What is 4E cognitive science?

Cameron Alexander[1]

Abstract

The 4E approach in (philosophy of) cognitive science—based on ideas that the mind is embodied, embedded, extended, and enacted—is so diverse that it defies straight-forward explanation. This paper considers the most ecumenical explanation of the extant concept of the 4E approach. Purported explanations of 4E based on contested definitions of cognition, contrasts with non-4E approaches, or essential and unifying features (including embodiment) either fail to capture the correct extension for the concept of 4E or lead to incoherence. The incoherence is generated by a failure to abide by several desiderata for non-revisionist conceptual explanations: informative-ness, non-contentiousness, and identification of any unifying features if they exist. By contrast, a family resemblance conception of 4E constrained by ties of histori-cal influence satisfies these desiderata. The 4E approach should be understood as a set of family resemblances of overlapping ideas, hypotheses, theories and concep-tual frameworks about the mind, as well as methods for its study. The family resem-blances span several dimensions, including but not limited to a rejection of dual-ism, non-representational explanations of the mind, phenomenological methods, the importance of embodiment, a dynamical systems perspective, and an evolutionary perspective on the mind. This family resemblance conception is complemented by a historical dimension: the concept of 4E cognitive science emerged in the period following the cognitive revolution of the 1950s. The advantages of this explanation are that it abides by the established use of '4E', explains 4E's apparent diversity, and warns against reductive explanations.

Keywords 4E · Embodied cognition · Conceptual explanation · Family resemblances

✉ Cameron Alexander
   cameron.alexander.147@gmail.com

1   Department of Philosophy, University of Zürich, Zürichbergstrasse 43, CH-8044 Zurich, Switzerland

🖉 Springer

1 Introduction

The view that the mind is embodied, embedded, extended, and enacted—the '4E' approach in philosophy and psychology—calls for clarification. Some proponents, whom I will refer to as '4E-ers,' claim that it is a revolution in thinking about the mind. Wheeler (2017) notes that "some thinkers who have recently been marching under the banner of 4E cognition have suggested that contemporary cognitive science is in its own revolutionary situation" (p.457). Wheeler's phrasing is apposite: 'revolutionary situations' are what revolutionaries call revolutions when victory is not assured. And for good reason; opponents of the 4E approach object that it is merely speculative or even vacuous (Aizawa, 2018; Goldinger et al., 2016; Mahon, 2015). For example, Carney's (2020) review of *The Oxford Handbook to 4E Cognition* is scathing: "the arguments presented by 4E theorists are sometimes not arguments at all, but rhetorical appeals to the reader" (p.79). Evaluating who is right requires a clear grasp of what 4E Cognitive Science is. This paper aims to provide this clarity as a propaedeutic to evaluation.

I aim to clarify what the 4E approach is through conceptual explanation. I explain what the concept of 4E Cognitive Science is by describing and elucidating it through its connections and contrasts with related concepts. In this sense, my approach is consciously connective, in Strawson's (1992) sense of connective rather than reductive conceptual explanation. My aim is non-revisionary. I will not revise the established understanding of what 4E Cognitive Science is in favour of a better understanding. Even if revisions to the concept of 4E Cognitive Science should be made, an initial, non-revisionist description is necessary. I aim to capture the extant concept of 4E Cognitive Science in a way that is recognisable to both 4E-ers and their opponents.

My thesis is that the concept of 4E Cognitive Science is a family resemblance concept constrained by historical ties of positive and negative influence. My argument is consciously analogous to Glock's (2008) explanation of analytic philosophy, where he argues that analytic philosophy should be understood with Wittgenstein's notion of family resemblances and a historical, but not overly historicist, perspective. The case of 4E Cognitive Science is interestingly different to analytic philosophy because the disciplines involved are more various (e.g., philosophy, psychology, neuroscience, computer science, etc.), but the subject matter is more restricted (i.e., the mind).

After distinguishing different perspectives on 4E Cognitive Science, Sect. 2 argues that 4E cannot be explained in terms of a definition of cognition. Section 3 sketches a paradigmatic example of the rules-and-representations approach in cognitive science associated with Fodor, against which paradigmatic examples of the 4E approach, described in Sect. 4, responded. Section 5 pinpoints what kind of explanation could successfully answer the question 'What is 4E Cognitive Science?' Non-revisionist explanations must aspire to being informative, non-contentious, and identify unifying features if they exist. I examine several candidate explanations and show why they fail along these lines. Section 6 examines a more promising route: zeroing-in on the notion of embodiment. An explanation

of 4E Cognitive Science follows, namely that 4E-ers assent to, or explicitly pre-scribe to, an embodiment thesis. I show that explaining 4E Cognitive Science in terms of embodiment is nevertheless unworkable. Section 7 looks at an explanation of 4E in terms of three overarching themes. I argue that this approach goes in the right direction but still fails to capture the 4E approach adequately. Section 8 introduces my preferred explanation, which comes in two parts. First, 4E Cognitive Science should be understood in terms of a set of overlapping similarities along the dimensions and themes that emerged in the discussion of paradigmatic examples. Second, 4E arose after an important divergence between behaviour-ists and advocates of the rules-and-representations approach. Nevertheless, the 4E approach retrospectively draws on both traditions. Explanations of 4E should be sufficiently historical to capture these two points. Section 9 states my *Family Resemblances and Historical Influences* explanation in full.

Note that the 4E approach is often referred to as "4E Cognition" (e.g., Newen et al., 2018). I use the label '4E Cognitive Science' throughout because a crucial issue is whether the *approach* coherently hangs together as an alternative to non-4E approaches. I use '4E Cognitive Science' interchangeably with '4E approach' and sometimes shorten to '4E'.

2 Practitioners, commentators and seeking definitions

There are two perspectives on the question 'What is 4E Cognitive Science?' First, there are *practitioners* of cognitive science who address first-order questions in cognitive science, such as: how does memory work? Which parts of the brain are responsible for language processing? How do verb classes in natural language affect concept learning? And so on. Second, there are *commentators* who address second-order questions about cognitive science including 'What is the 4E approach in cog-nitive science?' Commentators approach second-order questions in two ways. Non-engaged commentators have a sociological or intellectual history perspective. They investigate 4E Cognitive Science to see how scientific ideas emerge and change in general, not just for 4E. By contrast, engaged commentators address second-order questions for the benefit of practitioners. I focus on engaged commentators.

The need for commentators to address second-order questions about cognitive science arises from the fact that cognitive science is crewed by practitioners from a mishmash of different disciplines (e.g., psychology, linguistics, philosophy, ethol-ogy, biology, etc.). The distinction between practitioners and commentators often aligns with cognitive scientists and philosophers of cognitive science respectively. But disciplinary boundaries are routinely crossed. There are many examples of phi-losophers working on first-order questions, and even developing new experimental paradigms. For example, while working on the philosophical aspects of concept acquisition, the philosopher Allen (1999) suggested an empirical method for identi-fying concept use in nonhuman animals. There are also many examples of cognitive scientists considering second-order questions. Occasionally they do so philosophi-cally, by rationally reflecting on key concepts, but sometimes they do so non-philo-sophically, especially through historical reflection. It should be no surprise that the

division of labour for the different orders of question does not neatly correspond to scientists and philosophers, since disciplinary boundaries reflect departmental structures in universities of yesteryear. They are, therefore, no principled basis for drawing the distinction between practitioners and commentators. A slight complication with this distinction is that commentators are often also practitioners (e.g., Varela et al., 1991), but, in principle, they need not be.

The distinction between practitioners and commentators sheds light on different benefits of a non-revisionist conceptual explanation of 4E. On the one hand, a conceptual explanation is a prerequisite for commentators to answer second-order evaluative questions, such as: does the 4E approach differ from standard cognitive science? Should the 4E approach be changed? Do 4E explanations make sense? Adjudicating the revolutionary credentials of the 4E approach and assessing whether it is vacuous or not are downstream of getting to grips with what it is all about. On the other hand, cognitive scientists and philosophers aim to think about the mind and its capacities in a clear and scientifically informed way, in order to, for example, identify the causes of disorders and provide clinical treatments, find effective ways to mitigate social conflict, or develop models of learning to improve education. If these outcomes and others like them could be achieved with an improved cognitive science, and if adopting the 4E approach is the way to improve it, then there is value for non-4E practitioners to understand what the 4E approach is. An interesting benefit of a conceptual explanation of 4E is for 4E practitioners. In recent work on a 'reflexive turn' in 4E, Sanches de Oliveira (2023a, 2023b) argues that the questions, hypotheses, methods and explanations advanced by 4E practitioners are recognized by those same practitioners as constrained or generated by the embodied and situated way that they conduct their research. As Sanches de Oliveira (2023b, p.48) puts it, any explanation is "scratching an itch." This is not simply a metaphor but refers to the way that embodied manifestations of confusion and frustration shape how 4E-ers do their research. If 4E practitioners recognize other 4E-ers itches and situated research practices, this might expand possibilities for how 4E can be conducted.

