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Emotion and Life: A Deweyan Perspective on Challenges Facing the Quest for Artificial Intelligence

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Introduction

Since its early years in the 1950s and 60s, the quest to construct intelligent machines has undergone a methodological diversification. This has occurred in parallel with a number of conceptual shifts in cognitive science and philosophy of mind. The computationalist paradigm that dominated the formative years of the artificial intelligence (AI) programme seems to have been largely superseded by approaches that focus on the themes of embodiment, situatedness and adaptivity. Despite the increased focus on the role of the body in cognitive science and AI, emotional processes have largely been seen as inessential to thinking *per se*. Recently emotion has started to play a more central role, and some are now arguing that the bodily processes which it involves must be seen as integrated in cognition in a strongly constitutive way. This line of thinking continues in the tradition of the embodied-situated-adaptive approach in that it is motivated by the perceived need to understand intelligence as grounded in biological processes. *In this paper I shall argue that the need to properly integrate emotion into AI is a central challenge facing the quest to create machines that can think like a human.* I will use an analysis of classical pragmatist John Dewey's views on life, mind and emotion, and a demonstration of how they correlate with and are supported by contemporary cognitive science, to *emphasise both the importance and complexity of this challenge, and to show how it is bound up with the wider challenge of imitating biology in AI.*

The aim of Part 1 will be to justify an approach to the philosophy of AI that appeals to ideas from classical pragmatism. I will argue that the shift from computationalism towards an emphasis on the themes of embodiment, situatedness and adaptivity reflects the pragmatist deconstruction of Cartesianism, and the account of mind that was developed in its place.

Part 2 will begin with a discussion of the metaphysics of Dewey's views on life and mind, which will be relevant for understanding his views on intelligence and emotion. Section 2.2 will describe Dewey's criticism of the reflex arc concept in psychology, and his solution in terms of dynamic coordination, which will set the ground for his theory of emotion. Section 2.3 will describe Dewey's criticism of the James-Lange theory of emotion, link it with his theory of dynamic coordination and his metaphysics of life, and will explain how Dewey saw emotion as integral to human intelligence. Section 2.4 will describe some recent developments in cognitive science that seem to imply a similar picture of the role of emotion in cognition as can be drawn from Dewey. Section 2.5 will give some evidence that these insights are starting to be incorporated into AI, and explain how emotion presents a challenge to contemporary AI.

Part 1: Mind, Body and World; Philosophy and AI

Despite most often being associated with the work of 'Continental' philosophers such as Heidegger, Gadamer and Merleau-Ponty, the conceptual underpinnings of what I shall call the embodied-situated-adaptive approach (or 'embodied approach' for short) in modern AI correlate strongly with some central ideas about mind in classical pragmatism.[1] They also share a motivation to understand the mind as grounded in biology.[2]

A good place to start for both the embodied approach to AI and the philosophy of mind of classical pragmatism is with the similarities between the views they oppose. In 1970, Marvin Minsky predicted that "in from three to eight years we will have a machine with the general intelligence of an average human being".[3] Minsky and others felt confident to make such predictions due to an assumption that human intelligence was fundamentally constituted by calculation – in the form of symbol processing according to explicit logical rules, i.e. the sort of activity that formed the foundation of what computers did.[4] Coupled with the ever-increasing speed and power of computers this assumption led many in the early years of AI to the conclusion that it would not be long before computers could think for themselves, and in the same way as humans.[5] I will follow Haugeland in referring to the computationalist approach to AI based on this assumption as 'good old-fashioned AI' (GOFAI).[6] Within this paradigm perception was seen as the reception of sensory information with which a representational image of the external world is formed, and bodily action as the physical output of computations involving these representations and behavioural rules. The mind was thought of as like a computer programme, abstracted from its physical instantiation in the 'hardware' (or, rather, 'wetware') of the brain.[7]

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[1] On the links of the embodied approach with 'Continental' philosophy see, for example: Varela, F. J., Thompson, E. & Rosch, E., *The Embodied Mind* [1991] (Cambridge: MIT Press, 1993), pp. 149–150; Clark, A., *Being There* [1997] (Cambridge: MIT Press, 2001), pp. 171–172. What I am calling the embodied-situated-adaptive approach is not a unified programme, but a number of views and methods in AI and cognitive science with these family resemblances, exemplified by fields such as behaviour-based robotics, nouvelle AI, artificial life robotics, embodied and situated cognition, enactive perception etc.

[2] This similarity will be made more explicit in Section 2.1.

[3] *LIFE* magazine, Nov 20th, 1970

[4] See also the 'physical symbol system hypothesis' of Newell and Simon: Newell, A. & Simon, H. A. (1976) 'Computer Science as Empirical Inquiry: Symbols and Search'. *Communications of the ACM.* Vol. 19 (No. 3), pp. 113–126, p. 116

[5] I will not restrict the discussion in this paper to 'weak AI', but will assume that the end aim of the quest for artificial human intelligence is for machines that can genuinely think, experience, understand and behave in ways we take to be characteristic of the human mind. I will also therefore be making use of a very broad conception of 'intelligence', one that needn't necessarily be distinguished from the 'conscious' aspects of the human mind. For the distinction between strong and weak AI see: Searle, J. (1980) 'Minds, brains and programs'. *The Behavioural and Brain Sciences*. Vol. 3, pp. 417–457

[6] Haugeland, J., *Artificial Intelligence: The Very Idea* (Cambridge: MIT Press, 1985), pp. 112–113

[7] See: Horst, S. 'The Computational Theory of Mind'. The Stanford Encyclopedia of Philosophy (Spring 2011 Edition)

There are relevant parallels with Cartesianism in philosophy of mind.[8] Descartes saw the mind as an entity separate from the body, and ideas as private representations, or symbols, contained within the mind.[9] It was not possible to experience the external world directly, but only through the medium of these internal representations. The human self was an isolated subject aware only of the contents of his or her mind. Many have seen the Cartesian idea of a fundamental dualism between mind and body, and of thinking as the manipulation of internal symbols, to be underlying motivations of GOFAI.[10]

It is not only in terms of what they oppose that the embodied approach and pragmatism overlap. Some of the central ways that the former has gone beyond GOFAI have strong conceptual parallels with pragmatist philosophy of mind. A brief consideration of an important non-symbolic approach to cognitive modelling will help draw out these similarities.

