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A Continuum of Intentionality: linking biogenic and anthropogenic approaches to cognition

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Abstract

Biogenic approaches investigate cognition from the standpoint of evolutionary function, asking what cognition does for a living system and then looking for common principles and exhibitions of cognitive strategies in a vast array of living systems – non-neural to neural. One worry which arises for the biogenic approach is that it is overly permissive in terms of what it construes as cognition. In this paper I critically engage with a recent instance of this way of criticising biogenic approaches in order to clarify their theoretical commitments and prospects. Fred Adams (2018), who in his critique of the biogenic approach, provides a strict demarcation criterion that uses the presence of intentional states with conceptual-level representational content as a manner of picking out behaviour that is underwritten by cognitive processing. In this paper I propose to grant Adams' contention that intentionality is a mark of the cognitive, but I argue that this is compatible with endorsing he the biogenic approach. I argue that because cognitive science is not exclusively interested in behaviour driven by intentional states with the kind of content Adams demands, the biogenic approach's status as an approach to cognition is not called into question. I then go on to propose a novel view of intentionality whereby it is seen to exist along a continuum which increases or decreases in the degrees that behaviour is tied to representational content. Understanding intentionality as existing along a continuum allows biogenic approaches and anthropogenic approaches to investigate the same overarching capacity of cognition as expressed in its different forms positioned along the continuum of intentionality.

Introduction

One kind of starting point for investigating cognition begins by asking questions pitched at the kind of 'high-level' capacities paradigmatic of human cognition (e.g., beliefs, desires, concept formation, language, reasoning, conscious experience, etc.). This starting point then attempts to account for possible instances of them within an explanatory framework tailored specifically to those kinds of 'high level' capacities. From this *anthropogenic* starting point, human cognition is the standard against which all other forms of behaviour are recognized as a proper topic for cognitive scientific inquiry. Another kind of starting point, the *biogenic approach* (Lyon, 2006) begins investigating cognition from the evolutionary assumption that 'higher' cognition, like other biological capacities, has evolved from simpler cognitive (or cognition-like) capacities. Under the evolutionary assumption, cognition, like forms of breathing, may have evolved many times over the course of evolutionary history. The biogenic approach (BA) as such starts with biological facts and attempts to work its way up to human cognition. By widening the scope of model organisms under consideration to include organisms such as bacteria and plants as cognizers, proponents of BA suggest that it is well placed to identify possible unifying principles and conserved mechanisms underlying a full range of cognitive capacities, from simple to complex (see Lengler et al., 2000; Ben Jacob et al., 2006; van Duijn et al., 2007; Baluška & Mancuso 2009; Bechtel, 2014; Barrett, 2019; Calvo et al., 2020).

One worry which arises for BA is that it is overly permissive in terms of what it construes as *bona fide* cognition. The behaviour of bacteria and plants is something that philosophers have been prone to consider as inflexible, reflexive response to sensory stimuli (Dennett, 1984; Sterelny, 2001; Godfrey-Smith, 2002; Schlicht, 2018). If such behaviour under BA qualifies as an expression of cognition, then it seems—one might worry—that the very notion of cognition is rendered too unconstrained to be explanatorily useful. This kind of worry is voiced by Fred Adams (2018), who in a recent critique of BA responds by providing a strict demarcation criterion that allows for the drawing of a sharp line between the cognitive and the non-cognitive. This classification methodology, which is informed by traditional philosophy of cognitive science, uses the presence of intentional states with conceptual-level content as a manner of picking out behaviour that is underwritten by cognitive processing. Armed with this conception of the mark of the mental, Adams mounts an argument against BA: because the various cases of behaviour that biogenic theorists have classified as cognitive are not underwritten by intentional states with conceptual-level content, such cases of behaviour fail to be expressions of cognition and are more accurately classified as hardwired responses to sensory information processing. What I call Adams' 'argument from intentional content' goes on to conclude that this conflation is harmful to the endeavours of cognitive science and that BA should be abandoned as an approach to cognition. The general worry that BA is overly permissive relies on an implicit appeal to some mark of the cognitive. Adams is thus useful to engage with because he makes a rare attempt to explicitly spell out what this mark of the cognitive is, in a way that purports to be informed by the nature and methodology of cognitive science. Identifying the infelicities of Adams' critique gives us a better view of the explanatory tools that BA might have at its disposal, and the manner in which anthropogenic and biogenic approaches relate to each other. Is there, however, another classification methodology available that is compatible with the range of cognitive behaviours recognized by biogenic theorists, yet which nonetheless offers a manner of distinguishing the cognitive from the non-cognitive?

For the purposes of this paper, I propose to grant Adams' contention that intentionality is a mark of the cognitive, but I argue that this is nonetheless compatible with endorsing BA. I do so by proposing and arguing for the intentionality continuum thesis, a thesis that is informed by looking at the range of projects cognitive scientists actually spend their time doing. On one end of the taxonomy I present there is *weak intentionality* of the internal dynamics that causatively drive sensorimotor and biochemical behaviour. Meaningful content at the level of weak intentionality is, we shall see, phenotype-dependent and directed at sensory states that are to be pursued (or avoided) given the conditions which an agent must remain in in order to preserve its organization over the long run. On the other end there is *strong intentionality* which involves internal representations with conceptual content and possible phenomenological character that may be used offline. Intentionality is a necessary feature of cognition, but where a particular behaviour/state falls upon the continuum of intentionality is of no relevance to that behaviour's being (or not being) an expression of cognition. I shall argue Adams' anthropogenic-based hallmark of the cognitive looks arbitrary once we appreciate that the intentionality that interests cognitive scientists is not exhausted by intentional states with truth evaluable content. Given that contemporary cognitive science does indeed investigate and recognize putative cognitive phenomena and mechanisms that fall all along the continuum of intentionality, the manner in which Adams delineates cognitive processes from non-cognitive processes is undermined by the range of interests and aims of researchers in the very discipline which he attempts to safeguard. Understanding intentionality as existing along a continuum allows biogenic approaches *and* anthropogenic approaches to investigate the same overarching capacity of cognition as expressed in its different forms positioned along the continuum of intentionality. This continuum is promising not only as grounds for a reply to cognitive chauvinists who use an overly sophisticated notion of cognition, but because it illustrates that both biogenic and anthropogenic approaches are valid starting points for investigating a common notion of cognition.