Commentators, when addressing the second-order question, 'What is 4E Cognitive Science?' have frequently noted 4E's diversity. As early as (2002), M. Wilson noted in her seminal review of the field that there is "a great deal of diversity in the claims involved and the degree of controversy they attract" (p.625). It is, according to Robbins and Aydede (2009), a "many splendored enterprise" (p.3) whose ideas are a "diverse and sundry lot" (p.9). In this vein, Shapiro (2007) points out how 4E's diversity breeds unclarity: "the commitments and subject matters of [4E Cognitive Science] remain fairly nebulous" (p.338). Even the unity of 4E Cognitive Science is questioned by some commentators on account of its diversity (Alsmith & de Vignemont, 2012; Casper, 2023). Similarly, there is perhaps "no homogeneity within 4E cognition, except a shared enemy—cognitivism" (Menary, 2010, p.460). Matters have not improved over time; Weber and Vosgerau (2018) question both 4E's theoretical coherence ("a huge variety of partly overlapping, partly contradictory theories that differ broadly regarding the degree to which cognition is thought to be embodied, embedded, enacted, extended, or coupled with the environment" (p.412)) and its terminological coherence ("similar terms for different mechanisms and different terms for similar mechanisms […] even the precise meaning of

underlying terms—such as 'embodied cognition' or 'embodiment'—lacks univocality" (p. 412)).

Conceptually explaining what 4E is should match commentator verdicts. This does not mean that one should side with these verdicts, but one should not contradict them by claiming harmony where none exists. Explaining 4E can involve providing reasons why commentators frequently note its diversity, without agreeing that the diversity is a sign of trouble. I will argue in Sect. 5 that this is a mark of a good conceptual explanation.

The difficulty with accounting for approaches in (philosophy of) cognitive science arises partly because their topics—most notably the mind, its cognates (e.g., mental), and its capacities (e.g., cognition)—are contested. Debates between both commentators and practitioners regarding these topics are ongoing with little sign of resolving. This is because they touch on fundamental assumptions leading to disagreement on both the intension and extension of the concepts involved.

This contestation puts pressure on a *prima facie* reasonable way to explain what 4E Cognitive Science is. One might wish to explain what 4E is by, first, defining cognition, and second, arguing that proponents and opponents of 4E Cognitive Science differ exactly over whether to accept the definition. However, the conflict is not exclusively a terminological dispute and cannot be settled by stipulating a definition. Besides, there are good reasons not to strictly define cognition in advance of commenting on the 4E approach. Aside from almost certainly begging the question against an opposing side whichever way one tries to define it, there are shortcomings from defining cognition too strictly (Allen, 2017). First, 'cognition' is not a precise label for phenomena that practitioners of (philosophy of) cognitive science find interesting. Second, it does not express a useful concept for making categorisations in the service of conducting empirical studies. More important than defining cognition, according to Allen, is an assessment of explanations of specific capacities (e.g., memory, attention, reasoning, etc.), as specifically as is feasible.

Although defining 'cognition' will not do, there are good reasons to characterise cognition in some way, for commentators on 4E must start somewhere. To their advantage, characterisations, but not definitions, do not stand or fall because of extensional boundary disputes. This is because characterisations, formulated with generics, aim only to state something salient about a phenomenon (Leslie, 2008), rather than perfectly capture their proper extensions. For example, one can characterise tools as fabrications with practical functions, but rightfully acknowledge that this would not encompass all tools (e.g., loose sticks and rocks), while it would include buildings, roads, and entire infrastructures. Importantly, characterisations often start with paradigmatic examples, to which I now turn.[1]

---

[1] Commentators who are already familiar with the essential aspects of Fodor's philosophy and paradigmatic examples of 4E may wish to skip Sects. 3 and 4 respectively, as these sections are written specifically with 4E and non-4E practitioners in mind, who might wish for an overview.

3 Rules-and-representations

It is almost routine for 4E-ers to contrast their approach to Fodor's (1975, 1986; Fodor & Pylyshyn, 1988) account of cognition. Fodor, like many others following the Cognitive Revolution of the 1950-60s, assumed that capacities for abstraction, memory, learning, language, and the like, are only explained with a 'rules-and-representation' view of the mind. Fodor's view is really a confluence of two positions: the representational theory of mind (RTM) and the computational theory of mind (CTM) (Smortchkova et al., 2020). According to RTM, all mental states are representational states whose contents, in some sense, depict the world to be a certain way. According to CTM, mental operations are exactly computational processes. In principle, these can come apart depending on one's view of the nature and role of representations and the kind of computational theory one has. Fodor ties them together: "no computation without representation" (1981, p.122). Specifically, for Fodor, cognition is a computational process involving symbolic representations. Fodor's view is not, at the personal level of explanation, that (folk) psychological rules-of-thumb are akin to computations. Rather, underpinning personal level psychology, sub-personal cognitive processing consists of computational processes describable with algorithms or computational rules. These computations are dictated by an abstract calculus which presupposes symbolic representations standing in syntactic relations to each other. Moreover, these symbolic representations are arbitrarily connected to what they represent. They are also amodal; they do not depend on the make-up or functioning of the sensorimotor system for their content or format. Fodor's view was strongly computationalist: not only is the mind *like* computer software, but, at the subpersonal level of explanation, the mind *is* carrying out (digital) computations (see also Pylyshyn, 1985).

Fodor's account, and the rules-and-representations view generally, is contentious, not only for proponents of 4E Cognitive Science, but for others who treat the mind from the perspective of neural networks (e.g., Rumelhart et al., 1986), predictive processing (e.g., Hohwy, 2013), or from the perspective of ecological psychology (Gibson, 1986).[2] Moreover, some of the central notions invoked to explain cognition are no less mysterious than what Fodor seeks to explain (e.g., rule, representation, arbitrary, computation, etc.). My aim, however, is not to motivate the case for 4E Cognitive Science by pursuing these criticisms. Rather, Fodor's view is a standard against which to highlight objections of various paradigmatic 4E-ers to specific features of the rules-and-representations account.

---

[2] The potential alignment between ecological psychology and 4E Cognitive Science is discussed by several commentators. While some commentators view ecological psychology as squarely within 4E (e.g., Michaels & Palatinus, 2024; Richardson et al., 2008), others suggest weaker affinities (e.g., McGann, 2016; Shapiro, 2019a; Zahidi & van Eemeren, 2016). One issue of contention is whether the enactivist strand of 4E and ecological psychology are compatible (Read & Szokolszky, 2020; but see Heras-Escribano, 2021). Like Shapiro, I shall leave it open whether ecological psychology should be seen as a paradigmatic part of 4E, although my family resemblance view favours treating a number of practitioners inspired by Gibson's work as paradigmatic 4E-ers (e.g., Chemero, 2009; Kiverstein & Rietveld, 2014).

4 Paradigmatic examples of 4E cognitive science

Sketching paradigmatic 4E responses to the rules-and-representations view adds flesh to the idea that cognition is embodied, embedded, extended, and enacted.

Varela et al. (1991) book *The Embodied Mind* attempted to centralise experience in explanations of cognitive capacities by synthesising ideas from biology, philosophy, phenomenology, Buddhism, and dynamical systems theory. What emerges is a recharacterization of cognition as "embodied action" (p.172), as opposed to an abstract, general purpose computational process. Two features of their account are noteworthy. First, they highlight an important point about cognition, which they claim went unrecognised by Fodor, namely that "cognition depends upon the kinds of experience that come from having a body with various sensorimotor capacities" (p.173). If an organism were to have a body with different sensorimotor capacities, then this would alter the kinds of experiences it would have, and hence its body would determine the kind of actions it would take. One can think here of animals with different sensorimotor systems to our own, such as ants who can produce and detect pheromone signals. As ants move along the forest floor, they detect pheromone signals which guide its subsequent actions, which in turn reveal more features of the environment to the ant's sensorimotor system. This, in turn, guides the ant's subsequent actions in an ongoing perception–action loop. The point generalises to animals of any morphology, like fish with lateral line organs that can detect changes in pressure gradients in the surrounding water, mole rats who have very low pain sensitivity in their skin, or humans with refined vocal apparatuses and manual dexterity. Cognitive capacities are dependent on, and limited by, the morphology because different morphologies generate different experiences. Second, their claim that cognition is embodied goes together with their claim that cognition is enacted, which they describe in terms of dynamical systems. Cognitive capacities "emerge from the recurrent sensorimotor patterns that enable action to be perceptually guided" (p.173). For example, as the ant navigates along the forest floor, its capacity to learn where food is located, and to subsequently remember where the food is located, are emergent properties of the ant repeatedly acting in a perceptually guided way in concert with the affordances available in the environment. Taken together, their account of cognition as embodied action recharacterizes the explanandum of cognitive science, uses phenomenology as a central plank of its experience-first approach to cognition, and combines the ideas of embodied cognition and enacted cognition.

