Interdisciplinarity and Pluralism in Cognitive Science

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Cognitive science, born out of the cognitive revolution in the 1950s, stands as a collective pursuit that integrates insights from six distinct disciplines: anthropology, artificial intelligence (AI), linguistics, neuroscience, philosophy, and psychology. Despite its singular nomenclature, reflective of an aspiration toward unity, cognitive science grapples with the inherent challenge of fostering interdisciplinary coherence in elucidating the complexities of the mind. While debates persist regarding the maturity of cognitive science as a scientific discipline, its legitimacy and significance as a scholarly endeavor remain undeniable.

Diversity emerges as a pivotal facet in the discourse surrounding the maturation of cognitive science, characterized by an inherent tolerance for divergent perspectives on the fundamental question of "what is cognition?". Each contributing discipline brings unique theoretical vantage points, fostering a rich tapestry of thought. Embracing this diversity becomes imperative for fostering fruitful interactions, even when convergence is not possible. Such receptivity involves not only recognizing but also actively understanding the distinct sets of assumptions inherent in diverse perspectives, thereby appreciating the nuanced approaches each discipline employs when confronting shared research questions.

The historical trajectory of cognitive science further complicates the pursuit of interdisciplinary and coherent interactions within the field. Núñez and colleagues, in their 2019 publication "What happened to cognitive science?," query whether cognitive science has evolved into a unified and coherent entity or if multiple, divergent cognitive sciences have emerged over time (Núñez et al., 2019). They assert that the original vision of cognitive science as

an interdisciplinary field, seamlessly integrating theories, has fallen short of realization.

In response to the concerns raised by Nunez et al., Dedre Gentner offers a counterpoint in her commentary titled "Cognitive science is and should be pluralistic." (Gentner, 2019). Gentner contends that the divergent views and ensuing debates within cognitive science have, in fact, enriched the field. Despite acknowledging the dominance of psychology within the interdisciplinary landscape as a potential drawback, Gentner remains optimistic about the field's trajectory. She emphasizes that cognitive science, anchored in its founders' commitment to exploring the representational and computational capacities of the mind, while being a pluralistic and open field.

This essay critically engages with the contentions presented by both Nunez et al. and Gentner regarding the interdisciplinarity of cognitive science. To achieve this, we embark on a comprehensive exploration of the historical origins of cognitive science during the cognitive revolution, examining the diverse visions that have emerged over its history. We also scrutinize the criteria for a successful research program, as articulated by Imre Lakatos (Lakatos et al., 1978), and the distinction between multidisciplinarity and interdisciplinarity, as outlined by Howard Gardner (Gardner, 1987)—arguments central to Nunez et al.'s claim of cognitive science's failure.

Delving into the critique by Nunez et al. regarding the field's lack of integration due to inconsistent views, we assess Gentner's perspective as a rejoinder. As both perspectives recalls back to the founders' intentions for interdisciplinary exploration, we critically reevaluate these initial visions. Additionally, we inquire into the historical overrepresentation of psychology relative to other constituent disciplines and contemplate the current common ground in cognitive science. Finally, we explore strategies to nurture interdisciplinary collaboration amid diverse perspectives in the evolving landscape of cognitive science.

The inception of cognitive science traces back to the 1950s, an era recognized as the cognitive revolution, coinciding with the advancements in computer technology. This epoch marked a pivotal shift, propelling the investigation of intelligence and intelligent systems through the lens of computation—a paradigm encapsulated by the notion that "cognition is computation." The impetus for this intellectual surge was driven by the growing field's foundational objective: to scrutinize the representational and computational capacities of the mind. Funding from entities like the Sloan Foundation played a significant role in the early stages of cognitive science, as elucidated

in its 1978 report. This seminal document not only delineated the field's core mission but also underscored the collaborative nature of cognitive science by acknowledging the potential contributions from six designated disciplines, symbolically represented in the field's hexagonal emblem.

In the cognitive revolution, the emphasis was on the theories of mind with complex representations, computations, and information processing. Subsequently, diverse views of cognition emerged within the historical evolution of cognitive science. These varying perspectives, constituting different stages, include cognitivism, emergence, and the enactive theory of cognition, as outlined by Varela et al. (2017). Cognitivism, serving as the catalyst for the cognitive revolution, construed cognition as a computational and symbolic set of manipulations, placing paramount importance on mental representations. However, this approach tended to neglect the multifaceted dimensions of cognition, such as neurological, biological, sociological, cultural, and anthropological aspects.