This paper will proceed as follows: *Section 2*, provides an overview of BA. In *Section 3*, I present Adams' argument from intentional content against BA. In *Section 4*, after quickly surveying some of the practices and projects of contemporary cognitive science, I argue that because cognitive science is not exclusively interested in behaviour driven by intentional states with truth evaluable representational content, BA's status as an approach to cognition is not called into question in the way that Adams suggests. I then propose a novel view of intentionality whereby it is seen to exist along a continuum which increases or decreases in the degrees that behaviour is tied to representational content. I make use of some of the conceptual apparatus of the free energy framework to illustrate the kind of 'weak intentionality' that arises at the initial end of this continuum. This section concludes by returning to the worry that BA is overly permissive. I argue that the worry is defanged when it is recognized that there may be living systems that do instantiate weak intentionality and that cognition, even if widespread, takes many forms. This being said, sharpening the concepts that delineate the various forms of cognition that are located along the continuum of intentionality will be central to the continued progress of any biogenic approach to cognitive science.

2.0 The Biogenic approach

In her seminal paper 'The biogenic approach to cognition' Pamela Lyon (2006) identifies a particular investigatory strategy which she claims has been central to two distinct kinds of cognitive explanation: *self-organizing complex systems theories* and *autopoiesis*. The first of these kinds of explanation, examples of which may be seen in the work of Goodson (2003), Rosen (1985), Gibson (1979), Piaget (1970), Popper (1965/1972), Vertosick (2002), Christensen (2004), Bickhard (2009), and Deacon (2012), among others, places emphasis upon the relation between cognition and the second law of thermodynamics. More precisely, it sees cognition as a process that underwrites an organism's ability to remain in thermodynamically improbable (non-equilibrium) steady-states despite the tendency for all systems to move towards thermodynamic equilibrium. Homeostasis, the preservation of steady-states (e.g., physiological states such as oxygenation, core temperature, and metabolic energy levels), is an ongoing result of a dissipative system's ability to modulate its parameters (i.e., internal processes and external behaviour) so as to avoid persistence-compromising situations (e.g., starvation or predation).[1] Self-organizing complex systems theorists thus see cognition as the host of capacities, varying in their complexity, that guide a

[1] A dissipative system is a thermodynamically open system that, which in virtue of exchanging matter and energy with the environment, remains far from thermodynamic equilibrium.

system's parameter modulation so as to preserve its homeostatic balance and keep it at thermodynamic disequilibrium despite environmental perturbance.

In contrast, rather than understanding cognition in terms of thermodynamic regulation, autopoietic theory (Maturana 1970/1980; Maturana & Varela,1980; Thompson, 2007; Di Paolo, 2005) understands cognition in terms of a biological system's ability to continuously produce itself and distinguish itself from its milieu. Where *self-production* is the internally driven process whereby a biological system continuously constructs and realizes its own network of processes (Maturana and Varela, 1980).[2] Self-distinction is the process of generating and preserving systemic boundaries (e.g., a cell membrane) by which an organism partitions itself from its non-systemic environment. Self-production and self-distinction are construed as necessary and sufficient conditions on life. According to autopoietic theory, cognition is entailed by life, expressing a deep continuity between life and mind. In other words, "living systems are cognitive systems, and living as a process is a process of cognition" (Maturana & Varela, 1980, p. 13).[3] The overlap between self-organizing complex systems theory and autopoietic theory should be clear: both kinds of theory construe cognition *functionally,* as expressed in a set of adaptive behavioural capacities which underpin a biological system's ability to remain alive. Self-organizing complex systems theory emphasizes capacities to navigate energetically dynamic environments so as to self-preserve; autopoietic theory emphasizes the capacities leading to self-production of the organismic boundary that defines the autonomous organism in relation to its external environment.

This overlap is illustrative of the core explanatory strategy of BA; BA starts from the notion that cognition is a functional capacity that, being driven by various selection pressures, has been gradually selected for—perhaps many times—over evolutionary timescales. Thus, BA starts with the facts of biology in attempting to understand *what cognition does for biological systems*. This is clear when Lyon writes:

> "An investigator adopting a biogenic approach assumes that the principles of biological organization and the requirements of survival and reproduction present the most productive route to a general understanding of the principles of cognition. Cognition, whatever it may be in the future, is naturally a biological process and a biological function" (2006, p.12).

We saw above that BA may be contrasted with the anthropogenic approach (AA) (Lyon, 2006). This latter approach may be understood in terms of two related claims. The first claim is that the most fruitful starting point to the investigation of cognition is understanding human cognition. The second claim is one of demarcation: the cognitive is demarcated from the non-cognitive by using distinctively human capacities (e.g., believing, thinking, planning, decision making, reasoning, etc.) as the non-negotiable standard of cognition. The notion of

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[2] There are important disagreements between 'autopoietic theory' as propounded by Maturana and the enactive approaches developed by Varela, Thompson and Di Paolo. See Villalobos & Ward (2015).

[3] Although autopoietic theory is an example of a biogenic explanatory approach, it is not required that a biogenic approach be committed to the kind of entailment thesis (i.e., that life entails mind and mind entails life) that is central to autopoietic theory. The entailment thesis, for example, is not held by self-organizing complex systems theories.

cognition that these kinds of capacities and their putative mechanisms suggest is then used comparatively to determine whether or not the behaviour of non-human systems should be considered as expressive of cognition. With these two moves, AA works from the human case "downwards" to possible cases of non-human cognition (Lyon, 2006). Because of its human-centred demarcation criteria, AA generally assumes that the possession of a central nervous system, the use of representational states, and rationality are all central features of cognition.

In contrast, by seeing the evolutionary function of cognition as the proper starting point of investigation, the biogenic theorist may choose to investigate how that function is expressed in humans as well as in bacteria depending upon the investigators interests. As such, BA's proponents argue that since it recognizes human cognition as being a determinate of a larger determinable category 'cognition', the biogenic perspective allows for a more complete picture of what cognition does for living systems and how various cognitive phenomena are related despite being selected in by different evolutionary pressures. Lyon writes:

> "It is important to stress that the two approaches are not mutually exclusive, indeed, both are necessary for a complete picture. We must understand what cognition is and what it does as a natural phenomenon, but we also have to understand human psychological experience" (2006, p. 26).

