Pragmatism and Cognitive Science

Shaun Gallagher

In recent years numerous researchers have discussed a pragmatic turn in cognitive science (Crippen and Schulkin 2020; Engel, Friston and Kragic 2015; Engel et al. 2013; Gallagher 2014; Johnson 2016; Madzia and Jung 2016; Menary 2015). The general consensus is that this turn, or return to pragmatism, is closely tied to the turn within cognitive science to non-representational embodied cognition, sometimes referred to as 4E (embodied, embedded, extended, and enactive) cognition. Thus, Engel et al. (2013: 202) write:

> In cognitive science, we are currently witnessing a 'pragmatic turn', away from the traditional representation-centered framework towards a paradigm that focuses on understanding cognition as 'enactive', as skillful activity that involves ongoing interaction with the external world.

In some regards the pragmatic turn just is this turn to embodied action-oriented cognition that came to the fore starting in the 1990s. Still, I'll argue that this is an oversimplification in a number of ways. First, in regard to the timing; second in regard to how pragmatism may have already been influencing mainstream cognitivists even prior to the turn to embodied cognition (EC); and third, in regard to how pragmatism relates, somewhat unevenly, to the variety of EC theories. Furthermore, we should be careful not to conflate pragmatism with 'the pragmatic turn', even if these two movements are conceptually linked.

Timing and connections with pragmatism in mainstream cognitive science and philosophy of mind

First, in regard to timing, anything that resembles a self-conscious pragmatic turn in the EC camp doesn't correlate to the emergence of EC approaches. If we review the early works on EC, there is rarely a mention of the pragmatists. Varela, Thompson and Rosch (1991: 30–31), for example, make a general reference to pragmatism but leave it undeveloped and do not directly relate it to the embodied-enactivist aspects of their work. Likewise, even in later texts associated with enactivism, for example, in Noë (2004), Thompson (2007), or Hutto and Myin (2013), there is no mention of pragmatists like Peirce, Dewey, or Mead. When James is mentioned, it's not James the pragmatist but James's *Principles of Psychology* (1890; see, e.g., Varela 1999: 266). Although Clark (2008) begins his book on the extended mind with an invocation from Dewey, he fails to exploit any further connection with pragmatism. Significant mentions of the pragmatists in these

contexts, however, do start just around this time. Menary (2007), for example, does exploit pragmatist themes to frame his understanding of the extended mind. He appeals to Dewey's notion of organism-environment transactions to work out a characterization of how embodied cognitive processes incorporate the environment, and to Peirce's 'continuity principle', to counter the idea of a metaphysical discontinuity between the mind and the world (2007: 129). Steiner (2008, 2010) also points out the affinity between Dewey's account of experience and externalist approaches, including extended mind and enactivist accounts of cognition. Johnson (2008: 274) also celebrates Dewey and equates the latter's notion of transaction with enaction. The association between EC and pragmatism starts to gain traction in Chemero (2009), as well as in Menary (2011), and with further detail in Gallagher (2014), Johnson (2016), and Di Paolo, Buhrmann and Barandiaran (2017). Accordingly, if the pragmatic turn is measured by mention and use of the pragmatists, the turn is made only some 15 years after the initiation of EC in the early 1990s.

Second, there are elements of pragmatism that influence (implicitly at least) debates about cognition that predate EC and, indeed, from the very beginnings of the classical cognitivist regime. These influences remain implicit in the sense that they stay, for the most part, in the background. The psychologist, James Gibson (1977), whose ecological psychology and theory of affordances (later taken up by EC) were influenced by pragmatism (Burke 2013; Chemero 2009; Heft 2001; Rockwell 2005), was portrayed as the opposition to what Fodor and Pylyshyn (1981) defined as the establishment view of cognitivism. At the same time, Fodor and Pylyshyn admit that a 'conciliatory reading' of some of Gibson's points might be possible. According to them, Gibson's notion of direct perception as information pickup is overly promiscuous since it implies that we would pick up anything that catches our eye. Perception requires constraints – it needs to be selective – and for Fodor and Pylyshyn, constraint comes by way of internal representational, inferential processes. Although this is a rejection of the fully 'direct' nature of perception, the notion that there must be both some direct pickup (transduction) plus some selectivity may be the conciliatory point. We'll see later that inferential processes, understood as a kind of Peircean abduction, can fit with a pragmatic conception of what drives the cognitive process. The question is whether we should think of the required abductive selectivity process (conceived as active orienting, exploring, investigating, attuning, etc.) to be built into the affordance structure of the organism-environment relation (as Gibson and the pragmatists would hold), or to be the product of an internal representational process working with impoverished 'premises' generated by transducers more narrowly construed (as Fodor and Pylyshyn would have it). In this respect, however, it's clear that the pragmatic elements of Gibson's theory are, for Fodor and Pylyshyn, not the points of conciliation.

