Mind in Life and Life in Mind

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Guiding questions

- How is life related to mind and mind related to life?
- What is the place of the living body in an understanding of mind?

Outline

- Stage setting
- Enactive propositions
- Relation to the sensorimotor contingency theory
- Cognition and emotion
- Relation to the extended cognition thesis
- Is life necessary for mind?
- Boundary issues (internalism vs externalism)
- The problem of consciousness

Traditional view in cognitive science

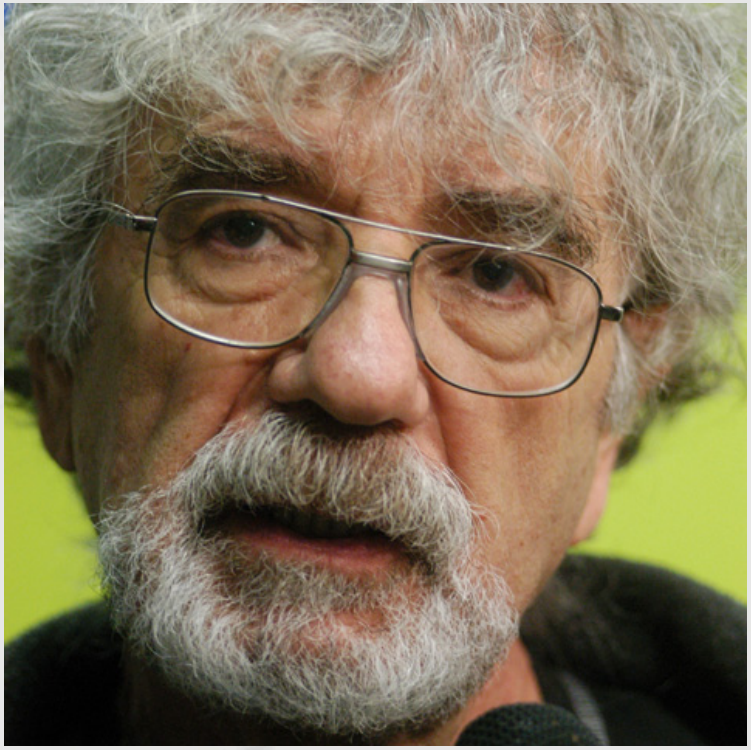
- Life is not necessary for mind and mind is not necessary for life:
- There can be living systems that aren't cognitive systems (all organisms without nervous systems of sufficient complexity).
- There can be cognitive systems that aren't living systems (AI systems, robots).

Life-mind continuity thesis

- Any living system is ipso facto a cognitive system (life is sufficient for mind).
- What makes a system living and therefore cognitive is its autonomous (circular) organization.
- Understanding cognition requires understanding the principles of biological autonomy.

Classic statement

"A cognitive system is a system whose organization defines a domain of interactions in which it can act with relevance to the maintenance of itself, and the process of cognition is the actual (inductive) acting or behaving in this domain. Living systems are cognitive systems, and living as a process is a process of cognition. This statement is valid for all organisms, with and without a nervous system" (Maturana 1970)



Varela's version

"Living is sense-making" (Varela1984, 1991, 1997)

Strong life-mind continuity

- Life "prefigures" mind:
  - life is sufficient for mind (mind is necessary for life)
  - any living system is at least a proto-cognitive system
- Mind "belongs" to life:
  - life is necessary for mind (mind is sufficient for life)

Classic statement

"A philosophy of life comprises the philosophy of the organism and the philosophy of mind. This is itself a first proposition of the philosophy of life, in fact its hypothesis, which it must make good in the course of its execution. For the statement of scope expresses no less than the contention that that the organic even in its lowest forms prefigures mind, and that mind even on its highest reaches remains part of the organic" (Jonas 1966).