Here, Lyon makes it explicit that the two approaches to investigating cognition are complementary; investigating what cognition does for biological systems will ultimately include investigating how it does what it does in the human case. That being said, there is a tension between AA's demarcation criterion and BA's biological starting point. For BA, many genuine instances of cognition may take a very different form than that of human cognition. It is due to their more restrictive conception of cognition that an AA theorist may attempt to dismiss the broader set of non-human-like capacities that BA recognizes as instances of cognition as something else. As will be seen in the next section, it is just this kind of charge that Fred Adams foists against BA.

3.0 The Argument from Intentional Content

Adams (2018), on behalf of AA, has recently raised an objection against BA. Appealing to the interests and practices of contemporary cognitive science, he argues that the term "cognition" when used by cognitive scientists. Hence, thinks Adams, attending to cognitive scientific practice shows that we should prefer AA to BA. In line with a venerable trend in philosophy of cognitive science (Fodor, 1990; Dretske, 1981), Adams's general anthropogenic classification methodology distinguishes cognition from non-cognition by holding that the former is a kind of processing that necessarily involves internal representational states with intentionality. Intentionality, the "aboutness" of mental states to be directed at the world was originally proposed by Brentano (1874/1995) as the mark of the mental. In other words, "all and only mental phenomena exhibit intentionality" (Schlicht, 2018, p. 8). These intentional states, Adams contends, take the format of representations with conceptual-level content, the meaning of which is determined by states of affairs in the world that they are about. Adams writes:

> "[…] cognition requires specific kinds of representational formats. And these formats are built on top of information processes. The symbols that are cognitive are built from information exchanged between system and environment. But the format of these representations is *semantic* at a level above that of the information itself" (Adams, 2018, p. 24; my emphasis).

It is only when intentional states with conceptual-level (i.e., semantic) content operate on sensory representations (i.e., sensory information states) that the resulting behaviour can truly be said to be cognitively driven.[4] Adams's clarifies this format distinction between meaning-bearing representations with conceptual-level content and sensory representations when, referring to his own work and that of Dretske (1981/1998) he writes:

> "But conceptual representations are different kinds of representations than sensory ones. The change from information to meaning (where the content of a concept is its meaning) involves changes in the format of representation" (Adams, 2018. 28).

And again

> "I am suggesting that cognition is this kind of information processing which alters the representational format to a different level—to the level of meaning and not just information" (Adams, 2018. 28).

To get an idea of the kind of representational format that he argues underwrites genuine cognition, Adams offers an example. If a person senses that the temperature of a room is increasing, whether or not she is aware of it, she also senses the increasing mean molecular kinetic energy (mmke) of the air surrounding her. However, if she thinks that the room's temperature is increasing, she needn't think that the mmke of the surrounding air is also increasing. This example demonstrates that although thoughts, beliefs, desires, and other representations with intentional content may be about the same referent (in this case a target event), thinking one kind of thought (distinguished by its meaning) about a referent does not entail thinking all corollary thoughts about the same referent. Although sensory information processing may involve representations, such representations fail to have the right format, on Adams' construal, and thus they never to rise to the level of meaning.[5]

In contrast to the deployment of intentional states with conceptual-level content, Adam claims that what BA calls 'cognition' is mere information processing of sensory states which

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[4] The mere deployment of representations with intentional content without resulting behaviour (e.g., thinking, reasoning, etc.) or in the absence of sensory information states would also qualify as cognitive according to Adams.

[5] The distinction between what Adams calls sensory representations and representations with intentionality may be interpreted as being analogous to Grice's (1957) distinction between "natural meaning" and "non-natural meaning". Natural meaning is indication-based. For example, smoke indicates fire, but smoke is not *about* fire in the sense that one cannot intelligibly speak about the presence of smoke in the absence of fire as something that is 'false'. Non-natural meaning, on the other hand, rises to the level of semantics. For example, that the word "water" means "tasteless, odourless, colourless liquid" makes it the case that the proposition "water is black and tastes like tar" is false.

results in hardwired, adaptive behaviour. Although cognitive and non-cognitive processes both involve information processing and adaptive behaviour, the kind of adaptive behaviour that is driven by mere sensory information (in a sensory format) alone does not rise to status of being cognitive behaviour. It is because what biogenic theorists refer to as cognition is actually "information-driven behaviour that is adjusted in response to variable environmental conditions" (Adams, 2018, p.27), that biogenic plant scientists and biologists erroneously categorize the adaptive behaviour of organisms such as plants and bacteria as cognition-driven processes. When biogenic theorists claim that plants and bacteria exhibit cognitive capacities what they are really doing is changing the subject altogether from cognition to something else. For in such cases "there are no internal states that mean (in the sense of having truth values) things outside the system" (Adams, 2018, p.29). Adams concludes that because intentionality is a distinctive characteristic of the cognitive and this is something which BA by ascribing cognition to plants and bacteria fails to respect, biogenic researchers are in the practice of investigating something very different than what cognitive science recognizes as cognition.

I will now respond to this argument by providing another classification methodology for distinguishing the cognitive from the non-cognitive, one which is compatible with the range of cognitive behaviours that BA recognizes.