GOFAI systems have proved incredibly successful at performing certain tasks formally the exclusive remit of humans. For example, solving mathematical problems, playing chess, and other tasks that can be described in terms of the following of explicit rules. Despite this they have been found wanting in their ability to produce intelligent behaviours that it had been believed would be simple in comparison, such as moving a robot across a room, recognising a face or using more than an extremely limited language.[11]

'Distributed' processing such as connectionist and neural network models have had some success where GOFAI has failed. These architectures function by the interaction of multiple parallel layers of simple processing units – based on the neuronal structure of the brain. In the simplest (connectionist) models environmental inputs from sensors are communicated to a layer of 'neurons', which pass on signals to the next layer with a strength that depends on the type and strength of the signal received. By repeating this process through multiple layers various behaviours are produced, such as the actuation of a limb movement.[12] Such a network can 'learn' through experimentation with different response patterns, and the reinforcement of connections between neurons and layers. This process of adapting to environmental stimuli can occur even if the pattern of responses starts off completely random.[13] This type of learning process has had

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[8] And also with most of the empiricist/rationalist/Kantian traditions that followed in his wake.

[9] See, for example: Haugeland, *Artificial Intelligence: The Very Idea*, pp. 31–32; Murphy, J. P., *Pragmatism: From Peirce to Davidson* (Boulder: Westview Press, 1990), pp. 8–9

[10] See, for example: Dreyfus, H. L., *What Computers Still Can't Do* (Cambridge: MIT Press, 1994), xi; Weigmann, K. (2012) 'Does intelligence require a body?'. *EMBO report*s. Vol. 13 (No. 12), pp. 1066–1069, p. 1066; Haugeland, *Artificial Intelligence: The Very Idea*, pp. 112–113

[11] See: Moravec, H., *Mind Children* (Harvard: Harvard University Press, 1988), p. 15; Dreyfus, *What Computers Still Can't Do*, pp. 57–60. The assumption here is that these kinds of ability are at least as important to a characterisation of human intelligence as the ability to make logical deductions.

[12] McLeod, P., Plunkett, K. and Rolls, E. T., *Introduction to Connectionist Modelling of Cognitive Processes* (Oxford: Oxford University Press, 1998), p. 9. These simple models are 'feedforward' – the route from stimulus to response is one-way. More complex models, recurrent networks, involve feedback from later layers to earlier ones. These more complex networks are closer to the reality of the brain (see Section 2.4).

[13] *Ibid*., p. 15

significant successes with activities such as language-use and face-recognition.[14]

Robots that use similar types of processing can also perform tasks such as traversing rough terrain despite having no prior information about the space to be crossed. A classic example of the success that such architecture can have in comparison with GOFAI systems is Brooks' mobile robots.[15] The behaviour of these robots, such as the six-legged insect-like Attila, emerges from the parallel interaction of multiple neuronal layers processing signals from sensors on the legs.

In contrast to GOFAI's corresponding attempts, robots such as Attila do not depend on centralised access to a detailed map representing the robot's surroundings, or the deduction of overall behavioural responses from rules.[16] Due to the high level of computation required for this, GOFAI robots are inefficient, and cannot adapt as effectively to changes in the environment as robots controlled by distributed architecture.[17] Brooks' method takes advantage of the fact that, as he puts it, "the world is its own best model".[18] If there is any need to talk in terms of 'representations' of the world at all, these can be seen to be functions of a *distribution* of activity across multiple functional elements, including the structure of the body, rather than an entity constructed from sensory information accessed by a central processor.[19]

While distributed and computational architectures are not necessarily incompatible, research such as Brooks' has gone beyond GOFAI by putting into question the assumption that intelligence is *foundationally* constituted by symbol manipulation and logical rule-following.[20] If it can be shown that cognition and intelligent behaviours are built out of the dynamic interaction of simpler processes, then thinking is not symbol manipulation 'all the way down', if at all, and cognition need not be abstracted from the interactions of a physical body with its environment. This is the idea behind the hope of the embodied approach that it may be possible to build thinking systems from the 'bottom up' — by understanding intelligence as a complex of abilities that emerge through an adaptive learning process involving the direct interaction of the body with a

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[14] *Ibid*., pp. 2–5, pp. 178–209

[15] Brooks, R. A. (1990) 'Elephants Don't Play Chess'. *Robotics and Autonomous Systems*. Vol. 6, pp. 3–15

[16] Brooks uses a 'subsumption' architecture, which has subtle differences to connectionist versions, to do with things like the uniformity of processing nodes, but these details are not significant here. It is the broader picture of the lack of central processing, representations and symbol-based rules that is important. I will use the term 'distributed architecture' to refer to this set of similar methods. For more on the differences between these various approaches see: Brooks, R. A. (1991) 'Intelligence without Representation'. *Artificial Intelligence*. Vol. 47, pp. 139–159, p. 147–148

[17] Russell, S. J. & Norvig, P., *Artificial Intelligence: A Modern Approach (2nd Ed.)* (New Jersey: Pearson Education Ltd, 2003), pp. 930–933