Another paradigmatic example of the 4E approach is Brooks' (1991) work in robotics, whose characteristic feature is to reject the need for representations. Brooks noticed that robots which used representations or models of the world to solve tasks showed very poor performance. For example, robots that were designed to navigate and collect objects in a normal office, frequently failed to avoid obstacles or find and pick up target objects. Instead, Brooks argued that it is better to "use the world as its own model" (p.140), and he built robots that could perform tasks without representing the external environment. One technique was

to program robots to engaged in physical movements first, only subsequently adjusting their physical movements based on sensory feedback. For example, imagine a robot which must place a peg in a hole. The robot first moves the peg towards the hole. In almost all cases it does not successfully put the peg in the hole first time but rebounds off one of the interior sides of the hole. Rather than program the robot to respond to these rebounded movements with a compensatory movement, one can rely on the loose assembly of the robot's arm to naturally spring back in response to the rebounded movement (see also Clark, 2016). The properties of the robot's physical construction – its embodiment – thus play a role in solving the task, without representations of the world (e.g., the size and position of the hole, of the length of the robot's arm, the size of the peg, etc.) or complex programming.

Other examples of 4E agree with the need for representations, but reject Fodor's account of representations, specifically amodalism. Barsalou (1999) criticised Fodor's assumption that information is stored in amodal formats. If computational processes underpinning cognitive capacities like memory, learning and language really involve amodal representations, there should be no influence of the semantics of concepts expressed in natural language on the way that cognitive tasks are solved. This prediction of the standard approach is not borne out by a range of studies showing an influence of handedness on categorisation and evaluative judgment tasks (Casasanto & Henetz, 2012), or the activation of motor regions of the brain when subjects are presented with action-related words like 'kick' and 'lick' (Pulvermüller, 2005). Similarly, Lakoff and Johnson (2003) argued that natural languages are permeated by metaphor. Metaphors, on their view, are linguistic devices allowing subjects to understand one concept in terms of another. For example, 'Love is a journey,' allows subjects to understand the concept LOVE in terms of the concept JOURNEY, since journeys have a direction of travel, duration, various possible routes, and so forth. In turn, the (sub-)concepts related to journeys are understood in terms of other concepts via yet more metaphors. They argued, however, that metaphors cannot be the basis of how we understand the world conceptually, as this would lead to an ongoing circle of concepts with no grounding in experience. Instead, there are some concepts for which we have non-metaphorical understanding. They proposed that we have embodied knowledge of basic facts about orientation and motor capacities of the human body, and this knowledge provides content to a stock of basic concepts (e.g., UP, DOWN, FORWARDS, BACKWARDS), which thereby provide content for metaphors. These basic concepts are stored in sensorimotor regions of the brain (i.e., they are modal concepts) and their contents depend on basic facts about human embodiment (i.e., embodied concepts). The implication is that organisms with radically different embodiments (e.g., starfish) would have different basic concepts, if they have concepts at all.

Other 4E-ers question the *prima facie* reasonable hypothesis that the brain is the sole locus and underpinning of cognitive processing. The ensuing thesis, known as extended cognition, maintains that the constituents of cognitive processing span parts of the external environment beyond the brain. Interestingly, the classic proponents of this strand of 4E argue from the perspective of a rules-and-representations view (Clark & Chalmers, 1998). They point out that in typical cases of remembering

we accept that (parts of) the brain is causally responsible for storing and processing information. They argue, by parity of reasoning with the typical, non-artefact-involving case, that there are similar cases of remembering for which equivalent information storage and processing are implemented by artefacts like notebooks and smartphones. Since we accept that the brain is causally responsible for cognition in the typical case, we should accept that any artefact (e.g., notebook) that plays an equivalent role should be deemed causally responsible for cognition. An objection to the artefact-involving case claims that artefacts are merely prompts for the so-called real cognitive process occurring in the brain. They block this with the case of Otto's notebook: Otto's notebook substitutes for cognitive processes that would normally be implemented by a part of his brain which is in fact damaged. The absence of Otto's notebook would scupper his memory, in a way that a mere prompt should not. They conclude that cognition can be constituted by processes that occur beyond the brain.

Another strand of the 4E approach, exemplified by Hutto and Myin (2017) and Cisek (2021), argues that the topics and problems tackled by practitioners of cognitive science are subordinate to the fundamental biological fact that cognitive capacities are traits with evolutionary histories. As Cisek puts it, "From an evolutionary perspective, embodiment is fundamental. All aspects of brain function, including thoughts and feelings, must ultimately serve overt action or they would not have been supported by natural selection" (2021, p.547). The methodology and conceptual framework of evolutionary biology should be used to study cognition and doing so presupposes that cognition is embodied. This is because "embodiment is not an aspect of cognition—it is the other way around" (p.549). This evolutionary view picks up on an assumption in Fodor's account, namely that explanations at the sub-personal level should be computational rather than metabolic. The evolutionary view of embodiment prioritizes sub-personal explanations which make sense of an organism's behaviour and metabolic processes. Over an evolutionary timescale, explanations for the origin and function of cognitive traits in terms of dynamics of metabolism that facilitate environmental resource exploitation for selective advantage are far more plausible than the rules-and-representations view of the mind. Metabolic explanations cannot avoid discussing the embodiment of organisms, since not referring to the structure and functioning of an embodied organism is to not give a metabolic explanation at all. And even if Fodor were to grant the importance of an evolutionary explanation for brain structure and functioning, the rules-and-representations view precludes seeing the connection between an abstract computational architecture and the selective advantage of organisms gaining cognitive traits over evolutionary time. This evolutionary view of embodiment also substantiates one sense of embedded cognition. One way that biologists explain traits is to explain how an organism exercising the trait relies on resources available in the ecological niche. For example, to explain monkey alarm calling behaviour, a functional explanation would have to show how the monkey's ecological niche is populated by predators. Producing alarm calls is a risky behaviour as they typically reveal the signaller's location, so they only function well if they are selectively produced, to minimize risk to signallers and their kin. The capacity to selectively produce alarm calls is embedded in an environment that is replete with risks, rewards and

hence opportunities for action (i.e., affordances). This explanation of how a cognitive capacity is embedded goes beyond referring to any causally relevant factor. For example, it is not part of the embedded view of cognition to simply point out that a functioning digestive system is a causally relevant factor for thinking. The idea that cognition is embedded should consider how the exercise of a cognitive capacity is responsive to constraints in the organism's environment.

Another strand of work developed by Di Paolo, De Jaegher and Cuffari (2018, see esp. pp.13–14) distinguishes different senses of embodiment. They distinguish between (i) biological embodiment (i.e., the body is the product and locus of evolutionary processes), (ii) situated embodiment in action (i.e., the body as caught in a web of context-specific scripted actions), (iii) phenomenological embodiment (i.e., the body is experienced in the first-person perspective as living and capable), and (iv) social embodiment (i.e., the body is subjected to cultural norms). They claim that each conception of embodiment offers true but mutually conflicting insights into the connection between body and mind. An important aspect of this strand of 4E is its proposed *methodological innovation*: standard cognitive science fails to recognize the limitation of its (functional) conception of the body as a vessel which is similar in some respects to a machine (p.6). Di Paolo and colleagues propose a dialectical methodology to break away from non-4E cognitive science: 4E-ers should recognize and play-off the limitations of extant conceptions of the body against each other. Doing so generates contradictory insights about the role of the body that can be overcome through conceptual innovation. Using this dialectical method, one innovation is to reframe the body in relational and processual terms (p.99). Another is a new conception of linguistic embodiment, which they engineer to make sense of the way that language alters the way that different forms of embodiment are enacted (p.101).

This sketch of paradigmatic 4E-ers is not only short but incomplete. One could also mention Dreyfus' (1992) critique of artificial intelligence research from a Heideggerian perspective; replacing rules-and-representation explanations with dynamical systems explanations (Thelen & Smith, 1994; Van Gelder, 1995); O'regan and Noë's (2001) account of enactivist perception; or Clark's (2016) interpretation of predictive processing from the perspective of embodied cognition. Despite its shortcomings, this sketch illustrates two things. First, commentators are right to point out 4E's diversity. Second, 4E practitioners diverge from the standard approach epitomized by Fodor in numerous ways. What brings them all together?

5 Explaining the concept of 4E cognitive science

I want to suggest three desiderata that a conceptual explanation of 4E Cognitive Science should satisfy. The explanation should be informative, non-contentious, and identify any essential and unifying features if they exist. To get a handle on these desiderata, consider this disjunctive account of 4E:

Disjunctive Explanation: 4E Cognitive Science is an approach in (philosophy of) cognitive science. It is purportedly distinct from the rules-and-repre-

sentation approach exemplified by Fodor. It emphasises either the embodied, embedded, extended or enactive nature of cognition. It is exemplified by the work of Varela, Brooks, Barsalou and Clark, among many others.

This explanation addresses the question 'What is 4E Cognitive Science?' but does it provide a good answer? First, an explanation should be *informative*. Informativeness depends on our epistemic goals and on what those to be informed understand already. To be more precise, those goals might be to (i) understand what kind of thing 4E is, (ii) understand 4E's distinguishing features, (iii) understand how 4E relates to other phenomena, and (iv) learn of some paradigmatic examples of 4E.[3] Disjunctive Explanation is reasonably informative. (i) 4E Cognitive Science is an approach (rather than a theory, view, account, hypothesis, worldview, conceptual framework, or methodology). An approach is an inclusive category: it includes all the alternatives just mentioned, and there are examples of each within 4E. (ii) It is distinguished by its emphases on embodiment, embeddedness, enaction and extension (though how that should be understood is left open). (iii) It contrasts with the approach associated with Fodor. (iv) Varela, Brooks, Barsalou and Clark are paradigmatic practitioners of 4E.