The subsequent stage, known as the era of emergence, witnessed the rise of a connectionist view of the mind, inspired by the newfound understanding of the interconnectivity of the neural system. The evolution continued with the advent of parallel distributed processing, which diverged from serial computations, reshaping the landscape of cognitive science by challenging the conventional emphasis on mental representations. Situated cognition emphasized the inseparable connection between cognition, environment, and context, followed by distributed cognition, which contested the individualized and internalized notion of cognition by highlighting its distributed nature among agents and their environment. Embodied cognition emerged as a critical response to the prevalent brain-centric view, accentuating the role of bodily features and the agent's existence in cognitive processes. Subsequently, enactive cognition advanced a radical departure from the notion of cognition as a representational device, instead underscoring the enactment of individual and environmental dynamics through a variety of actions. This proliferation of diverse perspectives posed a formidable challenge for fostering cohesive and productive studies within the realm of cognitive science.

Within the expansive and diverse terrain shaped by various disciplines and visions, Nunez et al. raise a critical inquiry into the trajectory of cognitive science, questioning whether it has successfully cultivated a well-defined and cohesive research program that embraces interdisciplinarity. Central to their scrutiny is Lakatos's framework for constructing a successful research field, which hinges on the preservation of fundamental tenets and conjectures

as shared foundations. This preservation involves establishing a consensus on research paradigms, assumptions, and approaches. The embryonic principles of cognitive science were initially grounded in the concepts of "mental representations" and the computer model of the mind. However, these foundational ideas have encountered challenges and refutations from diverse cognitive perspectives. Nunez et al. contend that such oppositions have eroded the field's common ground, leaving it devoid of essential principles and assumptions—a precarious situation that jeopardizes the success of any scientific research program.

Drawing further attention to the dynamics of interdisciplinary collaboration, Nunez et al. introduce a crucial distinction between multidisciplinarity and interdisciplinarity, as elucidated in Gardner's classification of weak and strong cognitive science. In the realm of weak cognitive science or multidisciplinarity, the integration of findings across different perspectives lacks depth; it involves exploring a phenomenon from various angles without the reciprocal exploitation or mutual benefit of these perspectives. In contrast, strong cognitive science or interdisciplinarity embodies a seamless interweaving of findings from diverse perspectives through meticulous analysis, synthesis, and the creative generation of knowledge—exemplified by disciplines such as biochemistry. The additive effect characterizing multidisciplinarity falls short of achieving a coherent integration inherent in interdisciplinarity. Nunez et al. argue that cognitive science, in practice, has become entrenched at the level of multidisciplinarity, wherein collaborative endeavors across different disciplines are dominated by the influence of psychology. They assert that despite the coexistence of varied views, cohesive integration into interdisciplinarity has remained elusive over the decades. Therefore, they are in favour of using "cognitive sciences" in plural form rather than in singular form, since it does not fulfil a coherent interdisciplinary endeavour.

Nunez et al. focalize their critique on the pervasive divergence of opinions and approaches within cognitive science, contending that this dispersion obstructs coherent interaction and integration. They assert that these diverse perspectives often rely on opposing or mutually inconsistent foundations, leading different approaches within cognitive science to persist as disparate collections of academic practices devoid of shared goals or paradigms. Nunez et al. emphasize the absence of common objectives and unified efforts within the field, lamenting the inability of distinct communities across disciplines to converge. This fragmentation, they argue, not only impedes the establishment of cognitive science as a distinct field but also exposes it to the risk of

subjugation by more narrowly defined disciplines, particularly cognitive psychology. The emergence of divergent trajectories within the field, according to Nunez et al., becomes a recipe for an unsuccessful research program.

While the apprehension about the potential subjugation of cognitive science by other fields is indeed a valid concern, Nunez et al.'s characterization of the diverse interests maintained by cognitive scientists as "dizzying" may need a more nuanced evaluation. They suggest that oppositions to foundational assumptions and the advent of new views of cognition have left the field free of principles, allowing researchers to impose their preferred paradigms. Nunez et al. convicts the seemingly unrelated series of interests pursued by scholars identifying themselves as cognitive scientists, positing that this diversity disorients the field. Such a characterization, however, may unfairly discourage interdisciplinary interactions and dissuade scientific inquiries from adopting diverse positions, contradicting its own intention.