[18] Brooks, 'Elephants Don't Play Chess', p. 5

[19] McLeod, Plunkett & Rolls, *Introduction to Connectionist Modelling of Cognitive Processes*, p. 30

[20] Some argue that for complex logical processing a neural network may have to instantiate activity essentially the same as symbol-processing and logical rule following, but just at a higher level. See: Boden, M. A. 'The Impact on Philosophy' in Broadbent, D. (ed.), *The Simulation of Human Intelligence* (Oxford: Blackwell, 1993), pp. 178–197, p. 193

changing and unpredictable environment.[21] For Brooks, "as the complexity of the world increases, and the complexity of processing to deal with that world rises, we will see the same evidence of thought and consciousness in our systems as we see in people other than ourselves now. Thought and consciousness will not need to be programmed in. They will emerge."[22]

The embodied-situated-adaptive approach in AI/cognitive science is much wider than the incorporation of distributed cognitive modelling, but the resulting focus on the essential role of the body in grounding cognition, and an agent's situatedness – being in direct contact with, and learning through adaptive interaction with, the environment – are central characteristics of this wider tradition.[23] This account of the thinking self as distributed, situated and emergent, rather than abstracted and private in the Cartesian sense, correlates with central pragmatist views.[24]

Inspired by Peirce's criticisms of Cartesian epistemology,[25] James and Dewey rejected the mind-body dualism on which it rested. James described ideas as "phases of readjustment within the "stream of thought" rather than discrete representational entities",[26] and argued that 'consciousness' was not the name of a private entity containing "intervening mental images", but was to be understood in functional terms, as a way of being that was involved in certain forms of real-world action such as knowing and perceiving.[27] Dewey echoed this functional picture of the mind as a complex of *activities embedded in the world* rather than a private arena containing atomistic ideas.[28] For Dewey, intelligence was to be seen as a capacity that emerges through

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[21] See: Clark, *Being There*, pp. 11–25, pp. 53–67; Brooks, R. A. 'Intelligence without Reason' in Steels, L. & Brook, R. A. (eds.), *The Artificial Life Route To Artificial Intelligence* (Hillsdale: Lawrence Erlbaun Associates, Inc., 1995), pp. 25–70, pp. 25–28

[22] *Ibid*, p. 70

[23] See, for examples: Clark, *Being There*, pp. 87–97; Steels & Brooks, *The Artificial Life Route To Artificial Intelligence*, pp. 15–24; Kaelbling, L. P. 'The Importance of Being Adaptable' in Steels & Brooks, *The Artificial Life Route To Artificial Intelligence*, pp. 265–273; Di Paolo, E. A. (2005) 'Autopoiesis, adaptivity, teleology, agency'. *Phenomenology and the Cognitive Sciences*. Vol. 4, pp. 429–452; Varela, Thompson & Rosch, *The Embodied Mind*, pp. 147–207; Gigerenzer, G., *Adaptive Thinking* (Oxford: Oxford University Press, 2000)

[24] Many different thinkers associated with the nebulous school of pragmatism have given views on the nature of mind, and not all in agreement. I will concentrate only on James and Dewey here, and will give a particular interpretation of their ideas that, insofar as AI was not an existing scientific project at their time of writing, will be somewhat anachronistic.

[25] See: Peirce, C. S. (1868) 'Questions Concerning Certain Faculties Claimed For Man'. Journal of Speculative Philosophy. Vol. 2, pp. 103–114; Peirce, C. S. (1868) 'Some Consequences of Four Incapacities'. Journal of Speculative Philosophy. Vol. 2 (No. 3), pp. 140–157; Murphy, Pragmatism: From Peirce to Davidson, pp. 7–13

26 Alexander, T. M. 'Dewey, Dualism, and Naturalism' in Shook, J. R. and Margolis, J. (Eds.), A Companion to Pragmatism (Chichester: Wiley-Blackwell, 2009), pp. 184–192, pp. 186–7

[27] James, W. (1904) 'Does 'Consciousness' Exist?'. The Journal of Philosophy, Psychology and Scientific Methods. Vol. 1 (No. 18), pp. 477–491, pp. 478–481

[28] Dewey, J. [1917] 'The Need For a Recovery of Philosophy' in Talisse, R. B. and Aikin, S. F. (eds.), The Pragmatism Reader (Princeton: Princeton University Press, 2011), pp. 109–140, p. 111

adaptive interactions with an environmental context,[29] and thought and understanding as grounded in the interaction of organism and world.[30]

Dewey ridiculed the dualist view as the 'spectator theory', in which all experience is seen as fundamentally a relation between an isolated subject and private objects inside the mind.[31] This critique amounts to what Bernstein calls the 'decentring of the subject'.[32] Just as pragmatism 'decentres' the thinking-subject-as-isolated-ego, the embodied approach to AI sees cognition as distributed across processes of interaction between brain, body and environment.

Given the rejection of mind-body dualism and the emphasis on situated, adaptive interaction with environment common to both classical pragmatism and the embodied approach, it is appropriate to elaborate on some aspects of pragmatist views on the mind, and to apply this analysis to modern AI.[33] *Emotion* was also seen as integral to intelligence by both James and Dewey. The details of their views on this matter, and their relevance to modern AI, will be developed in Part 2.

Part 2: Emotion and life

2.1. Dewey on life and mind

Both classical pragmatism and the embodied approach to AI/cognitive science share a motivation to understand mind and intelligence as attributes of living organisms, as grounded in biological processes. The latter has developed methods inspired by this. For example, neural network models are based on the architecture of the brain, and some contemporary robotics programmes attempt to replicate the developmental learning processes of human infants.[34] Both schools are influenced by ideas of evolutionary adaptation and continuity between simple biology and 'higher' mentality.[35] I will now turn to the underlying metaphysics of Dewey's views on life and mind as this will later be relevant to his theory of emotion.

