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Introduction to 30th Anniversary Perspectives on Cognitive Science: Past, Present, and Future

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During the summer of 2008 in Washington, DC, the Cognitive Science Society celebrated the 30th anniversary of its seminal 1979 conference in San Diego. The 2008 conference organizers—Bradley Love, Ken McRae, and Vladimir Sloutsky—commissioned a symposium to celebrate the occasion. In discussing possibilities, we agreed that the symposium should not simply address the Society's origins and subsequent history, but that it should focus on contributions from the disciplines and theoretical perspectives central to Cognitive Science, along with their future directions.

We originally settled on five disciplines and five theoretical perspectives, and then we invited 10 active established researchers to address them at the conference. To accommodate these 10 speakers, two symposia were presented, one on disciplines and one on perspectives. Each speaker was asked to address: (a) What was your discipline/perspective like at the time of the 1979 conference? (b) How has the discipline/perspective changed over the past 30 years to what it is today? (c) How do you foresee the discipline/perspective changing in the next 30 years?

Because of time constraints, we could not include all disciplines and perspectives central to Cognitive Science. Fortunately, however, we were able to remedy this limitation by asking additional researchers to contribute articles here. The resulting collection of articles covers disciplines and perspectives that have been central to Cognitive Science for the past 30 years and that are likely to be central for the next 30 years and beyond. Specifically, the disciplines (and the authors addressing them) include the following:

Psychology (Dedre Gentner)
Artificial Intelligence (Kenneth D. Forbus)
Philosophy (William Bechtel)
Linguistics (Elissa L. Newport)

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Anthropology (Andrea Bender, Edwin Hutchins, and Douglas L. Medin)
Education (Susan Chipman)
Neuroscience (Rick Cooper and Tim Shallice)
Primate Cognition (Amanda Seed and Michael Tomasello)

The theoretical perspectives (and the authors addressing them) include the following:

Cognitive Architectures (Neils Taatgen and John R. Anderson)
Emergentist Approaches (James L. McClelland)
Formal Modeling (Richard Shiffrin)
Developmental Systems (Linda B. Smith)
Cognitive Ecology (Edwin Hutchins)
Grounded Cognition (Lawrence W. Barsalou)

1. Emerging themes across articles

All 14 articles offer historical perspective on their respective discipline or perspective, while charting intellectual contributions and trends. I leave readers to discover and enjoy these individual contributions, saying nothing further about them here. Instead, I focus on themes emerging across articles that offer guides for where the field is going, as well as themes that raise issues for the Society's future orientation.

1.1. Psychological imperialism

Many authors note that Psychology has become the dominant discipline in the Cognitive Science Society, as defined by the typical scope of the Society's conference and journals (Gentner, Forbus, Newport, Bechtel, Bender et al., Hutchins). Specifically, these authors note that the Society has become heavily oriented toward (a) computational accounts of human cognition, and (b) experimental human evidence from relatively narrow and idealized laboratory paradigms. As many of these authors further note, the field has not always been this way. Artificial Intelligence, Linguistics, Philosophy, and Anthropology were once much more involved in Cognitive Science.

None of these contributors view this as a positive development but are not sure how to proceed. Often interdisciplinary work in other areas winds up being presented at other conferences and published in other journals, including research on Artificial Intelligence, Linguistics, Philosophy, Anthropology, Neuroscience, and Primate Cognition.

Some of these authors argue further that the Cognitive Science Society needs contributions from these other disciplines to be strong (especially Gentner). One suggestion is to become aware of implicit biases against certain kinds of research, thereby encouraging greater inclusion. Other suggestions mentioned include encouraging greater acceptance of naturalistic evidence, instead of focusing so exclusively on evidence from highly controlled laboratory paradigms (Bender et al., Hutchins). Another possibility is to encourage greater

interest in computational mechanisms and evidence associated with artificial systems, not just with humans (Forbus).

1.2. Embedding cognition in the environment

Many authors argue that cognition should not be viewed as an independent modular system, given that it depends critically on the contexts in which it exists. One form of this argument is that cognition depends on the environment (Hutchins, Bender et al., Smith, Barsalou, Chipman). As a consequence, studying cognition in naturalistic environments is essential. By no means is this is a call to exclude idealized laboratory paradigms. Instead, the concern is that idealized laboratory paradigms should not constitute the only acceptable approach. Furthermore, laboratory paradigms could be more oriented toward explaining real-world phenomena, rather than simply serving as ends in themselves. In general, we have much to learn from studying cognition in its natural environments, establishing the roles that cognitive mechanisms play in the real world, along with establishing how physical environments shape cognitive mechanisms.

1.3. Embedding cognition in sociocultural processes

Researchers increasingly argue that sociocultural processes shape cognitive mechanisms significantly. One form of this argument is that human cognition evolved under pressures that rewarded sophisticated social processing and coordination (Seed & Tomasello; also see Donald, 1993). As a result, the mechanisms in human cognition are highly oriented toward supporting sociocultural activities, such that studying these mechanisms outside sociocultural contexts will significantly limit understanding them. Conversely, understanding the sociocultural nature of cognitive mechanisms will not only inform the nature of these mechanisms, it will help us understand the most important differences between humans other primates.

A second form of this argument is that culture has a large impact on the form that a given individual's cognitive phenotype takes (Hutchins, Bender et al.; also see Henrich, Heine, & Norenzayan, in press). Rather than a single set of basic cognitive mechanism developing for all individuals independently of culture, an individual's basic cognitive mechanisms significantly reflect the cultural context in which they develop. The message again is that studying cognition outside sociocultural contexts will ultimately preclude a full understanding.