Another way that a conceptual explanation can be informative is that (v) it makes sense of why there is confusion about a concept in the first place by identifying sources of confusion. Conceptual explanations, by contrast to empirical explanations, clarify and elucidate concepts. This not only involves but requires highlighting barriers to understanding including sources of conceptual confusion (see Strawson, 1992, Chapter 1). In the spirit of dispelling confusion, an explanation gains advantage if it explains why commentators often remark on the diversity of the 4E approach. One source of conceptual confusion is the diversity suggested by the label '4E'. Disjunctive Explanation does not satisfactorily fulfil this desideratum; it fails to make the commitments and subjects matters of the 4E approach any less nebulous. This is partly because it simply lists 4E's commitments and subject matters. But this does nothing to identify a source of confusion about why and how they are central topics. A successful explanation of 4E Cognitive Science would provide more information about why commentators and practitioners still seek clarity on this point. Disjunctive Explanation needs to be elaborated if it is to make sense of the widespread, persistent confusion about what it is.

A second desideratum for non-revisionist conceptual explanations is that it should be as *uncontentious* as possible. The extension of 4E Cognitive Science that Disjunctive Explanation picks out is somewhat contentious, but some degree of contestation is unavoidable. Some commentators regard the inclusion of Barsalou as perfectly reasonable (Foglia & Wilson, 2013). Others, like Gallagher (2018), view Barsalou's project as only a weak account of how cognition is embodied. On their view, which is a strong account of how cognition is embodied, Barsalou should only

---

[3] We might satisfy one or other of these goals by way of another. For instance, learning of paradigmatic examples can help us understand what kind of thing we are talking about, and understanding distinguishing features of one phenomenon is sometimes useful for understanding its relationship to another. This does not mean, however, that these goals are indistinguishable.

be considered a borderline case for inclusion in the 4E approach, since he accepts many of the assumptions of the standard approach. Ironically, one of the most controversial examples of 4E Cognitive Science, as far as 4E's critics are concerned, is the extended cognition thesis put forward by Clark and Chalmers (1998). This is surprising since they accept many of the assumptions rejected by, for example, dynamicists (Chemero, 2009) or enactivists (Gallagher, 2017), themselves paradigmatic 4E-ers. Examples like Clark and Chalmers' extended cognition thesis show that the contentiousness of an explanation of 4E neither rests on the extremity of any specific 4E view, nor does it rest on disagreements among 4E-ers about some fundamental ideas. A disjunctive view (and, I will contend, a family resemblance view) can cast the net as uncontentiously as any explanation of 4E could.

Even if Disjunctive Explanation is reasonably informative and reasonably uncontentious, it leaves open whether there is something in common between the Es, and, if so, what that common thing is. Likewise, what is held in common by Varela, Brooks, Clark and Barsalou? Disjunctive Explanation does not tell us how 4E Cognitive Science's distinguishing features are unified, except via *negativa*, through its contrast with the standard approach. This issue affects disjunctive explanations in general. Disjunctive explanations do not explain why the disjuncts referring to essential features should be brought together disjunctively at all. One can think here of an analogy with a simple filing system for documents. Typically, filing systems organise documents into categories, with documents that do not fit neatly into any category filed under 'miscellaneous.' To be sure, miscellany is a category for documents in the filing system, but it has different membership criteria to all the other categories. If one were to inspect the documents in the category of miscellaneous, one would not only happen to find no unifying features, but one *should not* find any unifying features, except not being included in the other files. Otherwise, a new non-miscellaneous category would be formed out of the old, with documents that still cannot be filed into any category filed under a new miscellaneous category. As it stands, Disjunctive Explanation appears to be just like a miscellany category: it contains instances of (philosophy of) cognitive science which do not fit neatly into the standard approach. And this is no labelling dispute. Newen and colleagues (2018) misdescribe the challenge when they say, "Although the concept of 4E cognition brings [...] different approaches together under one heading and conceives of them as coherently opposed to [the traditional approach], there are continuing disagreements about a variety of issues within and among these embodied approaches" (p.4). This is a misdescription of the problem because, while the label '4E' certainly brings these approaches together, it is disputed whether there is a concept of 4E Cognitive Science picked out by this label that coherently brings different approaches together.

One might augment Disjunctive Explanation by proposing an essential and unifying feature that is shared by all and only the strands of the 4E approach under the disjunction. Many commentators have suggested that the various practitioners of 4E Cognitive Science are united because they address what they allege to be a dualistic philosophical framework in standard cognitive science (Chemero, 2009; Dreyfus & Taylor, 2015). The point is not that underlying rules-and-representationalism is Cartesian substance dualism. Rather, the accusation is that it operates with a conceptual framework that inherits conceptual distinctions underlying Cartesian philosophy.

The dualist conceptual scheme sometimes goes by different names, depending on the aspect of the dualist conceptual scheme under scrutiny. For instance, Kenny (1991) identifies what he calls the "homuncular fallacy" in standard cognitive science, the idea that the mind is treated as if it were a person within the skull of a person. Similarly, Bennett and Hacker (2022) pick up on what they call "brain-body dualism," as opposed to Descartes's own mind–body dualism; the idea is that the brain is treated by proponents of standard cognitive science in the same way that Descartes viewed the mind. Glock (2020) criticises the idea that what goes on inside the head is the central locus of, and the only source of information about, the workings of the mind, which he dubs "encephalocentrism." Finally, Dreyfus and Taylor (2015) argue that the Cartesian conceptual framework inherited by standard cognitive science is consistently "mediationalist": the mind is thought to be located between an input and output layer coinciding with the skull, a point encapsulated by Hurley's (2001) criticism of a sandwich metaphor of mind. In line with the 4E approach's avowed nondualism, Disjunctive Explanation could be adapted to include the claim that the 4E approach emphasises either the embodied, embedded, extended or enactive nature of cognition *because* good explanations are non-dualist explanations, and the four Es exemplify non-dualist accounts of cognition.

However, appealing to non-dualism leads to problems. First, philosophical criticisms of an alleged dualism in standard cognitive science are contentious. They are not criticisms that all 4E-ers would agree with, let alone have heard of. That there are different criticisms is precisely because there is no agreed way to formulate what standard cognitive science's conceptual scheme is. This reflects the unclarity of the long historical shadow of dualism in cognitive science and contemporary philosophy, let alone the extent of its rejection. Moreover, there are counterexamples within the 4E approach, where 4E-ers seem to be neutral with respect to dualism, even of the conceptual kind just discussed: Brooks (1991) and Barsalou (1999). As scientists, they simply do not focus on the issue of dualism. While one might think that they are non-dualist in their scientific practice, that is as much to do with a general outlook in cognitive science, as it might be with any reasons specific to the 4E approach in which Brooks and Barsalou operate. Another reason that appealing to a non-dualist outlook is inadequate to capture the essential feature of the 4E approach is that, if it is taken as a substantial point rather than mere professed allegiance, then some 4E-ers fail to be non-dualists. For example, Glock (2020) utilises his concept of encephalocentrism to not only criticise brain-centric assumptions in standard cognitive science, but to also criticise 4E-ers who take their criticism of encephalocentrism too far by denying that the brain is the organ of cognition. For example, Bennett and Hacker (2007) deny that the brain is the organ of cognition, despite arguing for a view of the mind as a set of intellectual capacities that are possessed by flesh-and-blood creatures rather than disembodied thinking substances or brains. A more coherent position than the one suggested by the non-dualist explanation is that 4E-ers can be dualist in some attenuated sense: the brain, insofar as it is the organ of cognition, is a focal point of the causal mechanisms underpinning cognition, albeit not the locus of that cognitive activity.

An alternative modification to Disjunctive Explanation, which might unify the Es in 4E Cognitive Science, is a shared commitment to non-representationalism. 4E

Cognitive Science emphasises either the embodied, embedded, extended or enactive nature of cognition *because* each of the Es shares a commitment to non-representationalist explanations of cognition. This has *prima facie* support from the historical fact that many 4E-ers were determined to depart from Fodor's rules-and-representations view of the mind. However, this suggestion is clearly overly restrictive. It would exclude paradigmatic 4E-ers such as Clark who buy into a rules-and-representations view of cognition and use this to argue that cognition should be extended to include artefacts that play a representational role in exercising capacities such as memory. It would also rule Barsalou out. Conversely, certain non-4E philosophers (e.g., Churchland, 1981), who think we should eliminate representations in our explanations of cognition altogether, would be included as part of 4E Cognitive Science. This would strike many commentators as mixing two very different, albeit equally daring, views together.