Like Gibson, the developmental psychologist, Jerome Bruner (1966), who helped to launch the field of cognitive psychology, and who proposed the concept of enactive (action-based) representation, was influenced by pragmatism, and specifically by Dewey (see Bruner 1961). In an essay on 'Language and experience', Bruner reflects on the revolutionary work of Chomsky and notes that Chomsky overlooks some of the more important aspects of language – 'those precisely that were context dependent'. This context dependency of language and the idea that linguistic practices 'necessarily reflect the circumstances' (Bruner, Caudill and Ninio 1977: 12) are ideas that Bruner finds in Dewey. For Bruner, this issue came back into focus at a conference in London in 1975 (the Third International Child Language Symposium). He is led to emphasize language as performance and the importance of intersubjective interaction for the child's acquisition of speech.

> As Dewey says, communication by itself does not accomplish anything. In so far as the dialogue between mother and infant succeeds in getting the child to fill his role in exchange … the child is in fact learning not so much a language, as how to proceed in achieving certain ends by the use of language. The input is not a corpus; the output is not a grammar.
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> *(1977: 19)*

It is notable that Bruner cites Grace de Laguna's (1927) work on speech and, in so doing, gestures (perhaps unknowingly) to deeper philosophical connections with pragmatism that continued to hover in the background, shaping the philosophy of science that was immediately informing the cognitive revolution.[1] De Laguna, along with her co-author (and husband) Theodore de Laguna, had early on engaged critically with pragmatism (de Laguna and de Laguna 1910). The pragmatist view is central to their evolutionary epistemology and confirmation holism: 'concepts, apart from the conduct which they prompt, mean nothing' (1910: 206). If they were not pragmatists in this regard, they were the first neo-pragmatists. Importantly, it also seems quite possible that their work informed another quasi- or neo-pragmatist, Willard V. O. Quine. Joel Katzav (2018) makes the connection clear. Both Grace de Laguna and Quine contributed papers to the 1950 APA Eastern Division symposium, which were subsequently published in *The Philosophical Review*. Quine's paper, 'Two dogmas of empiricism' (1951), in which, he suggests, there is 'a shift towards pragmatism', turned out to be highly influential. Like the de Lagunas, Quine also defends confirmation holism, the idea that no concept or theory can be verified in isolation since it is embedded in a background or web of other concepts and beliefs, including other scientific theories. 'Our statements about the external world face the tribunal of sense experience not individually, but only as a corporate body' (Quine 1953: 41).

Katzav (2018) argues that an even more sophisticated version of this idea is to be found in the de Laguna critique of pragmatism although in a formulation that incorporates the pragmatist linking of concept and conduct.

> Our thoughts direct our conduct, and it is in this service that their meaning ultimately consists; but every concept means both more and less than any particular application of it contains.
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> *(1910: 206)*

Likewise, with respect to the analytic-synthetic distinction, de Laguna holds that part of the meaning of any concept involves a reference to experience ('along the edges' or on the periphery of the web), such that the concept is judged by its ability to control conduct, although concepts of logic have a greater autonomy from experience (1910: 206–207, 210, 212; see Quine 1953: 42).

> We have always a multitude of general beliefs in accordance with which we interpret each new matter of fact; and though any one of these beliefs may at some time be called into question, this is always on the supposition of the acceptance of a host of others. Science, accordingly, can never be a system of judgments with one way relations of implication. Our judgments support one another. And when, as occasionally happens, they contradict one another, there is no ultimate standard of imperishable truth by which they can be tested.
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> *(de Laguna 1930: 404)*

Theodore de Laguna explicitly states that his views were directly influenced by James and Dewey (de Laguna 1930: 406; see Ben-Menahem 2016 for the James-Quine relation).

