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Introduction to 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

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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, & Graham, 1998; Boden, 2008; Pléh & Gurova, 2013). 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 the 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, and methods of studying the mind.

These challenges are not unique to us: The unity of science remains a debated topic in the 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, Dale, & Christiansen, 2022; Gentner, 2019). But we can try. We can summon members of our discipline and see what is possible. What are the achievements we have made, the major milestones we have 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 have learned and a firmament of what we have not 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 subset of the Editorial Board kindly volunteered their time and expertise in addition to their usual editorial duties. The Executive Editor used a double-anonymous process, distributing anonymized letter submissions to a pair of participating editors, who remained anonymous to authors.

These co-editors invited submissions on the following two themes:

> *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 1250-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 a "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, Lin, & Tseng, 2022; Christov-Moore, Jinich-Diamant, Safron, Lynch, & Reggente, 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, Galesic, & Goldstone, 2022;

Table 1
The accepted 36 Progress & Puzzles letters organized thematically

Theme/Title	Author(s)
Organizing Frameworks	
Cognitive Science in a Nutshell	Mekik & Galang, 2022
Three Simple Rules for Good Cognitive Science	Hardman, 2022
Formal Models at the Core	Chemla, Charnavel, Dautriche, Embick, Lerdahl, Patel-Grosz, Poeppel, & Schlenker, 2023
Problems and Mysteries of the Many Languages of Thought	Mandelbaum, Dunham, Feiman, Firestone, Green, Harris, Kibbe, Kurdi, Mylopoulos, Shepherd, Wellwood, Porot, & Quilty-Dunn, 2022
Bridges & Directions	
The Puzzling Chasm Between Cognitive Representations and Formal Structures of Linguistic Meanings	Mondal, 2022
Cognitive Science: Piecing Together the Puzzle	Feist, & Duffy, 2023
Reframing Cognitive Science as a Complexity Science	Favela, & Amon, 2023
The Bias-Variance Tradeoff in Cognitive Science	Doroudi, & Rastegar, 2023
Cognition: A Study in Mental Economy	Wojtowicz, Z., & Loewenstein, G.
Beyond Anthropocentrism in Comparative Cognition: Recentering Animal Linguistics	Schlenker, Coye, Steinert-Threlkeld, Klinedinst, & Chemla, 2022
Cognition & Context	
Cognitive Science of Augmented Intelligence	Dubova, Galesic, & Goldstone, 2022
Beyond Single-Mindedness: A Figure-Ground Reversal for the Cognitive Sciences	Dingemanse, Liesenfeld, Rasenberg, Albert, Ameka, Birhane, Bolis, Cassell, Clift, Cuffari, Jaegher, Novaes, Enfield, Fusaroli, Gregoromichelaki, Hutchins, Konvalinka, Milton, Rączaszek-Leonardi, Reddy, Rossano, Schlangen, Seibt, Stokoe, Suchman, Vesper, Wheatley, & Wiltschko, 2023
How do Humans Overcome Individual Computational Limitations by Working Together?	Vélez, Christian, Hardy, Thompson, & Griffiths, 2023
On the Problems Solved by Cognitive Processes	Smaldino, Pietraszewski, & Wertz, 2023
Humanity, Diversity, Society	
What Can Cognitive Science Do for People?	Prather, Benitez, Brooks, Dancy, Dilworth-Bart, Dutra, Faison, Figueroa, Holden, Johnson, Medrano, Miller-Cotto, Matthews, Manly, & Thomas, 2022
Cognition and Society: Prolegomenon to a Dialog	Scott-Phillips, T., & Nettle, D.
An Impoverished Epistemology Holds Back Cognitive Science Research	Goldrick, 2022
From Puzzle to Progress: How Engaging With Neurodiversity Can Improve Cognitive Science	Manalili, Pearson, Sulik, Creechan, Elsherif, Murkumbi, Azevedo, Bonnen, Kim, Kording, Lee, Lee, Obscura, Kapp, Röer, & Morstead, 2023
Cognitive Science & Technology	
Is it Possible to Preserve a Language using only Data?	Bensemann, Brown, Witbrock, & Yogarajan, 2023
The Puzzle of Evaluating Moral Cognition in Artificial Agents	Reinecke, Mao, Kunesch, Duéñez-Guzmán, Haas, & Leibo, 2023
Large Language Models Demonstrate the Potential of Statistical Learning in Language	Contreras Kallens, Kristensen-McLachlan, & Christiansen, 2023
Consciousness & Individuals	
Taking Conceptual Issues Really Seriously: One Next Step for the Cognitive Science of Consciousness	Cheng, Lin, & Tseng, 2022

(Continued)

Table 1
The accepted 36 Progress & Puzzles letters organized thematically

Theme/Title	Author(s)
Hidden Differences in Phenomenal Experience	Lupyan, Uchiyama, Thompson, & Casasanto, 2023
Consciousness, Exascale Computational Power, Probabilistic Outcomes, and Energetic Efficiency	Stoll, 2023
Cognitive Science Below the Neck: Toward an Integrative Account of Consciousness in the Body	Christov-Moore, Jinich-Diamant, Safron, Lynch, & Reggente, 2023
Cognitive Domains	
Core & Canonical Processes	
Toward an Atlas of Canonical Cognitive Mechanisms	Pirrone, & Tsetsos, 2023
Origins of Hierarchical Logical Reasoning	Dedhe, Clatterbuck, Piantadosi, & Cantlon, 2023
Perception & Attention	
The Binding Problem 2.0: Beyond Perceptual Features	Yu, & Lau, 2023
What Flips Attention?	Cleary, Irving, & Mills, 2023
Do Retinal Neurons Also Represent Somatosensory Inputs? On Why Neuronal Responses Are Not Sufficient to Determine What Neurons Do	Elber-Dorozko, & Loewenstein, 2023
Language	
Reimagining Language	Cohn, & Schilperoord, 2022
Defragmenting Learning	Kapatsinski, 2023
Cognitive Development as a Piece of the Language Learning Puzzle	Smalle, & Möttönen, 2023
High-Level Cognition	
The Puzzle of Belief	Van Leeuwen, & Lombrozo, 2023
Pushing the Bounds of Bounded Optimality and Rationality	Musslick, & Masís, 2023
Harnessing Computational Complexity Theory to Model Human Decision-making and Cognition	Franco, & Murawski, 2023

Scott-Phillips & Nettle, 2022; Vélez, Christian, Hardy, Thompson, & Griffiths, 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 of cognition, such as the nature of belief (Van Leeuwen & Lombrozo, 2023), perception and attention (Cleary, Irving, & Mills, 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 (Franco & Murawski, 2023; Pirrone & Tsetsos, 2023). A few letters highlight recent developments at the intersection between technology and cognitive science, such as the influential emergence of Large Language Models

(Contreras Kallens et al., 2023), technologies to preserve languages (Bensemann, Brown, Witbrock, & Yogarajan, 2023), and artificial intelligence and moral cognition (Reinecke et al., 2023).

There are surely many ways of organizing these letters and their themes. Some are shown in Table 1. 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.

Acknowledgments

RD penned the first draft of this introduction; some suggestions for revisions were shared from co-authors, a subset of the Editorial Board, who sign on in the spirit of a co-edited volume or proceedings. Editorial Board members who participated share enthusiasm about the general initiative to assemble big ideas about our discipline in a brief format. The particulars of this introduction's contents and of the many letters themselves could be the subject of some future discussion in a longer and more collaborative treatment. Indeed, spirited debate is entailed by the diverse proposals in "Progress and Puzzles of Cognitive Science." We invite such lively discussion, debate, and collaboration among readers.

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