Progress and Puzzles of Cognitive Science

Introduction to a Wiley Virtual Issue

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Interdisciplinary research is often regarded as difficult but worth it. A common justification for investing effort in interdisciplinary work is that most phenomena of interest to science are complex. This complexity beckons for input from many disciplines. Diverse input fills out the lines of our understanding as linkages across disciplines. Complexity science itself is like this. The synthesis of various life sciences may fall under this theme as well. It is in this spirit that cognitive science was born. The complexity of cognition, the rich phenomena of adaptive intelligence and more, require input from diverse fields. That was the idea.

This tension between challenges and benefits is an echo of the earliest moments of our discipline. Consider the so-called Macy Conferences on Cybernetics, held in the 1940s and 1950s, and often regarded as groundwork for cognitive science (Bechtel & Abrahamsen, 1998). Introductions to their proceedings can be rife with related discussion. On the very first page of the proceedings to one of the Macy Conferences, its host remarked that the cybernetics group, "…spread over the whole range of all the disciplines. I think we have found that communication among us is by no means easy." (Conference on Cybernetics, 1949, p. 9) The tension is in our roots.

Those roots explain some dismay about cognitive science at the time of this writing. Psychology seems to dominate (Gentner, 2010; Núñez et al., 2019), and the interdisciplinary approach has not yielded a unified canon of concepts (Núñez et al., 2019). Indeed, this dismay has deep roots too. In an incisive review of a proceedings for that Conference on Cybernetics, Miller remarked that "[i]nstead of becoming a scientific standard-bearer, however, the conference has chosen to emphasize interdisciplinary propaganda. After eight conferences this line is running a little thin." (Miller, 1953, p. 663) Considering the passion of our present debates, and many decades of hindsight, we can perhaps forgive Miller who began that review: "I am not sure at all how to review this book. I am not even sure it is a book. It looks like a book." (p. 661) Interdisciplinary research deviates from the comfortable appearances of academic convention.

But the interdisciplinarity of our research agenda and the mere complexity of its phenomena are only indirect measures of our nature. We do not seek them in themselves; they are consequences of research on the mind. So another explanation for interdisciplinary research is to simplify our understanding by finding common principles. Cognitive science expands through diversity. But this diversity should bring about some new efficiencies in understanding. What may appear like a complex tangle of multidisciplinary ideas, once in relief, form a tapestry. Each discipline can contribute. The result, promissory still, is a covering patchwork that spans the mindset of a cognitive scientist. This patchwork would be a codification of theories, models, methods of studying the mind.

These challenges are not unique to us: The unity of science remains a debated topic in philosophy of science and beyond. And there are compelling statements that a complex and pluralistic arrangement will be a natural one for cognitive science (Bender, 2019; Contreras Kallens et al., 2023; Gentner, 2019). But we can try. We can summon members of our discipline and see what is possible. What are the achievements we've made, the major

milestones we've reached as a discipline? What are the puzzles that remain that direct our interdisciplinary efforts? It is not *merely* interdisciplinarity that matters. Any intellectual mixing must be directed from a foundation of what we've learned and a firmament of what we haven't figured out.

Seeking this direction was the motivation of the "Progress and Puzzles of Cognitive Science" initiative. Across 2022, the journal *Cognitive Science* invited letter submissions serving as concise and provocative proposals for the next phase of our discipline. To review submissions, a team of Editorial Board members kindly contributed their time and expertise in addition to their usual editorial duties.

These co-editors invited submissions on the following two themes. These themes were as follows, drawing from the call itself:

> *Progress of Cognitive Science: What concepts, models, theories or findings belong at the core of cognitive science? These should be viable as centerpieces of our discipline — for inclusion as core knowledge, and as part of the curricular structure of our field's training. These submissions should frame progress in innovative ways, going beyond simply a review of one's favored current theory and findings.*

> *Puzzles of Cognitive Science: What critical next steps are important for our field? These may be critical next steps for theoretical development, such as computational models or adapting our default assumptions from the philosophy of science. They may be critical empirical questions that are unsolved yet central to mind. Are there empirical questions that haven't even been posed that represent puzzles that lie at the core of our enterprise?*

We encouraged wide multidisciplinary relevance and comprehensiveness, and we highlighted the importance of teams of authors. We received over 60 submissions, out of which 36 were published intermittently across 2022 and 2023. We thank all who submitted, and there were so many fantastic submissions. Unfortunately, we had to limit acceptance to those that seemed well suited to the letter format, with its 1,250-word limit. The letters can now be perused in this virtual issue that the present letter introduces.

We include an important caveat here. Most editors only saw a subset of the letter submissions. While this assignment was necessary given the volume of submissions we received, it may have also promoted an interdisciplinary and pluralistic overall message. For these reasons, we cannot as a group endorse any of the letters as being ultimately the "correct" account about cognitive science. Instead, we leave this as an exercise to readers, and hope it fosters dialogue about its many themes.