It is essential to approach Nunez et al.'s judgment of cognitive scientists maintaining diverse interests with caution. Labeling these pursuits as "disorienting" may prematurely dismiss the potential contributions of varied perspectives to the field. Evaluating whether a group of researchers possesses unrelated or irrelevant interests vis-à-vis their primary research questions can only be done in retrospect. Moreover, in the evolution toward a mature science, the exploration of seemingly "wild" ideas and the fluctuation of views can be deemed natural and, in certain contexts, even necessary for the advancement of interdisciplinary scientific pursuits. Constraining interdisciplinary endeavors from the outset may hinder the creative and exploratory nature that characterizes the trajectory of cognitive science.

In responding to Nunez et al.'s critique of cognitive science, Gentner takes a thought-provoking stance, reframing their concerns about the lack of coherent interdisciplinary interactions as an assertion that "pluralism is failure." However, this reframing seems to deviate from Nunez et al.'s core critique, which primarily centers on the challenge of diverse theories within cognitive science failing to coalesce into an integrated set. Nunez et al. underline the importance of consensus in research and education programs for guiding the orientation of future generations and fostering coherence within the field. Importantly, their critique does not advocate for cognitive science to be exclusively centered around a singular theory or viewpoint. Gentner, however, appears to interpret Nunez et al.'s claim as advocating for a single theoretical framework that may not align with the concerns raised by the original critique. To explore whether the propose was into a unified theoret-

ical framework, Gentner engages with two of the founders of cognitive science, Don Norman and Allan Colins, seeking clarification on their envisioned goals. Don Norman emphasizes the difficulty of uniting different levels of analysis into a single theoretical perspective. On the other hand, Alan Colins acknowledges their vision for interaction between artificial intelligence, psychology, and computational linguistics. This, however, leaves the roles of neuroscience, philosophy, and anthropology in cognitive science somewhat unaccounted for and ambiguous, casting doubt on Gentner's assertion that the founders aimed for a "fertile set of interactions among disciplines." While it is reasonable not to expect cognitive science to be constrained by a single theory, Gentner's interpretation may overstate the founders' intentions and overshot the ideal purpose suggested by Nunez et al.

While both Gentner and Nunez et al. concur on the founders' envisioned interdisciplinarity for cognitive science, they diverge in their assessments of the field's trajectory. Nunez et al. contend that the cognitive revolution, sparking the scientific investigation of the mind, launched a multidisciplinary research program with the explicit aim of integrating theories and findings from various disciplines. Their critique suggests that cognitive science, founded in the 1950s, initially sought to transform into a well-integrated interdisciplinary field, culminating in a comprehensive understanding of cognition. However, they lament the field's purported failure, asserting that it deviated from its original mission. According to Nunez et al., cognitive science's departure from a unified interdisciplinary effort and shared research questions prevented it from evolving into a coherent academic field with a well-defined and cohesive research program.

Then, Gentner portrays the early phases of cognitive science as intentionally unbounded, designed to remain open to flexibility and the inclusivity of diverse views and frameworks. Embracing this perspective, she highlights the positive impact of such openness, allowing for the emergence of diverse viewpoints like connectionism and acknowledging the influential role of embodied cognition in shaping the field. In a more optimistic tone than Nunez et al., Gentner contends that the existence of different views and the ensuing debates have facilitated the exploration of novel questions, such as the role of context and physicality in shaping cognitive representations. She argues that contradictions within the field's assumptions can be enlightening rather than detrimental.

Upon revisiting the initial purpose of the founders, especially within the cognitivist framework, it becomes apparent that the objective was not nec-

essarily a coherent integration of all six disciplines. The emphasis lay on investigating the computational and representational capacities of the mind, potentially incorporating neuroscience due to its focus on the central nervous system and a brain-centric perspective. However, the envisioning of contributions from other fields, such as philosophy and anthropology, appears less defined. Nunez et al. acknowledge the initial reductionist nature of cognitive science, framed by the cognitive revolution. Nevertheless, they argue that the emergence of opposing views and the advent of new perspectives have impeded coherence and integration, possibly indicating a struggle to transcend the reductionist view of the mind set at its inception. This reinterpretation suggests that the field's starting point may have played a role in fostering inevitable opposing views and tensions within cognitive science, as the initial objective, primarily seen as the marriage of psychology and AI, was inconsistent with the inclusive engagement of all six disciplines.