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29 *Ibid*., pp. 117–118. This is reflected in the motto of the Laboratory School, set up by Dewey in Chicago: "Learning by doing".

30 Dewey, J., Experience and Nature (Chicago: Open Court Publishing Co., 1925), p. 290; Dewey, J. (1896) 'The Reflex Arc Concept in Psychology'. The Psychological Review. Vol. 3 (No. 4), pp. 357–370, pp. 359–360

31 Dewey, 'The Need For a Recovery of Philosophy' in Talisse & Aikin, The Pragmatism Reader, pp. 135–136

32 Bernstein, R. J., The Pragmatic Turn (Malden: Polity, 2010), p.140

33 Johnson agrees with me on the compatibility of pragmatism to the embodied approach. See: Johnson, M. 'Cognitive Science' in Shook & Margolis, A Companion to Pragmatism, pp. 369–377

34 See, for example, Stapleton, M. (2012) Steps to a "Properly Embodied" Cognitive Science. *Cognitive Systems Research*, p. 4

35 See: Di Paolo, E. A., 'Organismically-inspired robotics: Homeostatic adaptation and natural teleology beyond the closed sensorimotor loop' in Murase, K. & Asakura, T. (eds.), *Dynamic Systems Approach for Embodiment and Sociality* (Magill: Advanced Knowledge International, 2003), pp. 19–42; Brooks, 'Elephants Don't Play Chess', p. 5; Clark, *Being There*, pp. 97–105; Dewey, 'The Need For a Recovery of Philosophy' in Talisse & Aikin, *The Pragmatism Reader*, pp. 111–118; Johnson, 'Cognitive Science' in Shook & Margolis *A Companion to Pragmatism*, p. 370

Influenced by this post-Darwin naturalistic motivation, and James' teleological picture of mind, Dewey viewed the activities of mind – including thought, volition, conscious experience – as a set of high levels of complexity which grow out of biological life, and are entwined with the nature of living organisms.[36] For Dewey, the difference between inanimate matter and animate beings is that the behaviour of the latter largely takes place as the result of a need to maintain a particular organisational unity or structural coherence. Animate beings are characterised by 'efforts' to satisfy this need, which are manifested through adaptation to environment.[37] In other words, unlike inanimate objects such as stones, the fate of which lies entirely with forces acting on them from without, what is characteristic of living things is their teleological activity – that which functions towards the end of organic coherence, and their use of adaptive interactions with their environment as a means to this end. In Dewey's words, animate beings tend "to utilize conserved consequences of past activities so as to adapt subsequent changes to the need of the integral system to which they belong".[38]

Dewey describes capacities of the mind – he prefers the term 'body-mind' to emphasise the dissolution of Cartesian dualism – as arising out of this unique organisation of animate matter.[39] Intelligence is instantiated in an organic coordination of highly complex adaptive capacities on an ontological continuum with the more basic interactions of a living being with its environment.[40] "The distinction between physical, psycho-physical, and mental is thus one of levels of increasing complexity and intimacy of interaction among natural events" rather than one of fundamental ontology.[41] In virtue of their grounding in life-processes, mental capacities are teleological rather than merely reactive: "man is led or drawn rather than pushed".[42]

The idea that mind is grounded in biology like this is complemented by the concept that living organisms are autopoietic[43] – organised wholes which function towards the maintenance and regeneration of their structural coherence. This view is akin to Dewey's conception of animate beings, and makes most sense when seen as relying on a metaphysics that attributes more than mere mechanical causation to the universe.[44] Dewey recognises that this view of nature parts from the atomistic and mechanistic view

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[36] On the influence of James' teleological theory of mind on Dewey, see: Murphy, *Pragmatism: From Peirce to Davidson*, p. 62

[37] Dewey, *Experience and Nature*, pp. 252–255

[38] *Ibid*., p. 254. Dewey seems to see adaptivity as a capacity of living beings both phylogenetically – as evolving species – and ontogenetically – as developing individuals.

[39] *Ibid*., pp. 277–278, 285, 290

[40] For example, anticipation of the future develops out of locomotion and distance-receptive organs, and language-use and culture out of social interaction. *Ibid*., pp. 257–258

[41] *Ibid*., p. 261

[42] *Ibid*., p. 270

[43] 'Autopoiesis' is not a term Dewey uses. It comes from Varela, F. J., *Principles of Biological Autonomy* (New York: Elsevier, 1979). See also: Ziemke, T. (2007) 'On the role of emotion in biological and robotic autonomy'. Draft paper for *"Modelling Autonomy"* workshop, San Sebastian, March 22–23, 2007, pp. 3–5

[44] Dewey, *Experience and Nature*, pp. 262–263.

largely indebted to Galilean-Newtonian physics.[45] Even though biological organisms are materially composed of inanimate matter, to deny the reality of their self-producing organisation that emerges on a higher level he saw as based on a metaphysical prejudice that the simpler is somehow more 'real' than the complex, which is essential to the view that sees the universe as exhaustively mechanistic.[46] Some exponents of the embodied approach explicitly propound this metaphysic of emergent autopoiesis, and the view of this paper also holds it to be important.[47]

2.2. Dewey on sensori-motor action

The idea of a coordination of processes functioning towards the maintenance of organic coherence also underlies Dewey's accounts of sensori-motor action and emotion. A brief consideration of the former will set the ground for the latter.