4.0 Responding to the Argument from Intentional Content

It may be assumed that Adams's primary reason for locating cognition at the level of intentional states with semantic content is based upon his view of what cognitive science recognizes as cognition.[6] If biogenic theorists when ascribing cognition to bacteria and plants are using "cognition" to mean something other than processing that reaches the level of intentional states with conceptual-level content "then no one in current cognitive science would be alarmed" (Adams, 2018, p.28). However, if such theorists are not ascribing cognitive capacities to plants and bacteria instrumentally and actually "intend the cognitive ascriptions to be true, then it is not harmless" (Adams, 2018, p.29). I will now demonstrate that proponents of BA can both agree with Adams that intentionality is a distinct feature of the cognitive and yet consistently reject the claim that intentionality must be of the kind that Adams requires of cognition. More specifically, using a classification methodology that both takes what cognitive scientists actually do as its lead, I shall propose a view of intentionality that conceives it as a continuum, ranging from weak to strong intentionality. Because cognitive science investigates and recognizes cognitive phenomena all along the continuum and not just at the level of strong intentionality where Adams restrictively locates cognition, his argument against BA turns out to be ill-motivated. In locating cognition exclusively at the level of strong intentionality, Adams disregards the range of research that cognitive scientists have engaged in over the course of the last 40 years. I begin with an initial response that considers some of the current practices of cognitive science. I shall then intentionality continuum thesis as a primary response to Adams' argument from intentionality and more

[6] To be clear, Adams is in agreement with Lyon, who when setting out what she identifies as the core anthropogenic principles (i.e., the core principles of contemporary cognitive science), claims that intentionality is a distinctive feature of cognition according to AA. BA principles as put forth by Lyon do not include intentionality. Interestingly, if the continuum that I propose below is correct then Lyon has overlooked intentionality as a necessary feature of cognition that is common to BA and AA.

generally as a ground for rejecting the kind of cognitive chauvinism that Adams' argument is representative of.

4.1 The Practices of Current Cognitive Science

Does cognitive science recognize and investigate only those phenomena that are underwritten by intentional states in the form of beliefs and desires with concepts as their constituents? While there is plenty of cognitive science that is aimed at investigating phenomena at the level of Adams' strong intentionality, it appears that there is plenty that is not. A wide range of cognitive scientific research programmes such as action-blindsight research (Kentridge, Heywood & Weiskranz, 1999), two visual streams research (Milner and Goodale, 1992), 4E cognition (i.e., enactive, embedded, embodied and situated cognition) (Clark, 1997/2008; Chemero, 2009; Beer 2000; Thompson, 2007; O'Regan, 1992; Lakoff & Johnson, 1980; Kirsh, 2010), action-oriented cognition (Jeannerod, 2006; Cisek & Kalaska, 2010; Engel, Maye, Kurthen, & König, 2013; Pezzulo, 2011; Tversky, 2019), and dynamic systems accounts (Thelen & Smith, 1994; Beer, 2000; Kelso, 2016; Newell & Liu, 2012)–to name a few–investigate and explain psychological processes in ways that do not essentially implicate states with conceptual-level contents. This is not to deny that much of cognitive science is focused upon phenomena at the level of strong intentionality. What I am arguing however is that cognitive science *does not exclusively* investigate phenomena at the level of strong intentionality. The existence of each of these many programmes demonstrates that cognitive science recognizes and investigates processes that do not exclusively involve conceptual representations. To take an example, the core of embodied cognition is based upon the claim that a complete understanding of cognition requires understanding the various constitutive roles that the sensorimotor systems play in not only conceptualization (see Lakoff and Johnson, 1980) but also how we respond to environmental changes and solve problems in the here and now (Clark, 2008). A classic example of this is the ecological solution to the baseball outfielder problem in which by moving so as to keep a flyball's position steady in one's field of view—staying coupled to it via sensorimotor engagement—one is able to adjust one's movement's in light of the ball's perceptible trajectory and eventually catch it (McBeath et al., 1995).[7] The kind of conceptual-level representation that Adams' argues is definitive of intentionality is rendered superfluous by this simple solution to the problem of how to catch a fly ball.

More generally, the kind of cognitive science which has emerged in the last 40 years has recognized a problem space that calls for the use of cognitive strategies not limited to detached planning, abstract thought, and conceptualization. The agreed problem space of cognitive science has been widened to include problems that arise on faster timescales. Attempting to address these problems has motivated many researchers to abandon the kind of traditional "sandwich" model of cognition that Adams uses (i.e., where cognition is conceived of as a process occurring sandwiched between perceiving and acting).[8] Many of the problems in this wider problem space may be efficiently solved by eliciting frugal and fast solutions of environmentally coupled perception and action loops (Clark, 2008). This is not to say (radically) that all solutions required within this widened problem space involve

[7] For different theoretical perspectives regarding this process see McLeod, Reed & Dienes, (2006) on optical acceleration cancelation and see McBeath, Shaffer & Kaiser, (1995) on linear optical trajectory.
[8] It was Susan Hurley (1998) who coined the term "sandwich model".

the coupling of an organism to the environment *via* action and perception, but rather that there are various kinds of cognitive strategies that may be deployed given the nature of the problems which organisms are faced with.

Adams' argument from intentionality would like to conclude that BA is untenable and is harmful to cognitive science because it conflates actual cognition with mere sensory information processing. However, if one takes into account the range of research programmes that have been developing over the last 40 years (i.e., what cognitive scientists have actually been investigating and how the field is developing), his claim about what "cognition" means to cognitive science is simply not true (any more). Adams hence fails to provide a valid reason to reject BA as *cognitive* explanatory framework. This being said, the argument from intentionality does however provided an opportunity to demonstrate just how BA and AA are linked across a continuum of intentionality. Disagreeing with Adams about BA doesn't entail rejecting the idea that intentionality is a distinctive feature of cognition. It does, however, require understanding more about the relationship between the kind of conceptual-level intentionality Adams emphasises and what is implicated in the self-organising/autopoietic dynamics of BA.

In the next subsection I will develop the intentionality continuum thesis and argue that when taking it into account, demarcating the cognitive from non-cognitive by way of an intentionality criterion fails to be consideration against BA. If the intentionality continuum thesis is correct, BA and AA merely lie upon two poles on the continuum, separated by the degree of intentionality involved in the kinds of cognitive phenomena they investigate. I will now introduce the crucial notion of weak intentionality that underlies all degrees of intentionality on the continuum and is a common thread in the two BA explanations previously canvased in Section 2.

