Discovering the Conceptual Primitives

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Summary

We believe that Cognitive Science is now in a position to discover the neural basis for many of the conceptual primitives underlying language and thought. The main concern is conceptual mechanisms that have neural realization that does not depend on language and culture. These concepts (the primitives) are good candidates for a catalog of potential foundations of meaning. This multi-disciplinary, bi-coastal Symposium will explore the current prospects for postulating and then experimentally investigating such conceptual primitives. The five panelists are a developmentalist (R. Saxe), a linguist (L. Talmy), a neuroscientist (L. Aziz-Zadeh) and a psycholinguist (D. Casasanto), and an AI researcher (J. Feldman) all of whom work extensively on the subject.

Introduction

This is not about some question of "innateness". We have known for decades that there is continual interplay between genetic and experiential (including cultural) factors starting from gestation and continuing throughout life. Strikingly, the basic neural wiring of prefrontal cortex is not complete until well past puberty. So it might seem to be a mistake to study fixed neural representations instead of developmental processes. But there do seem to be milestones of normal development and understanding these intermediate states appears to be essential. In particular, the development of language plays a crucial role in human experience and we may be on the threshold of determining the neural substrate of some of the pre-linguistic conceptual primitives involved. Of course, we should not expect every individual and culture to use exactly the same primitives (universality), but there should be enough commonality for an empirically grounded theory of language use and acquisition.

Putative Conceptual Primitives

Concepts that seem to be (nearly) linguistically universal are good candidates for the conceptual primitives. One immediate goal is to make an organized collection of such potential primitives and then try to design experiments to test which of these proposed primitives is always realized and therefore available as a basis for language (learning).

There are many *direct* cases involving body parts, actions, desires, experiences, etc. There are several studies that indicate that the neural representation of words and concepts concerning direct bodily experiences are based (at least in part) on the circuits that carry out the underlying action, emotion, perception, etc. There remain open scientific questions about exactly how these primitives (e.g., emotions) are encoded, but that is not the current concern.

However, there are also a large number of other potential conceptual primitives to explore and some fairly new experimental techniques that can help determine if a concept is primitive in our sense. Obviously enough, any concept that is learned is embodied somehow. The question is whether there is detectable neural encoding of mechanisms that help *organize* concepts and thus provide a basis for language and thought. Several developmentalists and linguists have suggested such possible conceptual primitives, but there does not seem to be any systematic collection of these suggestions. There should be.

Some Initial Examples

As we mentioned, many conceptual primitives are linked directly to body parts, actions, experiences, mental states etc. There is already excellent work in several fields aimed at better understanding these. Much of the work on more abstract cognitive primitives has come from linguists and developmentalists. We list some examples of the kinds of postulated conceptual primitives that may be suitable for multi-disciplinary investigation.

Physical World
day/ night; near/ far
physical properties - solid, etc.
affordances

Ontological categories,
event/ thing, animate/ inanimate, people, place
basic categories; sub/super types, prototypes
features of ontological types

Image Schemas, etc.
parameters of spatial cognition
action schemas - x-schemas, controller
goals, force-dynamics (including causation)
parameters of parts & boundaries
time

Social World
young/ mature/ old
authority, approval, help
value & reciprocity & exchange & obligation
theory of mind; perception and intention

Communication
speaker/ hearer, direct/ indirect
true/ false
question, command, etc.

Grammaticalized concepts
person, gender, age, agent, speaker, aspect
possession, mass/count, reflexives, instrument
Primal scenes/ event types – transitive, etc.

Mental Operations
learning
matching, binding
mental spaces; mappings
simulation, displacement

General Logic
connectives, numbers, distributions
similarity, inference, uncertainty
part/ whole; scales, magnitude
binding, variables, indefinites, generalization

The Known and the Unknown

There is actually quite a lot known about the neural basis for many of the concepts listed above. For example, at least part of the representation of concrete nouns is associated with the temporal pole. There is good reason to be confident that major ontological categories are primitive because animals also respond to food, conspecifics, shelter, etc. In some cases there are detailed analyses linking single unit recordings to postulated primitives of conceptual thought.

There is also some suggestive work on the neural encoding and localization of spatial prepositions, time concepts, etc. Physical properties and affordances are also clearly encoded for action, although this does not seem to be studied as much. So, we can probably establish the neural reality of a primitive conceptual system with entities, actions and events. It would have ontological categories with associated features, affordances, and actions and these can be linked to social groups and to emotions. This is a lot and science will be significantly advanced when all this gets worked out in detail. But something like this proto-conceptual system is present in (at least) all mammals and they are also quite flexible in how they learn and behave

Now for the hard part. People can also formulate and communicate complex relationships among concepts, displaced from the present situation. The big question is: What conceptual mechanisms support the rich compositionality of human thought? A number of the ideas in the list above are candidates for playing a central role, but essentially nothing is known about how these notions are neurally encoded, or even if they are the right primitives.

There are now experimental techniques that can test the neural connection in many cases. These include infancy studies, psycholinguistic experiments, and various kinds of imaging. Between them the panelists have considerable expertise in all these disciplines. The Symposium will try to assess the current prospects for using converging evidence to identify plausible conceptual primitives and to suggest specific problems of the greatest promise.

The plan for the Symposium is as follows. The panelists will communicate in advance to refine the set of potential primitives presented above. The panel discussion will start with Len Talmy describing some of the most important proposed primitives and the linguistic evidence for them. The other panelists will then discuss the prospects for experimental investigation, focusing on the most challenging feasible cases. Lisa Aziz-Zadeh will present neuroimaging data for concepts related to actions, faces and places. Rebecca Saxe will discuss evidence for conceptual primitives for intentions and propositional attitudes. Daniel Casasanto will discuss how the study of cross-linguistic and cross-cultural cognitive differences can inform the search for universal conceptual primitives. Jerry Feldman will discuss computational modeling and the role of cognitive primitives in a Unified Cognitive Science.

References

http://ecgweb.pbwiki.com/DCP