In response to the 'reflex arc' concept in psychology – according to which behaviour is the end result of a mechanistic causal chain from sensory stimulus to reactive motor response – Dewey developed what I shall call his theory of 'dynamic coordination'. He saw perception and action as artificially divided by the reflex arc concept such that "sensory stimulus is one thing, the central activity, standing for the idea, is another thing, and the motor discharge, standing for the act proper, is a third".[48] Dewey saw these distinctions to be the result of a lingering mind-body dualism.[49]

Dewey argued that these phases of sensori-motor action are not in fact distinct, but mutually constitutive. In perception one does not passively receive sensations from the world but must already be involved in a form of *action* for this perception to be meaningful. In order for the thing perceived to have significance for us we must engage with the world through directed attention, which is made possible by the particular constitution of the human body.[50] Sensation involves discriminatory, directed action, and this action is guided by sensation running parallel to it. This forms a recurrent circuit, rather than behaviour being merely the 'external' reactions to 'internal' mechanisms.[51] Dewey sees sensori-motor action as this dynamic coordination of activities. This needn't be seen as a conscious or deliberate coordination, but it is teleological in the sense that it functions towards the expression of particular adaptive behaviours, and is a capacity

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[45] See: Alexander, 'Dewey, Dualism and Naturalism' in Shook & Margolis, *A Companion To Pragmatism*, p. 190

[46] Dewey, *Experience and Nature*, pp. 255–256

[47] The concept of autopoiesis is also associated with the matter of autonomy. This is a question that I have set aside for this paper. However, I believe that similar conclusions may well be drawn regarding autonomy that I will draw regarding emotion, and the relation of these capacities to fundamental biological processes (see Conclusion).

[48] Dewey, 'The Reflex Arc Concept in Psychology', p. 358

[49] *Ibid*., pp. 357, 365

[50] On directed attention: *Ibid*., pp. 362–363; and on the constitutive role of human physiology: *Ibid*., pp. 358, 362, 364

[51] *Ibid*., pp. 358–360

grounded in the autopoietic organisation of living organisms.[52]

The idea that perception must be a form of embodied directed action in order to manifest meaningful experience is also to be found in the contemporary theory of enactive perception.[53] This hypothesis is supported by experimental evidence,[54] and has influenced research in the embodied approach to cognitive science and AI.[55]

2.3. Dewey on emotion, experience and cognition

Through his critique of the James-Lange theory of emotion, Dewey incorporates emotion into the concept of dynamic coordination. An assessment of this dialectic will reveal how emotion, and the bodily affect that it involves, are constitutive parts of experience and cognition for Dewey. This picture of emotion and cognition as intertwined, and coordinated in intelligent activity, is also founded on Dewey's idea of organic autopoiesis.

The James-Lange theory defines emotional feelings as perceptions of bodily perturbations which are direct reactions to external events.[56] Dewey agreed with James' general view that the 'emotional sensation' did not come first, followed by bodily 'manifestations', but saw in James' sequential description the influence of the reflex arc concept, and vestiges of both the mechanistic view of nature and the mind-body dualism that James himself had argued against.[57]

There is indeed a tension in James' writings on emotion, just as Dewey noticed. James wrote extensively on the central role that emotion plays in guiding action, belief and experience.[58] He noted that, "'without selective interest, experience is an utter chaos' [and that] the ultimate source of selective interest is the 'passional' nature of the human organism".[59] In other words, in order for the perception of aspects of the world *as* differentiated from each other to be possible, emotional evaluation must be involved in discrimination. Experience does not involve any objects passively received, but, as Dewey recognised in reference to sensori-motor action, is organised by the constitution of the body and its interaction with the world. This reading of James puts the bodily affective

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52 *Ibid*., pp. 362; Dewey, *Experience and Nature*, p. 257

53 See: Noë, A. (2006) 'Real Presence'. UC Berkeley, draft of 9 January 2006; Varela, *The Embodied Mind*, p. 173

54 See: Steels & Brooks, *The Artificial Life Route To Artificial Intelligence*, p. 16

55 See: Stapleton, 'Steps to a "Properly Embodied" Cognitive Science', pp. 5–6

56 James, W. (1884) 'What Is An Emotion?'. *Mind*. Vol. 9 (No. 34), pp. 188–205, pp. 189–190

57 Dewey, J. (1895) 'The Theory of Emotion 2: The Significance of Emotions'. *Psychological Review*. Vol. 2, pp. 13–32, p. 18; for more on the influence of the reflex arc concept on James' psychology see: Murphy, *Pragmatism: From Peirce to Davidson*, p. 16

58 On the role of emotion in action and belief see, for example: James, W. 'The Will To Believe' [1896] in Talisse & Aikin, *The Pragmatism Reader*, pp. 92–108; James, W. (1879) 'The Sentiment of Rationality'. *Mind*. Vol. 4 (No. 15), pp. 317–346

59 Barbalet, J. (2008) 'Pragmatism and economics: William James' contribution'. *Cambridge Journal of Economics*. Vol. 32, pp. 797–810, p. 801; see also: James, W., *Principles of Psychology Vol. 1* [1890] (New York: Cosimo, 2007), p. 402

aspects of emotion at the centre of that constitution of experience as well.[60]

If this is the case, Dewey argues, then the sequential description of emotional responses according to the James-Lange theory must be inaccurate.[61] According to this account the image of an “object falls on a sense-organ […] *and gives rise to an idea of the same object*. Quick as a flash, the reflex currents pass down through their pre-ordained channels, alter the condition of muscle, skin and viscus; and these alterations, apperceived like the original object […] combine with it in consciousness and transform it *from an object-simply-apprehended into an object-emotionally-felt*. […] Nothing is postulated beyond the ordinary reflex circuit.”[62] The problem is that, if experience is affectively organised, as James asserts elsewhere, then there can be no ‘idea’ of the object ‘simply apprehended’ prior to an emotionally-laden interaction with it.[63] Prior to such an affective evaluation the ‘object’ would not be differentiated from the famous ‘blooming, buzzing confusion’.[64]

Hence, for Dewey, sensation, motor control and bodily affect must all be involved in a directed coordination of activities in order for the full richness of human experience to be possible.[65] Emotional responses to a situation are directed at the world, they have ‘objects’, they are not merely “the ‘feel’ of bodily attitudes which have themselves no meaning”.[66] In addition to this enrichment of the concept of *experience*, Dewey’s exorcism of the reflex arc concept in his theory of emotion brings to light the fact that emotion must be bound up with *cognition*.[67] This integration makes possible the level of intelligent engagement with the world that humans are capable of.