4.2 The Intentionality Continuum Thesis: weak intentionality

On one end of the intentionality continuum is what I call *weak intentionality*. I shall define this as the phenotype-relative aboutness of internal dynamics directed at target objects/environmental state changes (e.g., gradients) which causally underpin adaptive behaviour. Such dynamics are meaningful insofar as they guide an organism's interactions with its relevant environment or *Umwelt* (von Uexküll, 1957), allowing it to remain in the select set of physiological (viable) states that are defined by its it's its phenotype.[9] Importantly, although these dynamics allow homeostatic maintenance, they are not reducible to the kind of closed loop feedback control involved in maintenance of homeostatic states. Much like what the autopoietic theorists have called "basic intentionality" (Thompson, 2007; Schlicht, 2018), weak intentionality is a feature of the entire organism and its behaviour rather than a feature of cognitive states or underlying mechanisms. It is a property of an organism's integrated internal dynamics that is *causatively manifested in sensorimotor and biochemical behaviour*. Given the integrated nature of these dynamics, not just any

[9] Similar to the notion of meaning underwriting J.J. Gibson's (1966/1979) ecological notion of *affordances* (i.e., perceivable organism-relative opportunities for action that the environment offers) the meaning expressed in weak intentional content is not something that may be divorced from either the (anticipated) structure of the environment or the (anticipated) states of the biological system.

behavioural response counts as weak-intentionality-driven. In order to qualify as such behaviour must be directed at having higher-order homeostatic influence; an organism invests its current short-term homeostatic stability (i.e., metabolic resources) for anticipated long-term homeostatic stability brought about as a result of that investment. In some organisms, this will be manifest as overt behaviour, exerting a direct influence upon its surrounds (e.g., spending metabolic resources now in cutting timber and building a fire to avoid freezing over the night). In other organisms, this higher-order influence may take the form of metabolically expensive investments in gene transcription in preparation for yet-to-be-encountered stress conditions (see below for an example).

One primary distinction between autopoietic basic intentionality and weak intentionality is that where the former may be understood as non-representational, the latter is representational but in an undemanding way.[10] Representation at the level of weak intentionality is compatible with the idea that biological systems detect rich environmental information to perceive their surrounds and direct their behaviour (Gibson, 1966, 1979; Michaels & Carello, 1980). This is because the function of these representations is not to mediate an organism's epistemic contact with the world or to be accurate proxies of their target states but rather to *poise* the entire biological system for adaptive interaction with meaningful aspects of its environment. The upshot of this poise is that an organism's integrated sensorimotor (and biochemical) behaviour is continuously driven towards anticipated outcomes brought about by that very behaviour (e.g., chemical gradient increases that specify food). These outcomes reflect the conditions under which that kind of organism can successfully continue to both preserve itself under selective pressures. In other words, the poising representational activity at the level of weak intentionality—when all goes well—may be inaccurate but nonetheless deliver satisficing results in the form of survival.

Representation at the level of weak intentionality may be conceptualized in terms of two different content-related aspects: weak intentional content is both future-oriented and action-oriented. Content is *future-oriented* in that it is anticipatory of environmental and sensory state changes which would occur were *such and such* a behaviour initiated given current environmental states. These future-oriented dynamics are tantamount to the occasioning of *subpersonal predictions* that (via sensorimotor or biochemical behaviour) mandate the temporary alteration of homeostatic equilibrium *now* (action) in order to avoid anticipated irrecoverable deviation from homeostatic equilibrium *later*.[11] Such predictions arise in virtue of the fact that living systems embody a model of itself and its environment; because all living systems that exist are the result of an evolutionary history of organism-environment interactions, any existing organism's anatomy, physiology and behaviour has been 'tuned' to its environment, capturing the very conditions under which it can metabolically function (i.e., its viable state range). These conditions take the form of stable expectations that are the standard against which all environmental perturbation is measured; they govern both when and how a system compensates for possibly damaging deviation from the evolutionary norms they capture. Future-oriented content allows some systems to act before deviation from the norms it embodies has occurred.

[10] Weak intentionality, as I am developing the notion, does not however suggest the correctness of what Schlicht (2018) has called the equivalence thesis. The equivalence thesis states that mental representations and intentionality are equivalent notions, both referring to property of mental states to be about states of affairs in the world (See Schlicht, 2018). The intentionality continuum that I am sketching is consistent with the possibility that there may be a different kind of intentionality that lacks representational content.

[11] For example, expending a lot of precious metabolic energy now (i.e., swimming as fast as you can to reach the shore) is a temporary deviation that might allow one to avoid being eating by hungry shark.

For example, after detecting decreasing levels of its preferred nutrient (glucose) in its environmental medium, some strains of wild yeast, *S. cerevisiae*, begin the metabolically expensive process of galactose utilization pathway induction, allowing them to catabolize galactose in preparation for *eventual* glucose depletion (Wang et al., 2015).[12] One manner of understanding this phenomenon is that the internal dynamics that facilitate galactose utilization pathway induction are modified in part by the yeast's sensitivity to a tendency in the structure of its environmental medium (i.e., decreases in glucose concentration specify the eventual exhaustion of glucose). This modification biases the system to behave anticipatorily, acting not solely with respect to its short-term homeostatic maintenance and the sensory/environmental states that it is currently detecting (which otherwise might be considered a mere reflex) but with respect to its homeostasis over the long-run and the sensory states that it is likely to encounter given the kind of model it embodies (i.e., the kind of organism it is).[13] Given that *S. cerevisiae* has the stable expectation "I am always in a nutrient rich environment", it will behave in ways that make its soon-to-be-encountered environment fit this expectation by inducing the galactose pathway. This expectation is a state of the whole organism, manifesting itself in a higher-order homeostatic influence.

The fact that content is future-oriented exposes a further important fact: weak intentional content has a degree of independence from the influences of the environment. This degree of independence frees behaviour from being fully determined by the current states of the encountered environment; it opens up a space for a kind of primitive agency and motivation; rather than being "pushed around" by sensory stimuli, an agent's behaviour is normatively constrained by maintaining certain long-term homeostatic steady-states that its persistence depends upon.

Relatedly, representational content at the level of weak intentionality is *action-oriented* (Clark & Toribio, 1994; Clark, 1997; Tschantz, 2020); it does not merely describe environmental/sensory states but imperatively guides action so as to bring preferred environmental/sensory states about. The descriptive content of the internal dynamics that cause the galactose utilization pathway to be induced may be something like "there will be an absence of local glucose in the near future, given the decreasing gradients of local glucose currently and in the immediate/near past"; the imperative content may be "start inducing the galactose utilization pathway now!". [14] One characteristic of this action-oriented aspect of representational content that is particular to the level of weak intentionality is that it is action

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[12] Wang et al. (2015), write: "We now have shown that low or decreasing levels of a preferred nutrient can serve as a predictive cue for eventual depletion. Since this is inevitable when cells deplete a mixture of nutrients at unequal rates, and mixed-nutrient environments are ubiquitous in nature, environmental anticipation may be a more widespread regulatory strategy than previously recognized" (p.16).