Whether we consider Quine a pragmatist or not (see Haack 2004; Koskinen and Pihlström 2006), Quine's naturalism and empiricism, views widely shared by cognitive science, mean there is no hard line between science and philosophy. He attributes this to the influence of Dewey (Quine 1969: 26):

> Philosophically I am bound to Dewey by the naturalism that dominated his last three decades. With Dewey I hold that knowledge, mind, and meaning are part of the same world that

they have to do with, and that they are to be studied in the same empirical spirit that animates natural science. There is no place for a prior philosophy.

(also see an interview with Quine in Bergström and Føllesdal 1994)

As Hilary Putnam puts it, 'like Quine, the classical pragmatists do not believe that there is a "first philosophy" higher than the practice that we take most seriously when the chips are down' – i.e., the practice of science (Putnam 1994: 154). This part of pragmatism is imported directly into the cognitivist camps of cognitive science. Patricia Churchland, for example, follows Quine on this point: 'philosophy at its best and properly conceived is continuous with the empirical sciences' (1986: 2).

It also leads to debates, which again hover in the deep philosophical background of cognitive science. Starting in the 1970s, for example, a debate between Putnam and Rorty about the relevance of pragmatism (and neo-pragmatism) ran simultaneously with debates about functionalism in the philosophy of cognitive science (Putnam 1975; Rorty 1972, 1982). Putnam, a central figure in the philosophy of mind who had a significant influence on the development of the concept of functionalism in cognitive science in the 1960s, started to explore the ideas of pragmatism in James and Peirce. This included Peirce's idea that a concept or a belief was not something one simply entertains in one's mind, in a propositional form, but something on which one is prepared to act, or something equivalent to the consequence of the habit that it is calculated to produce – a view that is not alien to the more recent embodied action-oriented views of cognition.[2] By the time that Putnam gives up his own earlier functionalist view, that is, just around the time that EC is getting started, the pragmatism he studied throughout the 1980s remains implicit but discernible in his emphasis on the role of the physical and social environment in cognition (Putnam 1992a; also see 1992b, 1995).

Let me say what many others have said (starting perhaps with Lovejoy 1908, if not Peirce himself; also see Haack 2004; Koskinen and Pihlström 2006; and discussions between Putnam and Rorty about whether Quine could be considered a pragmatist): it is difficult to define pragmatism or to say who counts as a pragmatist. In this regard there are more issues than we can address in this short chapter, but let me suggest that just as sure as Jerry Fodor never was and never could be considered a pragmatist, one could make a good argument that Dan Dennett is a pragmatist. There is, perhaps, a vague line of pragmatism that runs from William James' essay, 'Does consciousness exist' (1904), directly to Dennett's *Consciousness Explained* (1991). The invocation to one of the central chapters in the latter is a quote from James' *Principles of Psychology*, although, to be sure, there are only scattered mentions of James and no mention of other pragmatists. The point, however, is not about lineage but about strategy. Bjørn Ramberg (2004) makes a clear argument about this, which helps to explain why *Consciousness Explained* appears to some as 'consciousness explained away' (e.g., Lowe 1993).

Dennett is motivated by the diagnosis that the folk-notion of consciousness keeps us wedded to a set of interwoven descriptions of mind and self that inhibit our susceptibility to the naturalizing influence of science on our self-image. This set of descriptions is what we gesture at with the notion of the subjective. The sense that the notion of the subjective is a rich and bona fide mine of philosophical problems and insights is an explicit target of Dennett's seditious account of mind. Dennett's view is that the linguistic practices in which our notion of consciousness is embedded (the vocabulary from which the philosophical invention 'qualia' takes its intuitive power …), are practices we would do well, if we want to naturalize our conception of ourselves, to alter. But this, any pragmatist knows, we can do only in so far as we are able make satisfying alternative descriptions available.

(Ramberg 2004: 5)

In other words, Dennett uses a pragmatist's strategy, the 'interpretivist strategy', following Quine. Pragmatist interpretivism regards ontological intuitions about the mind as vocabularies to be de-constructed.[3] 'Naturalistic pragmatists [like Quine and Dennett] are proposing ways to describe ourselves as thinkers and agents that make the philosophical contrast between mind and matter seem to be without any particular ontological point' (Ramberg 2004: 3). Dennett is forever trying to undercut our armchair intuitions about the mind, mainly by appealing to empirical science (and sometimes humor). This interpretivist strategy makes him an unheralded pragmatist.