Switching to a methodological criterion, one might suggest that 4E-ers are united in the use of phenomenological methods, or at least a concern to recentre experience. However, if 4E Cognitive Science is explained as being an approach to studying mind and behaviour which takes phenomenological, first-person descriptions of experience seriously, then it is overly restrictive. Even if the importance of phenomenological methods and the first-person perspective can be demonstrated for many paradigmatic examples of 4E (e.g., Dreyfus, 1992; Gallagher, 2017; Varela et al., 1991), they are typically restricted to consciousness research, rather than the study of cognition in general. Also, some who sympathize with 4E do not invoke phenomenology (Glock, 2020) or are even hostile to its methodological prescriptions (Bennett & Hacker, 2022).

Where does that leave us? Disjunctive Explanation is reasonably informative and uncontroversial, but it requires modification so that it gives a reason why the different Es and the different paradigmatic practitioners of 4E Cognitive Science can and should be grouped together. The modifications I considered lead to the wrong extension. Moreover, each of the suggested modifications did little to explain the widespread sense of confusion about the notion of 4E. This is because each left it open exactly how non-dualism, non-representationalism or phenomenological methods are supposed to lead to the view that cognition is embodied, embedded, extended, or enacted. The next section will switch strategy and consider the idea that embodiment is a unifying factor.

6 The concept of embodiment

A more promising modification to Disjunctive Explanation is to centralise the concept of embodiment. Such an 'embodiment-first' explanation of 4E Cognitive Science can be summarized as follows (amendments in italics):

> *Embodiment-first Explanation*: 4E Cognitive Science is an approach in (philosophy of) cognitive science. It is purportedly distinct from the standard approach *because it assumes or tries to demonstrate the embodied nature of cognition. It can also emphasise the supposedly embedded, extended or enac-*

tive nature of cognition. It is exemplified by the work of Varela, Brooks, Barsalou and Clark, among many others.

Embodiment-First elevates embodiment and subordinates the remaining Es to it.

Embodiment is a plausible central feature of the 4E approach for both historical and philosophical reasons. Historically, embodiment figured prominently in the philosophy of Merleau-Ponty (1962), who had a large impact on some paradigmatic 4E-ers (e.g., Dreyfus, 1992; Varela et al., 1991). Philosophically, thinking of the mind as essentially connected to, or instantiated by, the body directly confronts the tendency towards dualism. 4E-ers also think the body is neglected or dismissed as unimportant by proponents of the standard approach.

More justification is required as to whether an Embodiment-First provides the essential and unifying feature of the 4E approach. Newen and colleagues (2018, p.6) is the clearest such attempt to unify all strands of the 4E approach under one idea. They specify four possibilities for cognitive processes to be embodied:

1) *Strong extracranial embodiment*: a cognitive process is partially constituted by processes in parts of the body beyond the brain.
2) *Weak extracranial embodiment*: a cognitive process is nonessentially causally dependent upon processes in parts of the body beyond the brain.
3) *Strong extrabodily embodiment*: a cognitive process is partially constituted by processes in parts of the environment beyond the body.
4) *Weak extrabodily embodiment*: a cognitive process is nonessentially causally dependent upon processes in parts of the environment beyond the body.

To clarify, they use 'embodiment' to mean instantiation, meaning that X is embodied by Y iff Y instantiates X. Central to their view is a difference between strong embodiment (i.e., X is constituted by Y) and weak embodiment (i.e., X is nonessentially causally dependent on Y). Note that these four options are not mutually exclusive, though each purports to capture key aspects and thinkers in the 4E approach. For example, option (2) neatly captures Barsalou's work on embodied conceptualisation, while option (3) aligns with Clark and Chalmer's extended functionalism.

This embodiment-first approach is elegant, but it faces problems. First, it is only workable given a prior grasp of the notion of a cognitive process (though grasping *that* might just be a hazard of doing cognitive science at all). Second, Rupert (2004) objects to a "coupling-constitution fallacy": just because a cognitive process is causally coupled to a process that is, at first blush, non-cognitive, does not entail that the latter process is, after all, a constituent of the cognitive process (see also Adams & Aizawa, 2010; Rupert, 2009). Constitution must mean something different from causal dependency, but the onus is on 4E-ers to spell out that difference. This problem is somewhat neutralised by its own terminological tenor: constitution might just be a question of what we say it is (Shapiro, 2019b).

Third, and trickier, it is seldom considered by commentators that the notion of the extracranial body (i.e., the parts of the body not including the brain) is not

straightforward. We have already seen that one strand of 4E is dedicated to disentangling notions of embodiment (i.e., Di Paolo et al., 2018), but the four-way distinction proposed by Newen and colleagues seems to miss some of the relevant distinctions (e.g., between biological and phenomenological embodiment). In general, there are rich philosophical traditions holding incompatible views about the body. To give a sense of the diversity of views, consider the following examples. Some Early-Modern European philosophy famously viewed the body as an automaton, which stands in contrast to the cybernetics of the mid-20th Century. In the phenomenological tradition, the body is a transcendental condition for experience, but some Marxists argue that important, purportedly transcendental features of the body only appear to be important due to historical processes that divided intellectual and manual labour (Sohn-Rethel, 1978). In Christian theology, the body is a condition of sin, while in classical Mayan philosophy the body is viewed as a container of vital forces. Mahayana Buddhist philosophy is well-known for repudiating any role for the body or embodied experience on the path to breaking the cycle of suffering, Tantrayana Buddhist philosophy the opposite. The list could go on. It is neither clear how the 4E approach could encompass all these perspectives on the body, nor is it reasonable to suppose that a syncretic research field like cognitive science could have remained unaffected by aspects of each of these competing conceptions of embodiment at some point. The problem of spelling out how best to understand the body stems from the fact that it is something with which we are all too familiar at a practical yet not at a theoretical level. For this reason, the body is a multifarious, contested concept, no less than the concept of the mind or cognition. This diversity and contestation regarding the notion of the body puts pressure on the embodiment-first explanation of 4E, since it will not do to explain one vague and contested notion—cognitive process—in terms of another vague and contested notion. Consequently, it is not obvious how problems with the rules-and-representations view can be corrected by appealing to the importance of the body.

An advocate of the embodiment-first explanation might respond by acknowledging the diversity of views on the body but argue that if a 4E-er prioritises any one of them they would still contrast with the standard approach. In other words, it seems clear that *all* 4E Cognitive Science rests on the notion that cognition is embodied, however we should understand this notion. There is, then, a kernel of truth to the embodiment-first explanation. However, granting the necessity of appeal to embodiment is not enough to justify the embodiment-first explanation of the 4E approach, because it is not clear that *only* 4E Cognitive Science rests on the notion that cognition is embodied. Two counterexamples that land squarely in the non-4E approach (or at least in its intellectual forebearers) suffice to show this. First, even a functionalist (even Fodor!) acknowledges the need for the body as a vehicle for delivering the outputs of cognitive processes in the form of behaviour. Second, even a Cartesian philosopher such as Amo (2020 [1734]) emphasised and centralised the body as the primary locus of sensation, all the while promoting the disembodied mind as the locus for other psychological activities (see Wiredu, 2005).

A fourth problem with Newen and colleagues' (2018) taxonomy is that it presupposes as definitive of 4E Cognitive Science what Shapiro (2019a) correctly claims to be only one theme among several. The embodiment-first explanation prioritises

the theme relating to the question: what constitutes cognition? But this does little to make sense of much work on embodied concepts (e.g., Barsalou, 1999; Lakoff & Johnson, 2003), and the issue of replacing explanations of standard cognitive science with explanations that do not appeal to rules-and-representations, for example by appeal to dynamical systems theory (e.g., Varela et al., 1991; Thelen & Smith, 1994; Van Gelder, 1995). This objection to Newen and colleagues' embodiment-first account leads to an alternative explanation of 4E.

7 Three themes or many?

According to Shapiro (2019a), 4E Cognitive Science[4] should be understood as follows:

> *Three-themes Explanation*: 4E Cognitive Science is an approach in (philosophy of) cognitive science. It assumes or tries to demonstrate the embodied nature of cognition. It can also emphasise the supposedly embedded, extended or enactive nature of cognition. *In some respects (conceptualisation theme) it is purportedly distinct from the standard approach, whilst in other respects (replacement theme & constitution theme) it is complementary.* It is exemplified by the work of Varela, Brooks (replacement theme), Barsalou (conceptualisation theme) and Clark (constitution theme), among others.

A 4E practitioner works on one of these three themes. Shapiro argues that, as far as conceptualisation goes, 4E Cognitive Science and standard cognitive science have competing hypotheses. But when we examine the themes of replacement and constitution, 4E and non-4E can complement each other.

There are three points I want to raise as objections to Shapiro's view and in support for my own account. First, even by Shapiro's own admission (2019a, p.4), the three themes do not capture all there is to 4E Cognitive Science. The evolutionary strand of 4E I identified in Sect. 4 is one of them. It is closest to Shapiro's conceptualisation theme, but the evolutionary strand is not principally concerned with a substantive thesis concerning the embodiment of concepts; it is rather a methodological intervention to bring the tools and frameworks of evolutionary biology to bear on problems in cognitive science.

Second, the three themes occlude different commentator perspectives, namely the differences between characterisations of the 4E approach in terms of programmatic missions, answers to specific problems, researching certain themes or defending specific theses. Between the three themes that Shapiro identifies lie overlapping similarities among commentators.