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[60] By ‘bodily affect’ I mean processes involving some sort of interaction between the conscious agent as a whole and their physiological perturbations, such as those recognised by James and Dewey, and others, to be involved in emotion. The state of the viscera, circulatory system, respiratory system and muscles are often cited as examples. See also: Stapleton, ‘Steps to a “Properly Embodied” Cognitive Science’, p. 2, pp. 12–14; Ziemke, ‘On the role of emotion in biological and robotic autonomy’, pp. 6–7

[61] In his critique of the James-Lange theory Dewey is incredibly charitable to James. He suggests that James’ definition of emotion should be seen as purposefully dealing only with ‘an intellectual abstraction’ which has no existence by itself, and that certain of his expressions should ‘not be taken literally’ (Dewey, ‘The Theory of Emotion 2: The Significance of Emotions’, pp. 15–16, 19–20). There may be a kernel of truth in this, but the purpose here of contrasting the reflex arc conception with Dewey’s dynamic coordination is better served by taking James’ statements in the way he made them.

[62] James, ‘What Is An Emotion?’, p. 203 (my italics)

[63] Dewey agrees: Dewey, ‘The Theory of Emotion 2: The Significance of Emotions’, p. 19

[64] James, *Principles of Psychology Vol. 1*, p. 488

[65] Dewey, ‘The Theory of Emotion 2: The Significance of Emotions’, p. 20. This same conclusion is reached in Barrett and Bar’s research on the neurological structure of perception. Visual processing is laden with affective value since the sensori-motor patterns involved integrate both external sensory information and internal – from muscles, organs, joints etc. Barrett, L. F. & Bar, M. (2009). ‘See it with feeling: affective predictions during object perception’. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*. Vol. 364 (No. 1521), pp. 1325–1334; cited in: Stapleton, ‘Steps to a “Properly Embodied” Cognitive Science’, pp. 8–12. See Section 2.4 for evidence that further enforces this view.

[66] Dewey, J. (1894) ‘The Theory of Emotion 1: Emotional Attitudes’. *Psychological Review*. Vol. 1, pp. 553–569, p. 563

[67] I will take the terms ‘cognition’, ‘reasoning’ and ‘thinking’ to be roughly interchangeable.

Whereas the James-Lange theory makes it conceivable to separate emotional evaluation from a 'purely cognitive' form of judgement,[68] Dewey recognises this division to be artificial, and intellectual activities to be bound up with emotional engagement.[69] In our engagement with a situation of, say, being confronted by an angry bear, we undergo a dynamic coordination of bodily, behavioural and intellectual processes which involves the highly adapted *sensitivity* to the world that is enabled by the integration of internal bodily affect, such as an increased heart-rate and muscle-tension, into this recurrent circuit.[70] These 'vegetative-motor' activities form part of the reality of this holistic understanding-responding to the situation, out of which *purely* cognitive judgements, conceptualisations, decisions, memories – the stuff of traditional cognition – are but post-hoc abstractions.[71] For Dewey, the idea of a totally *unaffective intellectuality* has no basis in reality.[72]

For Dewey, there is no 'pure reason' totally abstracted from a felt emotional involvement with the world. One of the problems with traditional rationalism and empiricism was that they made this distinction, and hence could never explain "how a reason extraneous to experience could enter into helpful relation with concrete experiences".[73] Reason must be grounded in experience, and experience is "primarily a process of undergoing: a process of standing something; *of suffering and passion, of affection*", i.e. is inherently an emotional affair.[74] Therefore, for Dewey, cognition must be grounded in emotional engagement with the world.

Dewey resolves the tension between James' insight that emotion involves bodily affect and his incomplete dissolution of mind-body dualism. He does this by integrating emotional sensitivity into experience and cognition via the concept of dynamic coordination. This is made possible by transcending a purely mechanistic metaphysics, and by the unifying ideas of adaptivity to environment and autopoiesis at the heart of life. Emotion and cognition are intertwined aspects of the human organism's 'higher' adaptive activities, which enhance our capacity to maintain organic coherence.[75]

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[68] "In every art, in every science, there is the keen perception of certain relations being *right* or not, and there is the emotional flush and thrill consequent thereupon. And these are two things, not one." James, 'What Is An Emotion?', pp. 202–203

[69] On the importance to Dewey of sensitivity to significance in 'situations' see also: Dewey, J., *Logic: The Theory of Inquiry* (New York: Henry Holt &Co., 1938), pp. 60–80

[70] Dewey, 'The Theory of Emotion 1: Emotional Attitudes', pp. 559–561.