[13] An important difference between sensorimotor (or biochemical) behaviour driven by weak intentional content and mere reflex is that the former necessarily has a degree of flexibility whereas the latter may be reducible to homeostatic control loops. Reflex control loops drive responses to stimuli in virtue of sensory deviations from genetically encoded, 'expected' setpoints (i.e., *constant* predictions that describe a limited range of values that states can take and remain conducive to the viability of the system). (See Pezzulo et al., 2015). Flexible behaviour on the other hand (minimally) requires a level protracted (i.e., longer timescale) systemic integration of sensory pathway information on the part of the behaving system, allowing for context sensitive anticipatory response to future global changes in that system's external and internal environment. Thus, future-oriented, weak intentionality-driven behaviour is 'for' homeostatic maintenance but is not itself homeostatic maintenance.

[14] Misrepresentation in this example may be understood as a case in which the induction of the galactose pathway occurs due to a small decrease in the sensed glucose concentration despite the overall tendency of the environment to be glucose abundant.

guaranteeing. In other words, where there is weak intentional content, action follows as a result.

This notion of weak intentionality is implicated in BA. Recall that in both autopoietic theory and self-organizing complex systems theory cognition is conceptualized functionally in terms of those adaptive behavioural capacities underwriting a system's viability maintenance. In order for behaviour to be adaptive it must be *constrained* in ways that are adequate to the viability of the kind of living system in question. It is only by being so constrained that behaviour qualifies as cognitively driven. The answer to the important question of "what constrains behaviour in ways that makes it adaptive for a particular system?" exposes how weak intentionally is implicated in BA. In self-organized complex system theory, it is in virtue of a system's embodying an anticipatory model of itself and its environment (i.e., the states that define it physiologically) (Rosen, 1985/2012; Goodson, 2001) that its adaptive behaviour is appropriately constrained.[15]

In autopoietic theory, the same important question may be approached from a different angle by asking: "how does a system distinguish autopoietic-relevant from autopoietic-irrelevant objects/environmental state changes that it should interact with?". Because the domain of autopoietic-relevant objects/environmental states that one interacts with *is* the "domain of the cognitive" (Maturana, 1980), answering this question addresses the question of what constrains cognitively driven behaviour. According to autopoietic theory, a system's adaptive (and hence cognitively driven behaviour) is constrained by its organization. Organization may be understood as the stable dynamics of a system that define it as the system it is and which, unlike its physical structure, cannot change without the system's ceasing to be. Adaptive behaviour, according to both self-organizing complex systems theory and autopoietic theory, is thus constrained by the subset of a system's internal dynamics (i.e., its model or its organization) that capture the kinds of objects/environmental state changes that are relevant to its continued survival. It should be clear by this point how weak intentionality is related to this account of cognition: weak intentionality follows from the fact that the activity of models and/or systemic organization are directed at phenotype-friendly environmental conditions that behaviour is geared towards bringing about; adaptive behaviour in BA is constrained by internal dynamics that, in virtue of their capturing phenotypic norms, are endowed with weak intentionality.

An illustrative and worked out example of the kind of weak-intentionality-endowed internal dynamics in place in BA is provided by the free energy framework (Friston, 2010, 2012; Friston & Stephan, 2007) and its notion of *generative models*. The free energy framework is a powerful unifying cognitive framework in neuroscience and biophysics, in which both life and cognition (e.g., action, perception and learning) are explained in terms of the same fundamental imperative to minimize free energy. Free energy is an information theoretic quantity that is the difference between the sensory states that are expected to be frequented (given an organism's generative model) and the sensory states that it actually observes. A generative model is a network of statistical 'beliefs' that are captured by an organism's internal dynamics and which encode the limited range of sensory states that it is most likely to encounter relative to its phenotype. Such models are entailed by both the continuous (subpersonal) prediction of sensory states that any phenotype-specific organism should

[15] For a self-organizing complex systems theory account of anticipatory cognition that rejects internal anticipatory models in favour of models that are physically embodied in a system's dynamics see (Riegler, 2001).

expect itself to be in (e.g., a fish should continuously embody predictions that it is in water rather than on land if it is to survive) and the actions which it engages into bring out those sensory states. It is by bringing about the environmental causes of its own preferred sensory states that a biological system reduces the difference between the phenotypic norms embodied by its generative model and the sensory states it observes. Weak intentionality in this context is none other than the phenotype-relative aboutness of the predictions engendered by the generative model that constrain free energy minimizing behaviour. It is because an organism and its behaviour entail the kind of generative model that it does that the predictions answering to that generative model have the organism-relative, biologically normative content that they do.

4.3 From Weak Intentionality to Strong Intentionality

On the opposite end of the intentionality continuum, I would like to suggest is the kind of intentionality that Adams identifies as a distinctive feature of cognition. Strong intentionality may be characterized as the *aboutness of mental states* rather than the aboutness of behaviour-driving internal dynamics of the organism. It is at this level of intentionality that representations with conceptual-level content (e.g., beliefs, desires, thought, etc.) arise that may be (but does not need to be) causally independent from the environmental states which an organism is currently encountering. For example, one can have a belief that “black widows are poisonous” and have access to one’s own belief “I believe that black widows are poisonous” despite the fact that there are no black widows present. What is distinctive about this notion of aboutness at the level of strong intentionality is that fact that its effects upon maintaining homeostasis occurs at slower timescales.[16] Having the belief that “black widows are poisonous” whilst living in (location removed for blind review) is valuable to one’s adaptive behaviour even when such spiders are not native to (location removed for blind review). For having such a belief could make the difference between careful and careless behaviour were one to encounter (and recognize) a black widow when visiting Los Angeles. In contrast, recall that weak intentionality is directed at environmental/sensory states that guide behaviour in the here and now. The effects of weak intentionality driven behaviour upon maintaining homeostasis occurs at faster timescales (e.g., the aboutness of an E. coli’s prediction that “there will be an increase in glucose concentration in THAT direction” is something that results in its immediately reducing the frequency of its tumbling behaviour and bringing its actual sensory states in line with its expectations of observing nutrients rich sensory states). It is because the aboutness of mental states may operate over increasingly longer timescales, influencing both other mental states and actions, that it endows living systems with the ability to cope with the more variability in their niches and hence to deal with more variability their environment.