The point of this quick and incomplete sketch of how some elements of pragmatism already inform discussions in cognitive science and philosophy of mind prior to the emergence of EC is intended to qualify any strong claim about a pragmatic turn in connection with EC. In some ways, cognitive science has always turned on some very basic pragmatist concepts that continue to inform the philosophy and practice of studying the mind.

How pragmatism relates to the variety of EC theories

I return now to the pragmatic turn. I've noted first, in terms of timing, there was not a complete coincidence between the development of EC approaches and any turn to pragmatism. Second, I've provided a brief sketch of some of the elements of pragmatism to be found in cognitive science and philosophy of mind prior to the advent of EC. My third task is to indicate how pragmatism relates to the variety of EC theories.

Weak EC

Mark Johnson and Tim Rohrer (2007) focus on the rejection of mind-body dualism and trace this rejection from pragmatists like James and Dewey into the recent EC theorists. They take this rejection as also a rejection of the representationalist theory of mind and the establishment of a pragmatically centered cognitive science. In place of representation, the pragmatists of-fer an emphasis on action, treating cognition as a kind of action as a response to problematic situations.

Johnson and Rohrer emphasize three features that derive from pragmatism to inform EC. First, in Dewey's terms, the idea that the explanatory unit is organism-environment rather than brain. As Dewey suggests, 'to see the organism in nature, the nervous system in the organism, the brain in the nervous system, the cortex in the brain is the answer to the problems which haunt philosophy' (Dewey 1925: 198). Second, a principle of continuity, concerning which they again cite Dewey: 'there is no breach of continuity between operations of inquiry and biological operations and physical operations. "Continuity" … means that rational operations grow out of organic activities, without being identical with that from which they emerge' (Dewey 1938: 26). Johnson and Rohrer suggest that this fits well with the concept of autopoiesis – the self-organizing, self-producing system discussed by Maturana and Varela (1980), which informs the enactive branch of EC. On this account, no internal representations are needed for intelligent action, and indeed, even single-cell organisms are capable of engaging in sensorimotor coordi-nation in response to environmental changes. Johnson and Rohrer marshal significant scientific evidence to support various notions of organism-environment coupling, and they emphasize brain plasticity and adaptability in this context.

The third feature relevant to cognition is the fact that in speaking about the environment, EC, like pragmatism, acknowledges that the environment is not just physical but also social, and this means that multiple organisms can cooperate in response to current or anticipated problems. Once again, pragmatists such as Dewey (1925) have taken this complex kind of social interaction as 'emblematic of cognition par excellence' (Johnson and Rohrer 2007: 18).

It is useful to distinguish between different versions of EC to understand how Johnson and Rohrer put these principles to work. As a first distinction, consider the difference between 'weak' EC and 'strong' EC (Alsmith and de Vignemont 2012). Strong EC (which would include enactivist views – see below) endorses a significant explanatory role for the (non-neural) body itself, and usually for the environment, in cognitive processes. According to weak EC, in contrast, the significant explanatory role is given to 'in the head' neural processes, or what are variously called body or B-formatted (neural) representations, understood as simulations of bodily functions in the brain (e.g., Goldman 2012, 2014; Goldman and de Vignemont 2009). In this regard, weak EC remains close, and consistent with, classic cognitivist-representationalist conceptions of cognition. Thus, Goldman and de Vignemont assume that almost everything of importance for human cognition happens in the brain, 'the seat of most, if not all, mental events' (2009: 154). They discount both the non-neural body (the role of anatomy and body activity, such as actions and postures) and the environment as significant contributors to cognition. They are thus left with, as Goldman and de Vignemont put it, 'sanitized' body or 'B-formatted' representations (2009: 155). Such representations are computational, even if they are not propositional or conceptual in format; their content may include the body or body parts, but also they may include action goals and the bodily-motoric means to achieve them. Barsalou's notion of grounded cognition also suggests that cognition operates on reactivation of motor areas, simulations that 'can indeed proceed independently of the specific body that encoded the sensorimotor experience' (2008: 619; see Pezzulo et al. 2011).