Third, there is a historical dimension which should be considered. The 4E approach could only have arisen in response to a prevailing rules-and-representations

---

[4] He discusses three themes of what his book calls "Embodied Cognition." Labels aside, we are referring to the same phenomenon. The label is grist to the embodiment-first explanation mill; there is a general trend to take embodiment as the primary phenomenon, and to enrich it with the other three Es.

view. In turn, this rules-and-representations view emerged in the 1950s in response to psychological behaviourism, the study of capacities as learned response patterns to stimuli. 4E Cognitive Science emerged after the 'Cognitive Revolution' of the 1950s repudiated behaviourism's neglect of cognitive processing underpinning behaviour (Chomsky, 1959). Crucially, the 4E approach was also influenced by behaviourism, especially Ryle's (2009 [1949]) philosophical behaviourism which laid the ground for 4E's anti-dualist strand. Shapiro (2019a) does not ignore this historical dimension of 4E's, and he pitches the 4E approach as following a pattern of similar critical departures from the rules-and-representations view (e.g., connectionism and Gibsonian ecological psychology). But the importance of a degree of horizontal positive influence from behaviourism is something that Chemero (2009, p.30), but not Shapiro, rightly identifies is a crucial part of understanding what 4E Cognitive Science is. Whereas Shapiro focuses on 4E's direct confrontation with its rules-and-representations ancestor (since Shapiro is specifically interested in whether the rules-and-representation view is really an ancestor of the 4E approach or not), he underplays the way that 4E Cognitive Science emerged from the cross-pollination of the rules-and-representations view and behaviourism.

8 Family resemblances constrained by lines of historical influence

If practitioners of 4E Cognitive Science are not exclusively grouped together by sharing a thesis about embodiment, and if strands of 4E cross between and extend beyond just three themes, how should commentators conceptualise 4E Cognitive Science? The first part of my answer takes inspiration from Wittgenstein's (1989) *Philosophical Investigations* (paras.65 – 88). The 4E approach should be understood in terms of overlapping similarities along several dimensions. I have already sketched some dimensions: non-dualism, non-representationalism, phenomenological methods, evolutionary frameworks, and a dynamical systems perspective. One dimension is plausibly present in every work of 4E Cognitive Science, but no work of 4E Cognitive Science must include all the dimensions to count as 4E (although Varela does in fact include all dimensions). Table 1 summarises the views of some paradigmatic 4E-ers along these dimensions.

Viewing concepts in terms of family resemblances raises problems (see Glock, 2008, pp.212 – 219). One might think that the fact that there is an essential feature (e.g., embodiment) is already reason to reject a family resemblance conception of the 4E approach. However, family resemblances are germane when we consider a set of phenomena lacking a feature common to all and only the set of phenomena in question: "to conceive of a concept F as a family resemblance concept is not to rule out the idea that there are features common to all Fs" (Glock, 2008, p.214). For example, all games are activities. Similarly, all analytic philosophers engage in philosophy, and all 4E Cognitive Scientists investigate cognition. These are essential features in the sense of being necessary conditions, but this falls short of identifying individually necessary and jointly sufficient conditions. Another objection is often made against conceiving of phenomena in terms of family resemblances: it risks ending the search for an analytic definition prematurely. The worry is that we may

Table 1 [Note: This data is mandatory]

	Varela	Brooks	Clark	Barsalou
Embodiment	✓	✓	✓	✓
Non-dualism	✓	?	✓	?
Non-representational	✓	✓	✗	✗
Phenomenology	✓	✗	✗	✗
Evolutionary perspective	✓	✗	✗	✗
Dynamical systems	✓	?	✗	✗

Paradigmatic 4E Practitioners and Dimensions. Dimensions are emblematic if they have been emphasised by paradigmatic 4E-ers (indicated by a check mark), but not others (indicated by a cross), or are unclear (indicated by a question mark)

not have considered all possible analytic definitions (Glock, 1996, p.124) before settling on a family resemblance conception. This objection has no bite, however. One could generate candidate definitions *ad nauseum*, but the real issue is whether these would be pertinent for explaining the extant notion and capture how 4E-ers and 4E commentators see the matter themselves. Whatever unifying feature is appealed to by a definition 4E Cognitive Science, it must guide the actual practice of classification by 4E commentators. The definition should not yield an extension that merely coincides with the widely recognised extension. This is a point where my family resemblance conception and Disjunctive Explanation differ. While both can uncontentiously pick out the widely recognized extension of 4E, the family resemblance conception provides an explanation for why practitioners coalesce into 4E and non-4E (even if there are some overlaps), namely it is apparent that they are similar along multiple dimensions.

Moreover, here are some positive reasons why a family resemblance conception of 4E Cognitive Science is plausible. First, it should not be surprising that an approach straddling disciplinary boundaries should be understood in terms of family resemblances. The fact that it is studied by different disciplines with various theories and methods generates diverse questions and topics as these disciplines converge. However, the convergences are uneven: the questions and topics generated by the confluence of two disciplines, say philosophy and biology, are likely different from those generated when two other disciplines come into contact, say computer science and dynamical systems theory.

Second, 4E Cognitive Science is about philosophically contentious topics. Even without shared assumptions tying participants together in a research field, philosophers and scientists approach these contentious topics creatively, leading to an especially vibrant and diverse intellectual culture. This creativity spawns unexpected resonances.

Third, the topics of the mind and cognition require navigating between ordinary and technical language. Unlike disciplines like particle physics or biology, when it comes to the mind in general and cognition in particular the status of common-sense notions is not universally understood by experts to be false or misleading and thus in need of replacement with technical notions. The place for ordinary notions in folk

psychology is legitimate, as is the need to bridge between folk psychology and cognitive science (Bermúdez, 2005). With the need to navigate between ordinary and technical language at the centre of the enterprise, issues of (mis-)interpretation and (mis-)translation can sustain incompatible views sitting alongside each other. It is therefore not surprising that 4E Cognitive Science should turn out to have no unifying core features.

Note that these three reasons favour not only a family resemblance conception of 4E Cognitive Science but of cognitive science generally. I do think that cognitive science admits of a family resemblance conception, but I will not provide further reasons to think so here. It is important to note, however, that a higher-order category (e.g., games) might be a family resemblance concept, while lower-order categories (e.g., solitary games) might have unifying essential features (Glock, 1996, p.123). It would therefore be invalid to infer from the idea that the concept of cognitive science is a family resemblance notion, any approach within it is also best understood in terms of family resemblances.

The following are reasons to conceive of 4E Cognitive Science specifically in terms of family resemblances. Being a family resemblance concept explains why commentators frequently comment on 4E's diversity, while nonetheless constituting an identifiable approach. Hence, a family resemblance conception satisfies criterion (v) from Sect. 5 (viz. the conceptual explanation of 4E Cognitive Science should make sense of commentator claims of diversity).

Finally, a family resemblance conception explains why different commentators have used very different strategies for unifying or summarising 4E Cognitive science. Some commentators, like Newen and colleagues (2018), suggest ways that the 4E approach's strands can all be explained in terms of a *specific notion* (e.g., embodiment). This is what I have called 'embodiment-first' explanations. Others, like Shapiro (2019a), suggest a restricted set of more *specific themes*: (i) conceptualisation by means of sensorimotor capacities and/or activities, (ii) replacement of standard explanations with dynamical systems explanations, and (iii) constitution of cognition by extracranial and/or extrabodily processes or substrates. In contrast to these thematic-based means of explaining what 4E Cognitive Science is, other commentators pitch 4E Cognitive Science as a solution to a *specific problem* facing the standard approach. For example, Barsalou (2008) thinks that embodied cognition aims to solve the symbol grounding problem. Barrett (2015) and Cisek (2021) argue that 4E Cognitive Science directly addresses a lacuna in the standard approach, namely that it does not recognise that embodiment is an inescapable fact of evolution. Yet another way that commentators explain the 4E approach is as a programme with a *specific mission* (Wilson & Golonka, 2013). It has no universally shared thesis, theme, or solution, but it is united in its purpose: to change the way that cognitive science is thought about and conducted. Finally, Gallagher (2017), following Godfrey-Smith's (2009) distinction between philosophies of nature and scientific research programs, has argued that one part of 4E Cognitive Science (enactivism, his preferred strand) should be understood as a *philosophy of nature* whose biggest impact is offering tools to interpret evidence gathered in standard cognitive science, whereas other strands are more akin to offering new scientific frameworks that have specific missions. Family resemblances hold these competing commentator

conceptions together. Not every strand of 4E Cognitive Science does all of these at once, but, on a family resemblance conception, we should not expect them to.