Content at the level of strong intentionality may be generated offline and (at least in principle) fully insensitive to the influences of environmental stimuli, thus serving to both control and select a range of future actions (i.e., policies) in virtue of representing action outcomes over longer timescales. This naturally places those living systems that have evolutionarily developed the capacity to engender mental states in the advantageous position

[16] Strictly speaking, although this is one thing that’s distinctive about strong intentionality, self-evidencing over increasingly longer timescales is a gradual property, a dimension along which the continuum runs.

of using aboutness to engage in counterfactual reasoning (e.g., if I locked myself out of my flat, I would execute *such and such* a course of action to re-enter). It is important to impress that although all content across the continuum of intentionality is future-oriented, it is only at the level of strong intentionality that content may come apart from causally bringing about behaviour. And as such intentional content at this level may be relevant to a range of different behaviours across varying timescales despite an agent never actually having to initiate any one of those behaviours (see Sterelny, 2003 for a similar emphasis upon the relationship between what I am calling strong intentionality and content relevant to a range of behaviour).

I would like to suggest that since weak and strong intentionality are located at opposite ends of a continuum, there is no sharp cut-off between them. Moreover, strong intentionality may be seen as grounded in the same anticipation-driven, self-preserving processes that underwrite weak intentionality. That weak intentionality shades off into strong intentionality does not imply that the former does not play a role in underwriting the latter. To the contrary, without the kind of weak intentionality that drives adaptive behaviour at shorter timescales, it would seem that strong intentionality could not arise. Consistent with BA's evolutionary assumption that 'higher' cognition, has evolved from simpler cognitive capacities, strong intentionality may be seen as an evolutionary achievement. I suggest that BA should construe strong intentionality as a variable trait that was *built upon a foundation of weak intentionality* and selected in because it allowed complex organisms to respond to selective pressures across progressively longer timescales and environments with more complexity.

One may reasonably speculate that the arrival of strong intentionality and the biological hardware underpinning it on the biological scene was closely linked to the fact that meeting selective pressures placed new requirements on organisms as they began to inhabit environments with more complexity (or their niches grew in complexity). One such requirement may have been being able to understand causal relationships without requiring that the agent itself be the cause. Intentional content that could be generated and monitored without entailing any behaviour at all, by allowing an agent to influence long-timescale dynamics and efficiently influence and predict other agents' behaviour made complex environments less hostile. The conditions underpinning the transition from lesser to increased environmental-organismal complexity might very well be a matter of what Sterelny (2003) describes as move from inhabiting "informationally transparent environments" (i.e., environments in which there are one-to-one mappings between sensory cues and environmental resources) to inhabiting "informationally translucent environments" (i.e., environments in which there are many-to-one or one-to-many mappings of sensory cues to resources).[17]

Strong intentionality and the conceptual representations that often accompany it, as I am envisioning them, allow organisms to exert influence upon the protracted and often informationally ambiguous environmental dynamics that are specific to complex environments. They allow such organisms to utilize control states (i.e., conceptual-level representations) that become further and further removed from influencing and the influence of current environmental states. On the other hand, when simpler organisms are able to meet the selection pressures in their lesser complex environments, using conceptual representations that are suited to long-timescale environmental dynamics to guide behaviour in the here and

[17] Importantly, Sterelny suggests that the increased complexity of informationally translucent environments is partly due to presence of hostile agents (i.e., prey, predators, and competitors) which pollute environmental information for a given agent via the subversion that agent's efforts or concealment. This induces the possibility of false negatives, making the obtaining of resources expensive.

now falls short of being an adaptive strategy. For too much organismic (i.e., model) complexity (relative to the level of environmental complexity that 'satisfices' for self-preservation) renders an organism's responses inefficient, slow and often detrimental to its survival. This illustrates what is known in the free energy framework literature as the model-accuracy vs model complexity trade-off (FitzGerald, Dolan & Friston, 2014). Although this may be the case, a continuum of intentionality helps to illustrate how responding to shorter timescale dynamics and less complexity nonetheless involves behaviour that is driven by weak intentionality; behaviour that is driven by future-oriented and action-oriented representations which recapitulates the normativity intrinsic to an organism's phenotype-relative internal dynamics (i.e., generative model/organization).

We can therefore agree with Adams that conceptual representations are distinct from sensory representation while rejecting that only conceptual representations demarcate the domain of the cognitive. As one moves from weak to strong intentionality, the content and the kinds of representations change from having content that is directed at target objects/gradients causally underpinning sensorimotor behaviour to having content that can be directed at one's own mental states (e.g., a belief about one's own belief – that it is false). As one moves along the continuum from weak to strong intentionality, there is also a move from representations that are behaviour entailing and influenced (but not fully) by impinging sensory stimuli to personal to representations that are behaviour contingent and possibly *stimulus insensitive* (i.e., content being immune to the influenced the impinging sensory stimuli) (Author, 2019a). As the continuum approaches stimulus insensitive representation, agents acquire the capacity to shift from behaviourally exploiting their environment to exploring their environment with no goal other than to reduce the complexity of their models through epistemic foraging (see figure1).[18]

[18] A further manner of understanding this transition across the continuum—at least along part of the continuum—is as a passage from minimal perception to 'maximal' perception, such that one moves from content that is about changes in meaningful gradient intensity to content that is about the sources of the gradients (i.e., objects). For a detailed account of minimal perception see (Author 2019b).