The processes involving B-formatted neural representations are models or maps internal to the brain. Such processes may be the product of evolutionary 'reuse' (Anderson 2010), i.e., the idea that neural circuits originally established for one use can be redeployed for other purposes while still maintaining their original function. An example can be found in linguistics. Pulvermüller's (2005) language-grounding hypotheis shows that a language comprehension of action words involves the activation of action-related cortical areas. This suggests that higher-order symbolic thought, including memory, is grounded in low-level simulations of motor action (Barsalou 1999; Casasanto and Dijkstra 2010; Goldman 2014; Glenberg 2010). Goldman (2014) considers Lakoff and Johnson's (1999) body-related metaphors to be a good example of B-formatted representations.

Although Johnson and Rohrer associate much of what they propose as pragmatic EC with enactivist views, they cash out most of these pragmatic principles in ways that remain close to weak EC. They link their analysis to image-schemas and neural maps as a way to explain higher-order thought. They argue, however, that these neural maps are not representations but are formed as different sets of neurons compete to become topological neural maps driven primarily by regularities in the environment. Brain plasticity allows for the reorganization of such maps in response to changing environments. The maps code perceptual space in a topological fashion but also increasingly allow for abstract topological structure so that 'we live in the world of our maps. Topologically speaking, our bodies are in our minds, in the sense that our sensorimotor maps provide the basis for conceptualization and reasoning' (Johnson and Rohrer 2007: 10). They reject a strict (Fodorian) representationalist interpretation of these maps but argue that 'actual neural representations are perpetually situated in dynamic organism-environment interactions'. Lakoff (1987) and Johnson (1987) propose the term 'image-schemas' to explain the cognitive relevance of these neural maps, and they cite evidence from psychology and linguistics that these image-schemas are neurally embodied as patterns of activation in and between topological neural maps. Image-schemas are involved in the simulations of abstract concepts (Gallese and Lakoff 2005) form the basis for Conceptual Metaphor Theory (Lakoff and Johnson 1999), and help to explain the neuroimaging findings of Pulvermüller (2005), as mentioned by Goldman.

Strong, enactive EC

Strong EC includes what is sometimes called 4E cognition. It maintains that cognition is not just a brain activity and that in regard to evolutionary claims, one has to understand the significance of the fact that the brain and body co-evolved. Consider, for example, the hypothetical case in which humans evolved without hands. Not only would our brains be different, if this were the case, but we would perceive the world differently. On enactivist and ecological accounts, our perception is action oriented, and we perceive the world pragmatically, in terms of affordances, i.e., in terms of what we can do with the things around us and how we can interact with other agents. Both physical and social affordances would be different for an organism without hands.

If, as Johnson and Rohrer have shown, pragmatism can inform weak versions of EC, Engel et al. (2013) propose that it can also inform strong EC. They emphasize the action-oriented perspective, moving away from representationalism and suggesting 'that cognitive processes are so closely intertwined with action that cognition would best be understood as "enactive"' (2013: 202), or 'pragmatic'.

> The term 'pragmatic' is used here, first, to highlight our conjecture that cognition is a form of practice. Second, we introduce the term to refer to action-oriented viewpoints, such as those developed by the founders of philosophical pragmatism [they cite Dewey and Mead], albeit without suggesting a return to exactly the positions put forward by these authors.
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> *(2013: 202)*

They cite empirical evidence, specifically brain imaging studies, to show that concepts are closely tied to action, specifically that 'object concepts in semantic memory do not only rely on sensory features but, critically, also on motor properties associated with the object's use' (2013: 204). Similar evidence exists for attentional and decision-making processes (Ibid).

Like Johnson and Rohrer, Engel et al. also highlight the brain plasticity of cortical maps, and they point to a great deal of empirical evidence to show how such maps 'critically depend on sensorimotor interactions and active exploration of the environment' (2013: 203). I think it is also clear, that, like Johnson and Rohrer, Engel et al. would eschew any kind of strict representationalism, and if neuroscientists have license to refer to 'neural representations', at most we should think of them as simple co-variations that exist between brain processes in a body that is coupled to an environment. In this respect, Engel et al. point to Andy Clark's concept of action-oriented representation (sometimes called minimal representation) (Clark 1997; Gallagher 2008), the idea that 'brain states prescribe possible actions, rather than describing states of the outside world' (Engel et al. 2013: 206).