[71] Dewey, 'The Theory of Emotion 2: The Significance of Emotions', pp. 24–25

[72] "Does anyone suppose that, apart from our interpretation of values, there is one process in itself intellectual, and another process in itself emotional? I cannot even frame an idea of what is meant." *Ibid*., p. 21

[73] Dewey, 'The Need For a Recovery of Philosophy' in Talisse & Aikin, *The Pragmatism Reader*, p. 119

[74] *Ibid*., p. 112 (my italics)

[75] For Dewey, emotional 'attitudes' emerge originally as adaptive measures to aid survival, to serve organic coherence (Dewey, 'The Theory of Emotion 1: Emotional Attitudes', p. 555, 563, 568–569). This allows him to see emotional engagement to involve the coordination of sensori-motor and internal vegetative-motor activities 'adjusted so as to cooperate with one another to accomplish a single end' (Dewey, 'The Theory of Emotion 2: The Significance of Emotions', p. 25)

If we follow this line of reasoning, any artificial system that is to manifest human-like intelligence must integrate the processing of internal bodily states into its cognitive system in order to develop the appropriate level of emotional sensitivity to situations involved in intelligent action. This capacity is likely to have to occur through an adaptive process of development in an environment, rather than being constituted by pre-programmed responses. New evidence from cognitive science is providing support for these implications of Dewey's philosophy, and some are attempting to take seriously the challenge it presents to AI.

2.4. The integration of emotion and cognition

Some recent research in cognitive science supports the view that many capacities traditionally viewed as purely cognitive inherently involve emotional engagement. In particular, evidence from neuroscience is beginning to confirm a picture in which affective processing of internal bodily states forms a constitutive part of both sensori-motor coordination and 'higher' cognitive activities. Stapleton argues that for the study of embodied cognition to become 'properly embodied' it must go beyond the study of the body's 'gross morphological' interactions with the world, and incorporate this *interoceptive* information. This is largely the interaction between the nervous system and the internal body which enables the bodily affect involved in emotion.[76]

Recent neuroscientific evidence suggests that the 'motor areas' of the central nervous system form part of a loop (a 'homeostatic loop' – involved in maintaining biological functions) which incorporates information from internal bodily states, such that it is reasonable to see action as not merely the 'result' of bodily affect but as part of an ongoing cycle of information involving both the proprioceptive/kinaesthetic and the interoceptive.[77] In other words, the body's interaction with its spatial surroundings and its sensitivity to internal changes are mutually constitutive of the wider activity of organic homeostasis. This supports Dewey's picture of emotion and sensori-motor capacity as coordinated aspects adaptive engagement with the world, underpinned by biological autopoiesis. Also supportive of Dewey's more phenomenological description of the interdependence of affect, sensation and motor control, Damasio's recent research suggests that:

> "even very early on in the neural pathways we find that affective, perceptual and motor information are inseparably intertwined. Due to the non-linear and recurrent nature of the brain's pathways, such integrated channels of information feed into what we might have thought of as purely perceptual pathways, and this integrated information constrains what is then available for perception."[78]

Other research suggests that bodily affect is also dynamically involved in classically 'cognitive' processes such as memory, planning and attention. The amygdala, widely

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[76] Stapleton, 'Steps to a "Properly Embodied" Cognitive Science'

[77] See: *Ibid.*, pp. 13–14. Proprioceptive information is the sense of body location and kinaesthetic the sense of bodily movement.

[78] *Ibid.*, p. 21; see also: Damasio, A., *Self Comes To Mind* (London: Vintage, 2010), especially chapters 3–5

perceived as a key brain-centre for emotion, is one of the most highly connected regions of the brain. It is beginning to be thought of as hub projecting to, and receiving projections from, brain areas previously deemed to be purely 'cognitive'. It seems to be playing a role of directing attention based on the evaluation of 'biological significance'.[79] This enforces the idea that there is a dynamic circuit of information involving basic affective and homeostatic processes integrated into traditionally non-emotional types of thinking. Further, LeDoux's work on 'survival circuits' shows that memory, body feedback and central nervous system arousal, among other processes, feed into cognition, and support a "more adaptive picture of cognition" underpinning "flexible adaptive behaviour in an environment".[80] Evidence like this is becoming more mainstream in cognitive science and points to a picture of cognition and sensori-motor action as inherently bound up with bodily affect, and as likely to be essentially emotionally-laden. It is also easily compatible with Dewey's insights that such processes must be understood as part of adaptive and coordinated activities underpinned by the need to maintain organic coherence.

2.5. From embodied cognition to emotion-cognition in AI

Despite the focus on the body, embodied cognition, and its extension into AI, has for the most part not taken seriously the role of internal bodily affect in cognitive processes to the extent that the above analysis of Dewey's views, and the neuroscientific evidence cited, would suggest is necessary. But there are signs that this is changing in contemporary AI. The main challenges now are to construct systems sophisticated enough to replicate human emotion-cognition and the adaptive processes from which it develops.

As well the emphasis on the role of the body in the theory of enactive perception (see Section 2.2), a central feature of the embodied approach has been theories that ground meaning and abstract thought in body morphology. The embodied approach to cognitive semantics "investigates the emergence of "higher" cognitive processes from those involved in the sensori-motor processes of perception, object manipulation, and bodily movement".[81] This field has influenced research in AI, largely as an attempted solution to the 'symbol grounding' problem. The idea is that robotic systems can gain meaningful understanding by building concepts out of embodied interaction with objects, and this can provide a means of symbol-grounding.[82]

The conceptual architecture of the iCub robot combines these insights with the idea of learning through adaptive development. The iCub, which can name and interact with objects remarkably effectively, is a recent example of how successful the embodied approach to AI can be. Its neural network architecture integrates more than just exteroceptive sensory information (of the world beyond the body). It also incorporates proprioceptive and kinaesthetic information. This is a progressive step towards AI taking

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[79] Stapleton, 'Steps to a "Properly Embodied" Cognitive Science', pp. 22–24

[80] *Ibid.*, p. 25

[81] Johnson, 'Cognitive Science' in Shook & Margolis, *A Companion to Pragmatism*, p. 373

