Conference on “Investigating Semantics: How to Combine Empirical and Philosophical Approaches” at Ruhr-University Bochum, Germany. October 2013

What can the study of schizophrenia tells us about the neural architecture of the language processing system?

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“I always liked geography. My last teacher in that subject was Professor August A. He was a man with black eyes. I also like black eyes. There are also blue and grey eyes and other sorts, too… ” (Bleuler, 1911/1950).

This is an example of language produced by some patients with schizophrenia—a common neuropsychiatric disorder that affects 1% of the adult population. This type of disorganized speech is usually attributed to a ‘thought disorder’ or a ‘loosening of associations’, which influences not only the production of language but also comprehension and other aspects of higher-order cognition in schizophrenia patients. It is usually assumed that thought disorder reflects a qualitative abnormality in the neurocognitive mechanisms engaged in language processing. The assumption is that healthy individuals first retrieve the meaning of individual words, combine these words syntactically to form sentences, and then combine sentences with other sentences to construct whole discourse. In contrast, thought disorder has often been viewed as a separate disturbance of memory—–stored associations between single words and whole events intrude upon normal language comprehension and production mechanisms.

Over the past ten years, our lab has carried out a series of cognitive neuroscience studies in both patient and control populations that challenge these assumptions. We are using multimodal neuroimaging techniques—event-related potentials, functional MRI and magneto-encephalography—–to probe the time-course and neuroanatomical networks engaged in language comprehension. Our findings suggest that memory-based mechanisms play a much larger role in normal language processing than has often been assumed. We are able to retrieve and mobilize stored semantic relationships between words and events very quickly to facilitate the processing of upcoming words as language unfolds in real time. This facilitation manifests as reduced activity within the anterior temporal cortex within 300ms after the onset of incoming words. Combinatorial mechanisms appear to be prolonged when bottom-up input conflicts with stored semantic knowledge, leading to the recruitment of left frontal and inferior parietal cortices past 500ms.

This type of language processing architecture offers several advantages: it allows us to extract meaning from language very quickly, even in ambiguous and in noisy environments, and it explains how our language systems are dynamic and flexible enough to respond to ever-changing task and environmental demands. It also can explain how language and thought can break down in disorders like schizophrenia: Seen within this broad framework, thought disorder does not reflect a qualitative abnormality in how language is processed; rather, it is best conceptualized as reflecting an *imbalance* of a tight reciprocal relationship between the memory-based and combinatorial neurocognitive mechanisms that constitute normal language processing. In this way, the study of how language breaks down in neuropsychiatric disorders like schizophrenia can give important insights into the architecture of the normal language processing system.