Table 1 highlights some of these themes. This is not an official endorsement of this disciplinary structure or strategy. Table 1 is simply an illustrative layout of what is in the collection of letters – that promissory patchwork of ideas and their connections.

For example, some letters emphasized important theoretical themes that have lasting relevance, such as task-oriented pragmatic explanations (Hardman, 2022; Mekik & Galang, 2022) and formalisms in grammatical systems (Chemla et al., 2023) and languages of thought (Mandelbaum et al., 2022).

Some letters highlighted critical open questions, like the continuing problem of consciousness (Cheng et al., 2022; Christov-Moore et al., 2023; Stoll, 2023). An especially prominent theme across letters was the puzzle of integrating social and other contextual dimensions to our understanding of cognition and intelligent behavior (Dingemanse et al., 2023; Dubova et al., 2022; Scott-Phillips & Nettle, 2022; Vélez et al., 2023; Wojtowicz & Loewenstein, 2023).

Early in our submissions, some editors were concerned about the lack of diversity among submitting authors along with a surprising number of sole-authored submissions. While this self-corrected to some degree as further submissions came in, this issue was an important theme among the letters. This theme relates to diversifying cognitive science, assessing what it can do for people more broadly than in the past (Prather et al., 2022) and how it should better engage neurodiversity (Manalili et al., 2023).

Some letters developed innovative ideas about core aspects cognition, such as the nature of belief (Leeuwen & Lombrozo, 2023), perception and attention (Cleary et al., 2023; Elber-Dorozko & Loewenstein, 2023; Yu & Lau, 2023), language and learning (Cohn & Schilperoord, 2022; Kapatsinski, 2023; Smalle & Möttönen, 2023), reasoning and other aspects of high-level cognition (Dedhe et al., 2023; Franco & Murawski, 2023; Pirrone & Tsetsos, 2023).

There are surely many ways of organizing these letters and their themes. Some are shown in Table 1 below. We hope readers find interesting threads of their own to tie various letters together and share with students. Whatever that arrangement, its empirical and theoretical substance is what unites us.

Table 1: The accepted 36 Progress & Puzzles letters organized thematically

Theme / Title	Author(s)
Organizing Frameworks	
Cognitive Science in a Nutshell	Mekik, C. S., & Galang, C. M.
Three Simple Rules for Good Cognitive Science	Hardman, D.
Formal Models at the Core	Chemla, E., Charnavel, I., Dautriche, I., Embick, D., Lerdahl, F., Patel-Grosz, P., Poeppel, D., & Schlenker, P.
Problems and Mysteries of the Many Languages of Thought	Mandelbaum, E., Dunham, Y., Feiman, R., Firestone, C., Green, E. J., Harris, D., Kibbe, M. M., Kurdi, B., Mylopoulos, M., Shepherd, J., Wellwood, A., Porot, N., & Quilty-Dunn, J.
Bridges & Directions	
The Puzzling Chasm Between Cognitive Representations and Formal Structures of Linguistic Meanings	Mondal, P.
Cognitive Science: Piecing Together the Puzzle	Feist, M. I., & Duffy, S. E.
Reframing Cognitive Science as a Complexity Science	Favela, L. H., & Amon, M. J.
The Bias-Variance Tradeoff in Cognitive Science	Doroudi, S., & Rastegar, S. A.
Cognition: A Study in Mental Economy	Wojtowicz, Z., & Loewenstein, G.
Beyond Anthropocentrism in Comparative Cognition: Recentering Animal Linguistics	Schlenker, P., Coye, C., Steinert-Threlkeld, S., Klinedinst, N., & Chemla, E.
Cognition & Context	
Cognitive Science of Augmented Intelligence	Dubova, M., Galesic, M., & Goldstone, R. L.
Beyond Single-Mindedness: A Figure-Ground Reversal for the Cognitive Sciences	Dingemanse, M., Liesenfeld, A., Rasenberg, M., Albert, S., Ameka, F. K., Birhane, A., Bolis, D., Cassell, J., Clift, R., Cuffari, E., Jaegher, H. D., Novaes, C. D., Enfield, N. J., Fusaroli, R., Gregoromichelaki, E., Hutchins, E., Konvalinka, I., Milton, D., Rączaszek-Leonardi, J., Reddy, V., Rossano, F., Schlangen, D., Seibt, J., Stokoe, E., Suchman, L., Vesper, C., Wheatley, T., & Wiltschko, M.
How do Humans Overcome Individual Computational Limitations by Working Together?	Vélez, N., Christian, B., Hardy, M., Thompson, B. D., & Griffiths, T. L.

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