Whether there is a better way to think about how the brain actually works in an enactive system is still a matter of debate (Gallagher 2020; Gallagher et al. 2013; Hutto and Myin 2013). Pragmatism, however, does have at least three things to offer in this regard. First, with respect to the question of representation, Menary (2015) reminds us that Peirce proposed a developed account of representation that is neither of the strict Fodorian kind nor of the minimal action-oriented kind. Peirce does not conceive of representation as a vehicle carrying information or semantic content, or as a stand-in for an object. Rather, he emphasizes 'continuous dynamical interpretation' (Menary 2015: 222). Peirce's notion of representation involves 'sign action'. In the simplest terms, something (a sign) is produced by a mechanism or agent, some other mechanism or agent (a consumer) attunes to it, thereby accomplishing something (leading to some end). In that case the sign counts as a representation in Peirce's sense. Menary explains that this representational process 'requires the coordination of producer and consumer mechanisms for some further end; therefore it requires either the coordination of mechanisms within the organism or the coordination of a

mechanism in the organism with a mechanism in that organism's environment' (2015: 224). Furthermore, this idea of representation 'makes no commitment as to whether sign action must be internal, external, or distributed across brain, body, and world' (Ibid.).

Second, I think that Engel et al. come close to what might count as a pragmatic solution, at least for basic perception-action cognition. They discuss 'dispositions for action embodied in dynamic activity patterns' rather than representations. Such dispositions are not simply neural events but include extra-neural patterns enacted by the body as it couples to the environment. Accordingly, '[k]nowing what an object is does not mean to possess internal descriptions of this object, but to master sets of sensorimotor skills and possible actions that can be chosen to explore or utilize the object' (2013: 206).

Third, Dewey offers an excellent clue that has nothing to do with representations or maps.

> The advance of physiology and the psychology associated with it have shown the connection of mental activity with that of the nervous system. Too often recognition of connection has stopped short at this point; the older dualism of soul and body has been replaced by that of the brain and the rest of the body. But in fact the nervous system is only a specialized mechanism for keeping all bodily activities working together. Instead of being isolated from them, as an organ of knowing from organs of motor response, it is the organ by which they interact responsively with one another. The brain is essentially an organ for effecting the reciprocal adjustment to each other of the stimuli received from the environment and responses directed upon it. Note that the adjusting is reciprocal; the brain not only enables organic activity to be brought to bear upon any object of the environment in response to a sensory stimulation, but this response also determines what the next stimulus will be.
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> *(1916: 336–337)*

Both Engel et al. (2013) and Menary (2015) suggest that pragmatism is consistent with embodied, extended, and enactive versions of EC, and we have seen, above, that it may also be consistent with weak EC, and perhaps even in some respects with aspects of more traditional forms of cognitive science. The final question that we will consider is whether pragmatism is consistent with predictive processing (PP) approaches. Engel et al. (2013) hint, and some of the essays in Engel et al. (2015), including Menary (2015), argue that pragmatism, especially in its conception that we are fallible cognitive agents who actively explore their environments, may provide some guidance for Bayesian PP.

Peircean and neuro-Peircean predictive processing

To provide a pragmatist interpretation of PP, Menary (2015) focuses on the Peircean concepts of 'exploratory inference', abduction, and their similarity to Bayesian or PP accounts of active inference. Pragmatist versions of PP, like enactivist versions (Gallagher and Allen 2019), would steer us away from internalist and avowedly non-pragmatist models of the sort found in Hohwy (2013), in which the brain, isolated from the world, tries to infer the causes of its sensory input while minimizing prediction errors, with the aim of maintaining a veridical representation of the world. Pragmatist versions rather push toward a more externalist conception of active inference according to which action and perception are both needed to minimize prediction errors by optimizing the states of brain-body-environment. Peirce's notion of abduction, 'the process of forming explanatory hypotheses' (CP 5.172), fits this externalist model. Abduction is a fallible, self-corrective process that allows the human agent to explore its environment in a hands-on fashion. In the process of problem solving, we form hypotheses primarily through action (rather than

by formulating propositions in-the-head), and we test them out in a science-like exploration of the environment. Menary takes this to be a process similar to PP accounts of active inference, which facilitates the development of priors and of stable predictions. This is a version of PP that emphasizes the Free Energy Principle (Friston 2010), roughly, the idea that the organism, by means of active inference, tends to remain in a range of states, close to homeostasis, allowing it to reduce surprise (prediction error or variational free energy, understood in an information theoretic way) and thereby survive or avoid entropy.