We saw that a problem with the Embodiment-First and Three Themes accounts was their insufficiently historical conception of 4E. Why should a historical conception of the 4E approach be complemented at all by a family resemblance conception? It is tempting to conceive of 4E Cognitive Science as an approach that was positively influenced by Varela and colleagues' landmark book *The Embodied Mind*.[5] Indeed, Shapiro (2019a, p.59) calls this book an "urtext". However, we should not leave it at that. Although it features in many intellectual biographies of 4E-ers, the notion of positive influence requires us to spell out what counts as a substantial positive influence, and that requires, in turn, an understanding of what *The Embodied Mind* and the book's descendants have in common. This point also stands if we are concerned with negative influence: the family resemblance conception is required if only to identify the relevant lines of influence from *The Embodied Mind* onwards. This point generalises to any putative 'last common ancestor' of 4E Cognitive Science. Whichever text, philosopher or scientist is deemed the last common ancestor, a purely genetic-cum-historical conception of 4E presupposes a clear conception of members of an intellectual lineage shared between 4E-ers and non-4E-ers, in contrast to works or figures who merely appear after the last common ancestor of 4E Cognitive Science. So, while 4E Cognitive Science might be a historical phenomenon, it is not to be understood in purely historical terms.

9 Conclusion

The view I defend is the

> *Family Resemblances & Historical Influences Explanation:* 4E Cognitive Science is an approach in (philosophy of) cognitive science. It is distinct from the standard approach, although the extent to which it differs is disputed by commentators. It emerged after the 'Cognitive Revolution' of the 1950/60s. It typically assumes or tries to demonstrate the embodied nature of cognition, but this is not unique to the 4E approach. Rather than there being anything that is both essential and unique to it, 4E Cognitive Science is best understood in terms of overlapping similarities along at least the following dimensions: embodiment, non-dualism, non-representationalism, phenomenological methods, evolutionary frameworks, and dynamical systems perspectives. 4E-ers who research cognition along these dimensions emphasise to various extents the supposedly embedded, extended or enactive nature of cognition. It is exemplified by the work of Varela, Brooks, Barsalou and Clark, among many others.

---

[5] The Oxford Handbook pinpoints Varela et al. (1991), a paper by Flor & Hutchins (1991), Hutchins' (1995) book *Cognition in the Wild*, Clark & Chalmers (1998) seminal essay on the extended mind, and Gibson's work on ecological perception from the 1970s and 80 s as early articulations of the 4E approach that we recognise today (Newen et al., 2018, pp.34). Gallagher, 2018, p.353) contribution to the same volume also pinpoints Brooks (1991) as a key text.

The closest I have found to this view is a discussion in an introduction to a special issue of *Topoi* on whether 4E is "one church or many" (Kiverstein & Clark, 2009). But after their discussion Kiverstein and Clark remain inconclusive. By contrast, my view of 4E lands squarely on the side of many churches under the same religion.

My view, like the disjunctive view entertained earlier, is uncontentious. However, a distinct advantage of this explanation is that it is generated by examples and the contrasts between them. Moreover, this explanation accords with commentators' characterisations of 4E Cognitive Science, as well as making sense of potential confusions and claims of 4E's extraordinary diversity. It also justifies the case for expanding the Es to include ecological (Rietveld & Kiverstein, 2014), emotional cognition (Colombetti, 2014) and beyond.

One consequence of a family resemblance conception is that it is a (quasi-) perceptual notion. We are told by Wittgenstein, when he discusses the notion of family resemblances, that we should "*look and see* whether there is anything common to all [examples]—For if you look at them you will not see something that is common to *all*, but similarities, relationships, and a whole series of them at that" (1989, para.66). Exemplars are therefore crucial for grasping what 4E Cognitive Science is. What exemplars show, when studied closely, can have different consequences for practitioners and commentators of 4E Cognitive Science respectively. Practitioners, who come to grasp the criss-crossing similarities spanning the 4E approach, may well strike upon a useful model for their own practice. Meanwhile, commentators, who appreciate that 4E Cognitive Science, like much that is contested, is not a single thing, should evaluate the prospects for 4E Cognitive Science while acknowledging that the whole enterprise does not fall based on a few fraying strands.

Data availability Not applicable.

Code availability Not applicable.

Declarations

Conflicts of interest/Competing interests The author has no relevant financial or non-financial interests to disclose.

Ethics approval Not applicable

Consent to participate Not applicable

Consent for publication Not applicable

References

Adams, F., & Aizawa, K. (2010). *The bounds of cognition*. Wiley-Blackwell.

Aizawa, K. (2018). 'Critical note: So, What again is 4E cognition?' In *The oxford handbook of 4E cognition*, by Ken Aizawa, edited by Albert Newen, Leon De Bruin, and Shaun Gallagher, 116–26. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780198735410.013.6

Allen, C. (1999). Animal concepts revisited: The use of self-monitoring as an empirical approach. *Erkenntnis (1975-), 51*(1), 33–40.

Allen, C. (2017). On (Not) Defining cognition. *Synthese, 194*(11), 4233–49. https://doi.org/10.1007/s11229-017-1454-4

Alsmith, A. J. T., & De Vignemont, F. (2012). Embodying the mind and representing the body. *Review of Philosophy and Psychology, 3*(1), 1–13. https://doi.org/10.1007/s13164-012-0085-4

Amo, A. W. (2020). *Anton Wilhelm Amo's philosophical dissertations on mind and body*. Edited by Stephen Philip Menn and Justin E. H. Smith. Oxford University Press.

Barrett, L. (2015). Why brains are not computers, why behaviorism is not Satanism, and why dolphins are not aquatic apes. *The Behavior Analyst, 39*(1), 9–23. https://doi.org/10.1007/s40614-015-0047-0

Barsalou, L. W. (1999). Perceptual symbol systems. *Behavioral and Brain Sciences, 22*(4), 577–660. https://doi.org/10.1017/S0140525X99002149

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology, 59*(1), 617–645. https://doi.org/10.1146/annurev.psych.59.103006.093639

Bennett, M, Hacker, P. M. (2007). The conceptual presuppositions of cognitive neuroscience: A reply to critics. *Neuroscience and Philosophy: Brain, Mind, and Language*. pp. 127 170.

Bennett, M. R., & Hacker, P. M. S. (2022). *Philosophical foundations of neuroscience* (2nd ed.). Wiley Blackwell.

Bermúdez, J. L. (2005). *Philosophy of psychology: A contemporary introduction*. Routledge.

Brooks, R. A. (1991). Intelligence without representation. *Artificial Intelligence, 47*(1), 139–159. https://doi.org/10.1016/0004-3702(91)90053-M

Carney, J. (2020). Thinking Avant La Lettre: A review of 4E cognition. *Evolutionary studies in imaginative culture, 4*(1), 77–90. https://doi.org/10.26613/esic.4.1.172

Casasanto, D., & Henetz, T. (2012). Handedness shapes children's abstract concepts. *Cognitive Science, 36*(2), 359–372. https://doi.org/10.1111/j.1551-6709.2011.01199.x

Casper, M. -O. (2023). A methodological problem of choice for 4e research. In *situated cognition research: methodological foundations*, edited by Mark-Oliver Casper and Giuseppe Flavio Artese, 17–43. Springer International Publishing. https://doi.org/10.1007/978-3-031-39744-8_2

Chemero, A. (2009). *Radical embodied cognitive science*. MIT Press.

Chomsky, N. (1959). Review of *Verbal Behavior*, by B. F. Skinner. *Language, 35*(1), 26–58. https://doi.org/10.2307/411334

Churchland, P. M. (1981). Eliminative materialism and the propositional attitudes. *The Journal of Philosophy, 78*(2), 67–90. https://doi.org/10.2307/2025900

Cisek, P. (2021). An evolutionary perspective on embodiment. In *handbook of embodied psychology: thinking, feeling, and acting*, edited by Michael D. Robinson and Laura E. Thomas, 547–71. Springer International Publishing. https://doi.org/10.1007/978-3-030-78471-3_24

Clark, A., & Chalmers, D. (1998). The extended mind. *Analysis, 58*(1), 7–19.

Springer

Clark, A. (2016). *Surfing uncertainty: Prediction, action, and the embodied mind*. Oxford University Press.

Colombetti, G. (2014). *The feeling body: Affective science meets the enactive mind*. The MIT Press https://doi.org/10.7551/mitpress/9780262019958.001.0001

Dreyfus, H. L. (1992). *What computers still can't do: A critique of artificial reason*. MIT Press.

Dreyfus, H. L., & Taylor, C. (2015). *Retrieving realism*. Harvard University Press.

Flor, N. V., & Hutchins, E. L. (1991). Analyzing distributed cognition in software teams: A case study of team programming during perfective software maintenance. *Empirical Studies of Programmers, 4*, 36–64.

Fodor, J. A., & Pylyshyn, Z. W. (1988). Connectionism and cognitive architecture: A critical analysis. *Cognition, 28*(1–2), 3–71. https://doi.org/10.1016/0010-0277(88)90031-5

Fodor, J. A. (1975). *The language of thought*. The language & thought series. Crowell.

Fodor, J. A. (1981). The mind-body problem. *Scientific American 244*(1): 114–23.

Fodor, J. A (1986). *Representations: Philosophical essays on the foundations of cognitive science*. 2. print. Harvester Press.

Foglia, L., & Wilson, R. A. (2013). Embodied cognition. *Wires Cognitive Science, 4*(3), 319–325. https://doi.org/10.1002/wcs.1226

Gallagher, S. (2017). *Enactivist Interventions: Rethinking the Mind* (1st ed.). Oxford University Press.