1.4. Grounding cognition in the modalities and in the body

Similar to arguments that cognition is embedded in the environment and sociocultural systems, several authors argue that cognition is grounded in the modalities and in the body (Barsalou, Hutchins, Smith). Because cognition relies heavily on the systems that underlie perception, action, and introspection, it cannot be understood independently of them. Rather than being modular, cognition relies on mechanisms in these other systems. Increasing empirical work from diverse disciplines supports these proposals.

1.5. Grounding cognition in the brain

Many authors increasingly believe that it is essential to establish relations between cognitive constructs and neural mechanisms (Cooper & Shallice, Gentner, Bechtel, Newport, Chipman, Taatgen & Anderson, Shiffrin, Smith, Hutchins, Barsalou). Indeed more authors mentioned this point than any other.

Notably, the dependence goes both ways. Not only do neural mechanisms provide important constraints on cognition, behavioral and cognitive methods provide important constraints on Neuroscience. As Cooper and Shallice note, Neuroscience needs Cognitive Science. Indeed, Cognitive and Social Neuroscience have proceeded largely by mapping cognitive and social constructs into the brain. Even more significantly, rigorous behavioral methods are required to perform solid empirical work in Neuroscience (see Bechtel, 2008). Without well-controlled paradigms, it is difficult to draw clear conclusions about lesions and brain activations. Neuroscience also needs the cognitive constructs that Cognitive Science provides, as implemented in process models, computational modeling, and formal modeling. Without this level of analysis, Neuroscience will simply establish crude localizations of behavior in neural systems. Understanding how the brain implements computation is the ultimate goal, and this will not be possible without sophisticated contributions from Cognitive Science.

1.6. Continued importance of computational and formal modeling

Numerous authors emphasized the value of computational modeling (Shiffrin, Taatgen & Anderson, McClelland, Gentner, Forbus, Cooper & Shallice, Newport, Smith, Barsalou). Specifically, these authors note that modeling makes theoretical assumptions explicit, makes theoretical accounts more complete, makes it clear how well theories fit data, and stimulates useful applications. Computational and formal accounts have resided at the heart of Cognitive Science for decades, and they will continue to do so. We have many very powerful tools already, and it is likely that even more powerful tools will become available.

1.7. Emergence as an important computational construct

Another frequent theme is that many important cognitive mechanisms and phenomena emerge in a dynamical manner (McClelland, Newport, Smith, Hutchins, Barsalou). Rather than existing as well-specified localized modules, cognitive mechanisms emerge dynamically from distributed processes and circuits. Candidates for emergence mentioned here include symbols, rules, linguistic structures, developmental stages, consciousness, and basic cognitive mechanisms (e.g., working memory, semantic memory). Furthermore, some authors argue that there is not a cognitive module in the brain. Instead, cognition emerges from multiple domains and systems, including the environment, perception, action, affect, and sociocultural systems (McClelland, Smith, Hutchins, Barsalou; also see Barsalou, Breazeal, & Smith, 2007; Spivey, 2007). From this perspective, continuing to study cognition as an independent isolated module is on the fast track to obsolescence.

Other authors similarly stress that the cognitive system depends intrinsically on the developmental process that produces it (Smith, McClelland, Gentner, Chipman, Barsalou). As a consequence, studying cognition only at the adult stage will probably be insufficient for understanding and establishing its basic mechanisms. Instead, understanding how cognitive mechanisms emerge from epigenesis will be essential, taking into account genetics, the body, the brain, the physical environment, and the sociocultural environment (also see Elman et al., 1996).

1.8. The important interplay between basic and applied research

On the one hand, extending insights from basic research to applied research is important (Chipman, Taatgen & Anderson). On the other hand, naturalistic and applied phenomena are likely to inspire insights and new directions in basic research (Bender et al., Hutchins, Chipman, Taatgen & Anderson). Additionally, the more that Cognitive Science can demonstrate the value of its basic research in applied domains, the more support it will receive from the public and from funding agencies, as has been true for Physics, Chemistry, and Biology. It is important to continue developing and strengthening bidirectional influence between basic and applied research.

1.9. The important role of technology

As technology has become more powerful, this in turn has enabled Cognitive Science to become more powerful. Increased technological power has had a major impact on computational and formal modeling (Forbus, Shiffrin, McClelland). It has also created new fields in data mining and data storage (Forbus). New technology has also revolutionized Neuroscience and its ability to become integrated with Cognitive Science (Cooper & Shallice).

1.10. A Final issue: Cognitive science the field versus cognitive science the society

As a field, Cognitive Science is everywhere, not only in the areas covered by these articles, and certainly not only in the areas central to the conference and journals of the Society. Just about anywhere we look these days, interdisciplinary teams of researchers are working on diverse problems. The combination of disciplines and theoretical perspectives included in these teams can take just about any form, often including behavioral methods, cognitive constructs, neuroscience, computational modeling, developmental analysis, sociocultural analysis, linguistic analysis, and so forth. As a result, the multiple levels of explanation integrated to address a common problem vary widely as well.

In contrast, Cognitive Science as a Society is relatively narrow. Again, as described by numerous authors, the practice of Cognitive Science in the context of the Society focuses primarily on computational models of human psychology supported by and/or bearing on empirical data from idealized laboratory paradigms with humans.

A key question is whether the Society wants to remain this way, or whether it wants to evolve in directions that the contributors to this special issue suggest (and perhaps in others

as well). Does the Society aspire to become the home for diverse forms of research that reflect interdisciplinary approaches to the study of intelligence, across diverse disciplines, from humans to nonhumans to machines? If so, how is this best accomplished?

If the Society does not aspire to such broad inclusion, then what the Society has is certainly of considerable significance. And perhaps it is in the nature of research communities and professional organizations for things to settle out this way (Bechtel, Forbus, Newport, Bender et al.). It will be interesting to see where things stand on this issue in another 30 years.

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