[82] See, for example: Harnad, S. 'Grounding Symbolic Capacity in Robotic Capacity' in Steels & Brooks, *The Artificial Life Route to Artificial Intelligence*, pp. 277–286, pp. 280–281

seriously the need for a more thorough embodiment of cognitive processing.[83]

Robotics projects such as ICEA ("Integrating Cognition, Emotion and Autonomy") are a sign that emotion is starting to be seen as a key challenge to AI. ICEA proceeded from the recognition that emotion "plays a crucial role in the constitution [of] higher-level cognitive processes" and hence that there is a need to replicate this if AI systems are to increase in sophistication.[84] Parisi, who has also attempted to produce robots whose behaviour develops by incorporating interoceptive information, has argued that the success of artificial systems at emulating natural intelligent agents depends upon the capacity of robotics to integrate this interoceptive capacity into other cognitive functions. To get the next step closer to thinking like humans, robots must reproduce "the internal physical structure of [a human's] body and the interactions of [its] nervous system with what lies inside the body".[85]

It doesn't seem to me that the addition of something like an 'emotion chip' to simulate emotional motivations will deal with the challenge of emotion satisfactorily.[86] The sheer complexity of the human capacity to develop appropriate behavioural responses to unpredictable and ever-changing physical and social environments requires that a replication of this intelligence matures through adaptive interactions between environment, bodily processes and 'higher' control systems, since emotional sensitivity enhances our intimate connectivity with significance in situations.[87] As demonstrated by the failure of the GOFAI attempts at producing effective robot mobility, the world gains meaning for us by our developing in it, it cannot be pre-programmed. Each situation is unique and must be dealt with in a situated fashion. A set of programmed responses to certain cues will not provide a sufficient basis for the replication of the full flexibility of intelligent human behaviour that is manifested through emotional sensitivity.

Conclusion

The embodied approach to modern AI/cognitive science shares key views with the philosophy of mind of classical pragmatism. I hope to have shown how these two schools of thought can be brought into greater collaboration. A central area of correlation is the motivation to understand the mind as grounded in the biological processes of living organisms. An assessment of some of Dewey's views suggests that this view of mind makes most sense when seen in terms of a metaphysics that allows for emergent autopoiesis, as opposed to a purely atomistic and mechanistic view of nature. Dewey sees human intelligence as involving a dynamic coordination of physiological and cerebral processes from which emerges sensori-motor action, experience, emotional sensitivity, cognition and so on. The close coordination and sophisticated co-integration of these aspects of body-mind is enabled by the human organism's highly complex

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[83] See: Stapleton, 'Steps to a "Properly Embodied" Cognitive Science', pp. 4–7; for a demonstration of the iCub's abilities see: Video: 'Learning the names of objects' by iTalkProject

[84] Ziemke, 'On the role of emotion in biological and robotic autonomy', p. 14; see also: Ziemke, T., *ICEA project profile Feb 2006*

[85] Parisi, D. (2004). 'Internal Robotics'. *Connection Science*. Vol. 16 (No. 4), pp. 325–338, p. 326

[86] Others agree: Stapleton, 'Steps to a "Properly Embodied" Cognitive Science', p. 18

[87] See also: Ziemke, 'On the role of emotion in biological and robotic autonomy', pp. 12–13

adaptive capacity, in response to the need to maintain organic structural coherence. Viewing the mind as a set of complex activities on a continuum with organic teleological organisation like this also allows for the possibility of naturalistic accounts of other characteristic aspects of human intelligence such as creativity, imagination, intentionality and autonomy. I have not considered these matters explicitly for want of space.

The picture of emotional engagement as inherently involved in cognitive activity that emerges from Dewey's views is supported by evidence from recent neuroscience. On this basis some in cognitive science are arguing that the internal bodily processes involved in emotion ought to be seen as integrated into cognition. The need to more thoroughly embody artificial cognitive systems by integrating bodily affect in this way is a main challenge facing the quest for human-like AI. Some recent projects have begun on this path, but it is likely that the complexity of the deep integration of bodily processes and cognitive faculties in human beings, and the highly adaptive processes by which emotion and intelligence develops, will prove complex to produce in AI.

Insofar as emotional engagement develops as an adaptive enhancement of sensitivity to situations, and is enabled by biological autopoiesis, it could be argued that the problem of creating emotion in AI rests on the problem of creating autopoiesis, of replicating the basic mechanisms of life. This is certainly suggested by my analysis of Dewey. Dewey saw biology as a necessary condition of emotion, and intelligence in general. The autopoietic nature of living organisms provides the grounding for dynamic coordination and the teleological nature of mind. Hence, we might infer from this that the quest for human-like AI is in-principle doomed to failure, insofar as robots are not naturally occurring autopoietic systems.

However, I think this may be too hasty a conclusion. Dewey was, of course, writing before the fields of AI, robotics or artificial life existed. Whereas Dewey saw biology as a necessary condition of mind, it *may* now be conceivable to think of it as only one possible precondition of it. His insights that human-intelligence-as-we-know-it was best understood as having grown out of biological adaptation and as ontologically continuous with our organic being can still be fruitful to research in AI. They imply that there should be a focus on manifesting adaptive capacities that enable a system to learn through interacting with its environment, and also on the production and integration of affective and homeostatic processes, such as those that ground emotional engagement. This will help enable artificial systems to develop the high level of contextual sensitivity to the world that is characteristic of human intelligence. I speculate that the challenge of emotional cognition in AI will be bound up with the success of architectures that instantiate basic functions similar to those of biology. The issue of to what extent 'artificial' systems must become like 'natural' ones in order to achieve this is an open question.

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