Gallagher, S. (2018). Building a stronger concept of embodiment. In *The oxford handbook of 4E cognition*, by Shaun Gallagher, edited by Albert Newen, Leon De Bruin, and Shaun Gallagher, 352–68. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780198735410.013.18

Gibson, J. J. (1986). *The Ecological approach to visual perception*. Erlbaum.

Glock, H.-J. (1996). *A Wittgenstein dictionary*. Blackwell Reference.

Glock, H.-J. (2008). *What is analytic philosophy?*. Cambridge University Press.

Glock, H.-J. (2020). Minds, brains, and capacities: Situated cognition and neo-aristotelianism. *Frontiers in Psychology, 11*, 3449. https://doi.org/10.3389/fpsyg.2020.566385

Godfrey-Smith, P. (2009). *Darwinian populations and natural selection*. Oxford University Press.

Goldinger, S. D., Papesh, M. H., Barnhart, A. S., Hansen, W. A., & Hout, M. C. (2016). The poverty of embodied cognition. *Psychonomic Bulletin & Review, 23*(4), 959–978. https://doi.org/10.3758/s13423-015-0860-1

Heras-Escribano, M. (2021). Pragmatism, enactivism, and ecological psychology: Towards a unified approach to post-cognitivism. *Synthese, 198*(1), 337–363. https://doi.org/10.1007/s11229-019-02111-1

Hohwy, J. (2013). *The predictive mind*. OUP Oxford.

Hurley, S. (2001). Perception and action: Alternative views. *Synthese, 129*(1), 3–40. https://doi.org/10.1023/A:1012643006930

Hutchins, E. (1995). *Cognition in the wild*. MIT press.

Hutto, D. D., & Myin, E. (2017). *Evolving enactivism: Basic minds meet content*. MIT Press.

Kenny, A. (1991). *The homunculus fallacy*. Routledge.

Kiverstein, J., & Clark, A. (2009). Introduction: Mind embodied, embedded, enacted: One church or many? *Topoi, 28*(1), 1–7. https://doi.org/10.1007/s11245-008-9041-4

Lakoff, G., Johnson, M. (2003). *Metaphors We Live By*. Edited by With a new Afterword. University of Chicago Press. Retrieved December 21, 2021, from https://press.uchicago.edu/ucp/books/book/chicago/M/bo3637992.html

Leslie, S.-J. (2008). Generics: Cognition and acquisition. *Philosophical Review, 117*(1), 1–47. https://doi.org/10.1215/00318108-2007-023

Mahon, B. Z. (2015). What is embodied about cognition? *Language, Cognition and Neuroscience, 30*(4), 420–429. https://doi.org/10.1080/23273798.2014.987791

McGann, M. (2016). Enactivism and ecological psychology: Divided by common ground. *Constructivist Foundations, 11*(2), 312–315.

Menary, R. (2010). Introduction to the special issue on 4E cognition. *Phenomenology and the Cognitive Sciences,* 9(4): 459–63. https://doi.org/10.1007/s11097-010-9187-6

Merleau-Ponty, M. (1962). *Phenomenology of perception*. Routledge.

Michaels, C. F., Zsolt, P. (2024). A ten commandments for ecological psychology. In *The Routledge handbook of embodied cognition*, 2nd ed., 23–34. Routledge Handbooks in Philosophy. Routledge/ Taylor & Francis Group.

Newen, A., Gallagher, S., De Bruin, L. (2018). 4E Cognition: Historical roots, key concepts, and central issues. In *The oxford handbook of 4E cognition*, edited by Albert Newen, Leon De Bruin, and Shaun Gallagher, 0. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780198735410.013.1

O'regan, J. K., & Noë, A. (2001). A sensorimotor account of vision and visual consciousness. *Behavioral and Brain Sciences, 24*(5), 939–973.

Paolo, Di., Ezequiel, A., Cuffari, E. C., & De Jaegher, H. (2018). *Linguistic bodies: The continuity between life and language*. MIT Press.

Pulvermüller, F. (2005). Brain mechanisms linking language and action. *Nature Reviews Neuroscience, 6*(7), 576–582.

Pylyshyn, Z. W. (1985). *Computation and cognition: Toward a foundation for cognitive science* (2nd ed.). MIT Press.

Read, C., & Szokolszky, A. (2020). Ecological psychology and enactivism: Perceptually-guided action vs. sensation-based enaction1. *Frontiers in Psychology, 11*. https://doi.org/10.3389/fpsyg.2020.01270

Richardson, M. J., Shockley, K., Fajen B. R., Riley, M. A., Turvey, M. T. (2008). 9 - Ecological psychology: Six principles for an embodied–embedded approach to behavior. In *handbook of cognitive science*, edited by Paco Calvo and Antoni Gomila, 159–87. Perspectives on Cognitive Science. Elsevier. https://doi.org/10.1016/B978-0-08-046616-3.00009-8

Rietveld, E., & Kiverstein, J. (2014). A rich landscape of affordances. *Ecological Psychology, 26*(4), 325–352. https://doi.org/10.1080/10407413.2014.958035

Robbins, P., Murat, A. (2009). A short primer on situated cognition. In *The cambridge handbook of situated cognition*, 3–10. Cambridge University Press.

Rumelhart, D. E., McClelland, J. L., & Group, P. R. (1986). *Parallel distributed processing, volume 1: Explorations in the microstructure of cognition: Foundations.* The MIT Press. https://doi.org/10.7551/mitpress/5236.001.0001

Rupert, R. D. (2004). Challenges to the hypothesis of extended cognition. *Journal of Philosophy, 101*(8), 389–428. https://doi.org/10.5840/jphil2004101826

Rupert, R. D. (2009). Cognitive systems and the extended mind. *Oxford University Press*. https://doi.org/10.1093/acprof:oso/9780195379457.001.0001

Ryle, G. (2009). *The concept of mind*. Routledge.

Sanches de Oliveira, G. (2023a). Explanatory diversity and embodied cognitive science: Reflexivity motivates pluralism. In *situated cognition research: Methodological foundations*, edited by Mark-Oliver Casper and Giuseppe Flavio Artese, 51–76. Springer International Publishing. https://doi.org/10.1007/978-3-031-39744-8_4

Sanches de Oliveira, G. (2023b). A professional guide to explanation. commentary on "A methodological problem of choice for 4E research". In *situated cognition research: methodological foundations*, edited by Mark-Oliver Casper and Giuseppe Flavio Artese, 45–50. Springer International Publishing. https://doi.org/10.1007/978-3-031-39744-8_3

Shapiro, L. (2007). The embodied cognition research programme. *Philosophy Compass, 2*(2), 338–346. https://doi.org/10.1111/j.1747-9991.2007.00064.x

Shapiro, L. A. (2019a). *Embodied cognition* (2nd ed.). New problems of philosophy. Routledge, Taylor & Francis Group.

Shapiro, L. A. (2019b). Flesh matters: The body in cognition. *Mind & Language, 34*(1), 3–20. https://doi.org/10.1111/mila.12203

Smortchkova, J., Dołęga, K., Schlicht, T., eds. (2020). *What are mental representations?* Philosophy of mind series. Oxford University Press.

Sohn-Rethel, A. (1978). *Intellectual and manual labour: A critique of epistemology*. Critical social studies. Humanities Press.

Strawson, P. F. (1992). *Analysis and metaphysics: An introduction to philosophy*. Oxford University Press.

Thelen, E, Smith, L. B. (1994). *A dynamic systems approach to the development of cognition and action*. MIT Press/Bradford Books Series in Cognitive Psychology. MIT Press.

Van Gelder, T. (1995). What might cognition be, if not computation? *The Journal of Philosophy, 92*(7), 345–381.

Varela, F. J., Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive science and human experience*. MIT Press.

Weber, A. M., Vosgerau, G. (2018). Critical note: Brain–body–environment couplings. What do they teach us about cognition? In *The oxford handbook of 4E cognition*, edited by Albert Newen, Leon De Bruin, and Shaun Gallagher, 0. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780198735410.013.21

Wheeler, M. (2017). The revolution will not be optimised: Radical enactivism, extended functionalism and the extensive mind. *Topoi, 36*(3), 457–472. https://doi.org/10.1007/s11245-015-9356-x

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review, 9*(4), 625–636. https://doi.org/10.3758/BF03196322

Wilson, A., & Golonka, S. (2013). Embodied cognition is not what you think it is. *Frontiers in Psychology, 4*, 58. https://doi.org/10.3389/fpsyg.2013.00058

Wiredu, K. (2005). Amo's critique of Descartes philosophy of mind. In *A companion to african philosophy*, 200–206. John Wiley & Sons, Ltd. https://doi.org/10.1002/9780470997154.ch13

Wittgenstein, L. (1989). *Philosophical investigations*. Translated by G. E. M. Anscombe. 3nd ed., Repr. Blackwell.

Zahidi, K., & van Eemeren, J. (2016). Radical enactivism and ecological psychology: Friends or foes? *Constructivist Foundations, 11*(2), 320–322.