The examination of whether the original goal set by the cognitive revolution was genuinely interdisciplinarity prompts reflections from both Gentner and Nunez et al., who underscore the overrepresentation of psychology within cognitive science among its constituent disciplines. Nunez et al. concede that psychology's dominance could be attributed to its alignment with the foundational tenets of the cognitive revolution—investigating the mind from a computationalist and representationalist perspective. In contrast, anthropology and biology, disciplines focused on studying living organisms, might not seamlessly align with these tenets. This acknowledgment leads to the recognition that the dominance of cognitivism, characterized by computationalist and representationalist approaches, continues to prevail in cognitive science, with psychology occupying a central role. Gentner, too, acknowledges the enduring commitment to computationalist and representationalist objectives within cognitive science, while maintaining optimism about evolving theories and research methods. However, she suggests that the limited contribution of philosophers and anthropologists to cognitive science may be attributed to their restricted interest in the field. Importantly, this oversight depends on the prevailing image of cognitive science among philosophers and anthropologists. If the emphasis continues to prioritize the computational theory of mind over a broader investigation into the biological, sociological, cultural, and ecological aspects of the mind, it is only natural that anthropologists would exhibit limited interest in cognitive science.

In the face of such a diverse landscape, identifying common ground in Cognitive Science becomes a nuanced task, especially as the original objective

set by the cognitive revolution no longer enjoys a unanimous consensus. Over time, the goals of cognitive science have evolved, transcending the initial reductionist view. The launch of the cognitive science journal in the 1970s marked a pivotal moment when consensus shifted toward a more elaborate understanding of interdisciplinary efforts, encompassing the inclusion of six fields, and sometimes education. Consequently, any researcher or academic identified as a cognitive scientist would recognize the potential contributions from each of these six disciplines and acknowledge the challenges inherent in interdisciplinary collaboration, signifying a successful advancement. Thus, a common goal persists — a commitment to interdisciplinarity.

This leads us to the crucial question of how to enhance interaction across such diversity. The varied disciplines and groups within cognitive science employ different jargon and operate on distinct assumptions, akin to a gathering of multilingual individuals attempting to address a shared problem, as noted by Gentner. The challenge lies in avoiding the illusion of a simple aggregation of ideas into a coherent narrative — a new shared language. While recognizing the non-trivial nature of interdisciplinary interactions, it is imperative not to shy away from concerted efforts to understand one another. The maturity of cognitive science can be measured by its tolerance for divergent thinking and the willingness to take responsibility for scientific communication across diverse domains. This involves synthesizing insights from one domain and making them comprehensible to another — a translational feature that should be a cornerstone of cognitive science. Such an approach facilitates cohesive interaction among scholars and researchers from different disciplines and viewpoints. Gentner's metaphor of multilingual individuals suggests a reasonable solution: encouraging individuals to become bi- or tri-lingual, fostering learning from one another through dyadic and triadic interactions among disciplines. Rather than pursuing the immediate unification of all perspectives, this approach promotes a dynamic exchange that accommodates the evolving nature of cognitive science. Gentner also underscores the inherent diversity within each component of cognitive science, acknowledging the existence of different views and schools of thought. This acknowledgment of diversity is not only to be expected but celebrated, as even seemingly monolithic fields like psychology and AI grapple with a spectrum of opinions and perspectives on current capabilities and future concerns. In embracing this diversity, cognitive science can thrive as a dynamic and evolving interdisciplinary endeavor.

In conclusion, Gentner's emphasis on the pluralism of cognitive science

is a positive direction. However, her reframing of Nunez et al.'s stance as "pluralism is failure" appears to be an exaggeration, as their concerns revolved around the need for coherent interactions and interdisciplinarity within cognitive science rather than being against pluralism. Doubts linger about whether the founders envisioned inclusivity of different disciplines and interdisciplinarity, as suggested by Nunez et al., or if they intended the pluralism and openness highlighted by Gentner. Nunez et al. provide a justified explanation for the current dominance of psychology in cognitive science, attributing it to the enduring reductionist view originating from the cognitive revolution. The tension arising from opposing views, though necessary, impedes cognitive science's journey toward maturity. However, this struggle is not unique, as fluctuations in perspectives are inherent in various scientific disciplines. Despite these challenges, the current state of cognitive science holds promise, offering a more optimistic trajectory than its inception during the cognitive revolution.

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