Menary highlights the potential of this model in non-representationalist, strong-EC, terms:

> [In] at least some sensorimotor cases, the conjecture and test may be based on motor activity rather than on beliefs or representations. Therefore, it is possible to give a non-representational account of active inference, and this would be entirely consistent with the likely evolutionary origin of those inferences in sensorimotor interactions with the environment. This interpretation is consistent with the reflex arc concept developed by Dewey … as a matter of sensorimotor coordination.
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> *(2015: 230)*

Again, in contrast to Hohwy's (2013) internalist version of PP, in which perceptual inference is accomplished entirely in an isolated brain, with active inference merely serving such central processes, the pragmatist model works out in the open and emphasizes interaction between organism and environment. This view sits well with Clark's (2016) conception of PP, where 'active inference and cultural props help to minimize prediction errors … and [where] there is a deep continuity between mind and world mediated by active inference and the cultural scaffolding of our local niche' (Menary 2015: 232; also see Williams 2018).

For Friston (2015), PP is based on a Bayesian mathematical formalism that is fully consistent both with the pragmatism of strong (externalist) EC, of the sort championed by Clark or Menary's Peircean model, and with Hohwy's non-pragmatist internalism, the idea that the brain, understood 'as a statistical organ that generates hypotheses', is doing most of the work. In the latter respect, Friston and Stephan (2007: 433) put it simply: 'sustained exposure to environmental inputs causes the internal structure of the brain to recapitulate the causal structure of those inputs. In turn, this enables efficient perceptual inference'.

Engel et al. (2013) stake out a center position, which might be called a neuro-Peircean model that frames the connection between pragmatic conceptions of action and PP in terms of very basic motor control processes (brain-based forward models), which run predictions about the sensory outcome of movement. Engle, Friston and Kragic (2015) interpret this in terms of the predictive aspects of sensory-motor contingencies (SMCs) as this idea has been developed in enactive accounts by Noë (2014) and O'Regan and Noë (2001).

> SMCs are defined as law-like relations between movements and associated changes in sensory inputs that are produced by the agent's actions. Once acquired, an agent can use these SMCs to predict consequences of its own actions.
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> *(Engle, Friston and Kragic 2015: 176)*

Engle, Friston and Kragic, however, take a very broad view of what counts as pragmatic EC, to include versions of weak EC (discussed above). Specifically, SMCs play a role in the formation of object concepts by means of neural simulation (or what Johnson and Rohrer called image-schemas), as well as in speech perception and language comprehension (Pulvermüller 2015; see Pezzulo 2015: 26ff).

Conclusion

In mapping out the influence of pragmatism on cognitive science, it becomes clear that there is a wide spectrum of pragmatic ideas that inform a diversity of models for studying the mind. The central idea that seemingly characterizes the pragmatic turn and that unites, or at least draws together, these various, and somewhat diverse, embodied approaches in cognitive science – weak or grounded EC, the SMC approach, some versions of active inference/PP, Gibson's affordance theory, and enactive perspectives – is the focus on the idea that cognition is action oriented. Dewey's emphasis on organism-environment coupling clearly shows up in the more embodied EC approaches. More generally, the pragmatist views on confirmation holism in philosophy of science, the tight conjunction of philosophy and science, and the interpretivist strategy have played a continuing role in the development of cognitive science.

Notes

1 He also cites David McNeil (1975), whose theory of gesture figures into later discussions of EC, enactivism, and extended mind, in Gallagher (2005) and in Clark (2008).

2 Zimmerman (this volume) makes clear Peirce's debt to Alexander Bain for this view ('belief [has] no meaning, except in reference to our actions' [Bain 1859: 568]) and Bain's insistence on the primacy of movement.

3 This way of putting it is more Rorty than Dennett; Rorty (1982b) sees Dennett as a pragmatist in just this way and approves; see Dennett's (1982) response – he agrees ±72.4%. Thanks to Aaron Zimmerman for alerting me to these two essays.

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