirely on behavior. They have developed amazingly sophisticated types of experimental designs, data analysis techniques, and an understanding of the connection between behavior and the mind. Other researchers have developed incredible skills in using imaging methods to understand how the brain physically functions. These two groups of people have different skills and conceptions of the relation between behavior, the mind, and the brain. By bringing these two groups to work on a problem, they each learn from the other's strengths and are thus able to shore up weaknesses that might stem from the use of any single approach to these questions.

There are linguists who have a deep understanding of the structure of language, but lack an understanding of the brain, and neuroscientists who have deep understandings of the brain, but no comprehensive knowledge of language structure. Working together, they have more holistic knowledge of language and the brain.

But interdisciplinary work can be more than scientific collaboration, more transformative than two types of scientists working together on a research project. We make real progress by creating an environment where new researchers, graduate students, and post docs learn both fields' approaches. These individual researchers now possess a synthesis of knowledge that before existed in different people in different disciplines. The motivation of our Center and also of the Center for Cognitive and Social Neuroscience is precisely this: to develop the next generation of researchers with interdisciplinary understanding.

Affiliate Lab Interview *Continued*

What are your current research projects?

Two of our current research projects are very promising. One involves understanding how knowledge of the grammatical properties of words might be represented in the brain—What is a noun? What is a verb? How is this distinction maintained and represented by the brain? Primarily, we have studied this problem by looking at brain-damaged subjects and the way this knowledge breaks down in a specific patient with specific structural damage. Over the past five years, we have been trying to answer these questions using neuroimaging techniques. I think we are beginning to make some progress. We are beginning to identify the neurocircuitry that is involved, at least with respect to how verbs might be represented in the brain. Part of this has involved looking across languages. We have studied how verbs are represented in bilingual speakers and in monolingual speakers of different languages. Our research seeks to capture some universals of verb processing. If we can establish the degree to which the same brain structures are involved in processing verbs in bilingual and monolingual speakers of different languages, then we can have some degree of confidence that we are looking at very basic mechanisms involved in verb processing.

In another study, we are trying to understand how conceptual knowledge is organized in the brain. Again, some of the deepest insights have been gained by looking at how brain damage affects knowledge of concepts. In my lab and many others labs, we have found that patients have selective damage for certain domains of knowledge. For example, there are patients who have difficulties understanding animal concepts, like “giraffe” or “elephant”, but have no difficulty with words like “hammer” or “screwdriver.” These kinds of dissociations suggest that this large domain of knowledge is organized in the brain in specific ways. The brain seems to represent biological entities very differently from non-biological entities. Within the biological domain, living things seem to be represented separately and distinctly from inanimate, biological entities like fruits and vegetables. These dissociations in performance suggest that the brain is organizing this information in different ways. The neuroimaging techniques help us parse these more specific organizational structures.

We have also studied how knowledge is organized in subjects who lack a sensory modality. How do congenitally blind subjects process concepts when they do not have a visual input? Exploring this question

allows us to explore the relationship between sensory processing and the brain’s conceptual system, and here, we are making some exciting progress. We have recently discovered that conceptual knowledge is organized in the congenitally blind in the same way in which it is organized in sighted individuals, in those parts of the brain that are involved in visual processing. This means that the knowledge that a person has of objects is much more abstract than one might assume, if one assumed that knowledge of objects comes mostly from sensory input. These two studies dovetail, because understanding how nouns and verbs are represented involves understanding how the meanings of nouns and verbs are represented and how they are both connected to how objects and actions are represented in the brain.

How is the study of language different than other areas of neuropsychology?

Language distinguishes humans from other species, and it provides a wonderful window into how the mind is organized. My interest in language is not merely in language as a formal object, but also how language connects with emotions, perception of objects, and actions. One can try to study language nearly divorced from these other aspects, but it’s very hard to do. If I say the word, “dog,” it automatically activates all kinds of information about dogs: the sounds they make, what they look like,

what they feel like when you touch them, and depending on the experience you’ve had with dogs, how affectionate they might be with you. All of these thoughts and feelings automatically activate upon hearing the word “dog,” so it is very difficult to study language without also studying these other aspects. Because of these connections, my initial interest in language has grown to include many other aspects of cognition.

Which research questions would you most like to explore?

There is so much that we do not yet know. As ours is a very young discipline, less than 150 years old, we have only a superficial understanding of how the mind is organized and of how the brain works. Our techniques are still imprecise. We have only just begun to scratch the surface to understand how the brain works and is organized.

There are two aspects of language that I would like to fully understand: how is knowledge of the grammatical properties of words represented and organized and how is knowledge of the meaning of words organized—how does the brain represent what “jump” means, what “table” means?

We have many new techniques, and hopefully some will clarify our understanding. Perhaps the most exciting development is that there are many young people who are looking

to research these kinds of problems. A few years ago, there were only a few people working on these problems. Now, there are thousands. The other promising development is a true convergence of research methods. Computer scientists have been developing all kinds of wonderful techniques for analyzing and studying brain-imaging information. These new insights are going to make it easier for a new generation of scientists to ask harder questions. I am organizing a laboratory where these techniques come together, where we can take some steps toward solving some of these problems, because they are not easy problems. These are fascinating and beautiful problems, and the journey is everything. And I’m enjoying the journey. ■

THESE ARE FASCINATING AND BEAUTIFUL PROBLEMS, SO THE JOURNEY IS EVERYTHING. AND I’M ENJOYING THE JOURNEY.

ALFONSO CARAMAZZA



BELOW: Alfonso Caramazza, Professor of Psychology at Harvard University and Director of the Center for Mind/Brain Sciences.

RECENT PUBLICATIONS BY ALFONSO CARAMAZZA

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