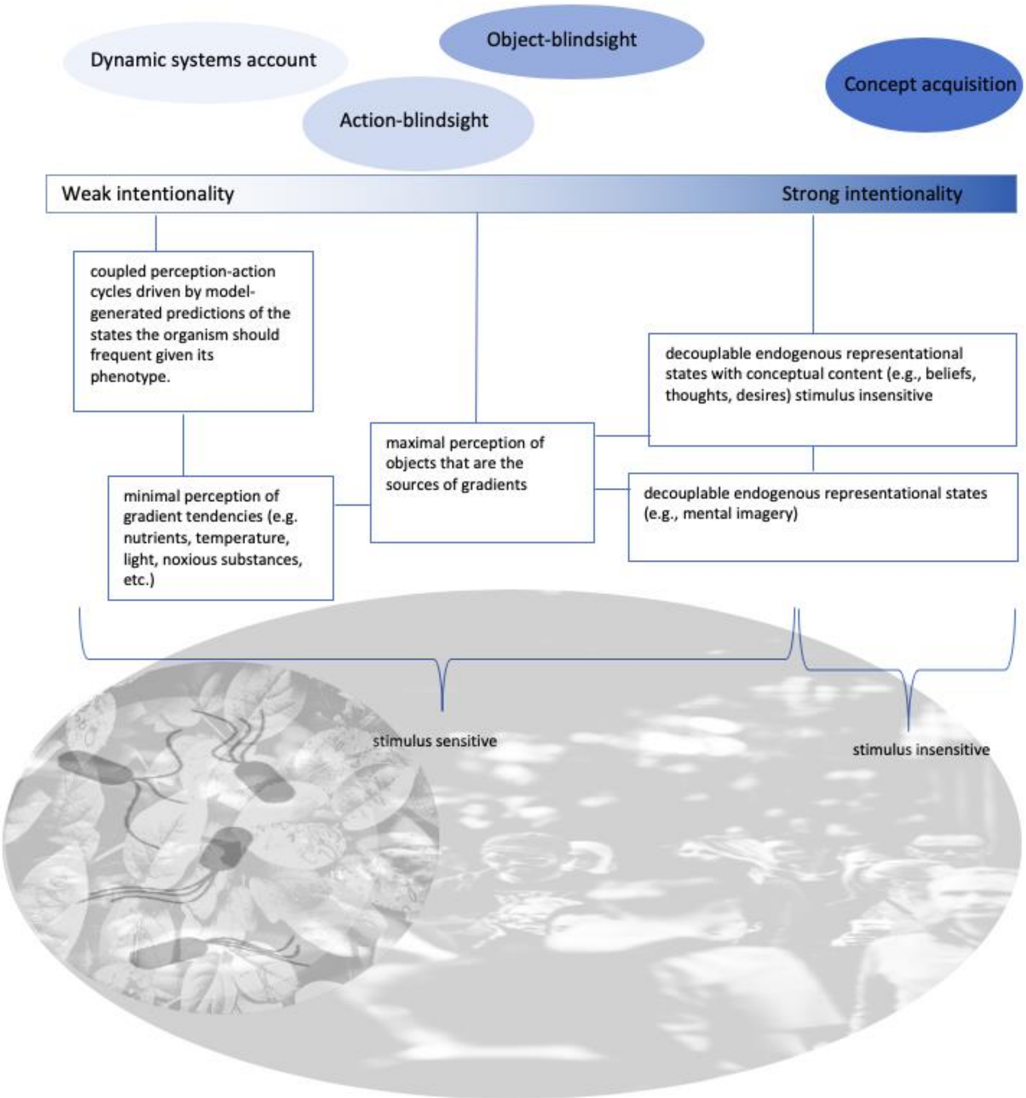

Figure 1. A continuum of intentionality: *above* are some of the various research programmes which might be seen to investigate forms of cognitive phenomena associated with a particular degree of intentionality; *below* are some of the primary attributes of representational content as they are located at various places upon the continuum and capacities associated with them.

4.4 Overly Permissive or Not?

The initial worry which set the stage for Adams' classification methodology and its upshot, the argument from intentionality, was that BA is overly permissive. Now given what has been said regarding the intentionality continuum, is there any reason for thinking that this worry has been defanged? One may still be concerned that if the behaviour of all organisms is driven by weak intentionality and intentionality more generally is the mark of the mental, then the behaviour of all organisms is driven by cognition. If this is correct, then BA is still too liberal and thus has little explanatory currency. However, from what has been proposed above, there is no reason to think that weak intentionality is something which drives the behaviour of all living systems. If there are living systems which fail the capacity for higher-order homeostatic influence, then such systems are not driven by weak intentionality; they are mere reactors to their environment. The extent to which weak intentionality is a widespread feature of living systems is an empirical question that cannot be answered from the safety of an armchair.

Given that evolution has endowed various forms of life with different (yet related) forms of cognition, the onus is placed upon the biogenic theorist to sharpen the concepts that delineate various forms of cognition (see for example van Duijn et. al., (2007) who develop one notion of minimal cognition; di Primio, et al., (2000) for a different notion of minimal cognition; Calvo & Friston (2017) who develop the hypothesis of plant predictive processing from within the free energy framework). Part of this work, if the intentionality continuum thesis is on track, will include identifying the differences in the processes and mechanisms that map on to these various forms. These evolutionary "transition markers" in cognition may be fuzzy, but this should only be expected given that biology is itself a fuzzy matter.[19]

Conclusion

From the perspective of BA, a complete investigation of cognition does not involve relinquishing AA full stop, but rather rejecting the notion that all forms of cognition must satisfy human-based demarcation criteria. If what I have argued in this paper is correct, weak intentionality may serve as a common feature of cognition for both BA and AA; a feature that in ensuring that both approaches are not talking past one another, allows for the possibility of a complete investigation of cognition in its various expressions and degrees of complexity. As such, both BA and AA are valid starting points for investigating the related assortment of capacities that drive adaptive behaviour at various timescales. Whether or not a scientist starts with human capacities or with the weak-intentionality-driven behaviour of simple living systems depends largely upon her/his explanatory interests. The intentionality continuum thesis offers a coherent manner of bringing these starting points together. Far from being harmful to cognitive scientific enquiry, as Adams suggests, a rich biogenic programme offers a peek inside the possible evolutionary development of the predictive brain by way of its noncentralized predecessors.

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[19] The term "transition marker" is taken from Ginsburg and Jablonka (2019), who define it as "a diagnostic feature of an evolutionary teleological transition" (p. 227).

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Figure

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