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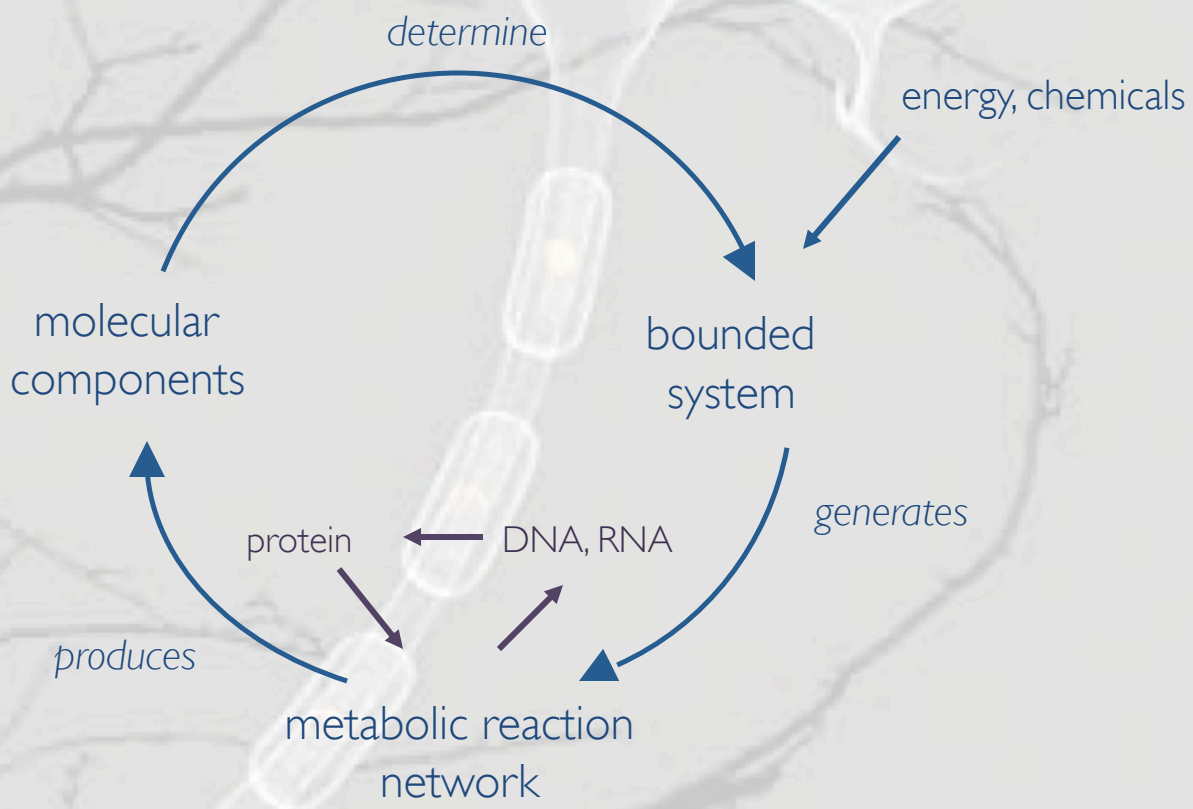
Enactive propositions

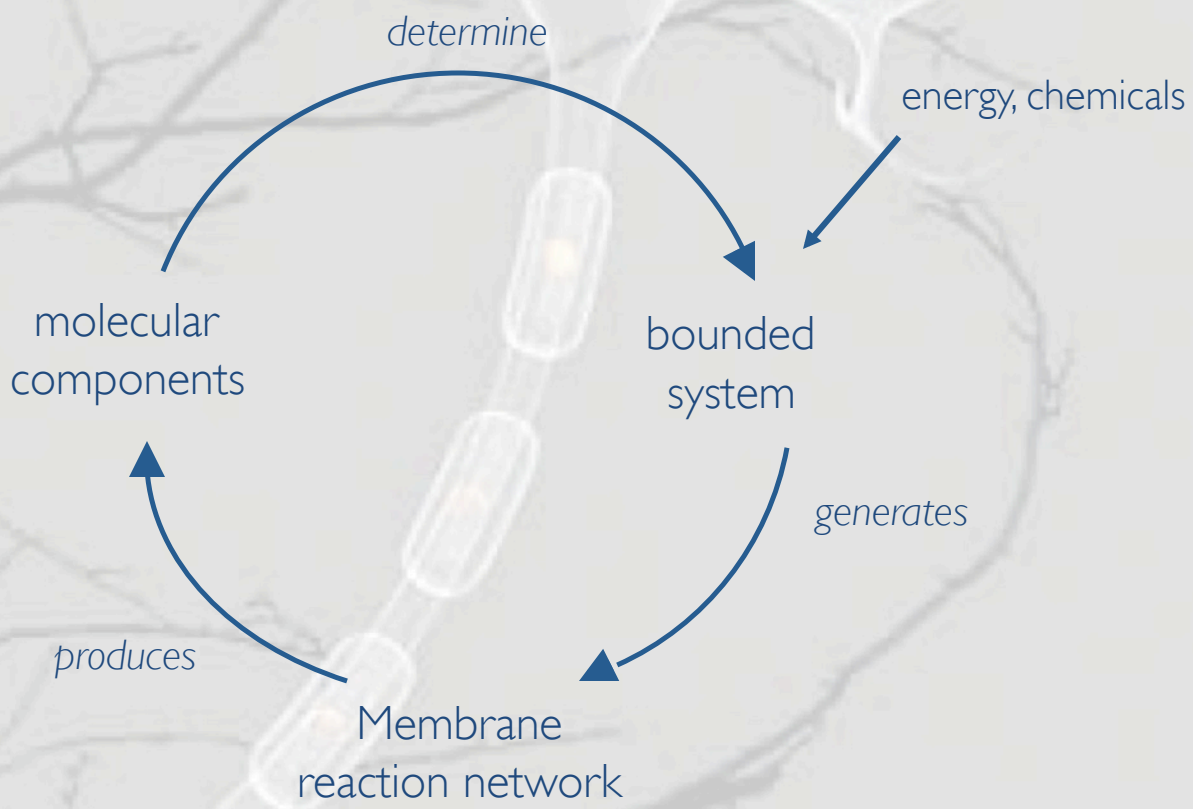
1. Autopoiesis and adaptivity are individually necessary and jointly sufficient for life.

Autopoiesis



Maturana & Varela 1980

Minimal autopoiesis (no adaptivity)



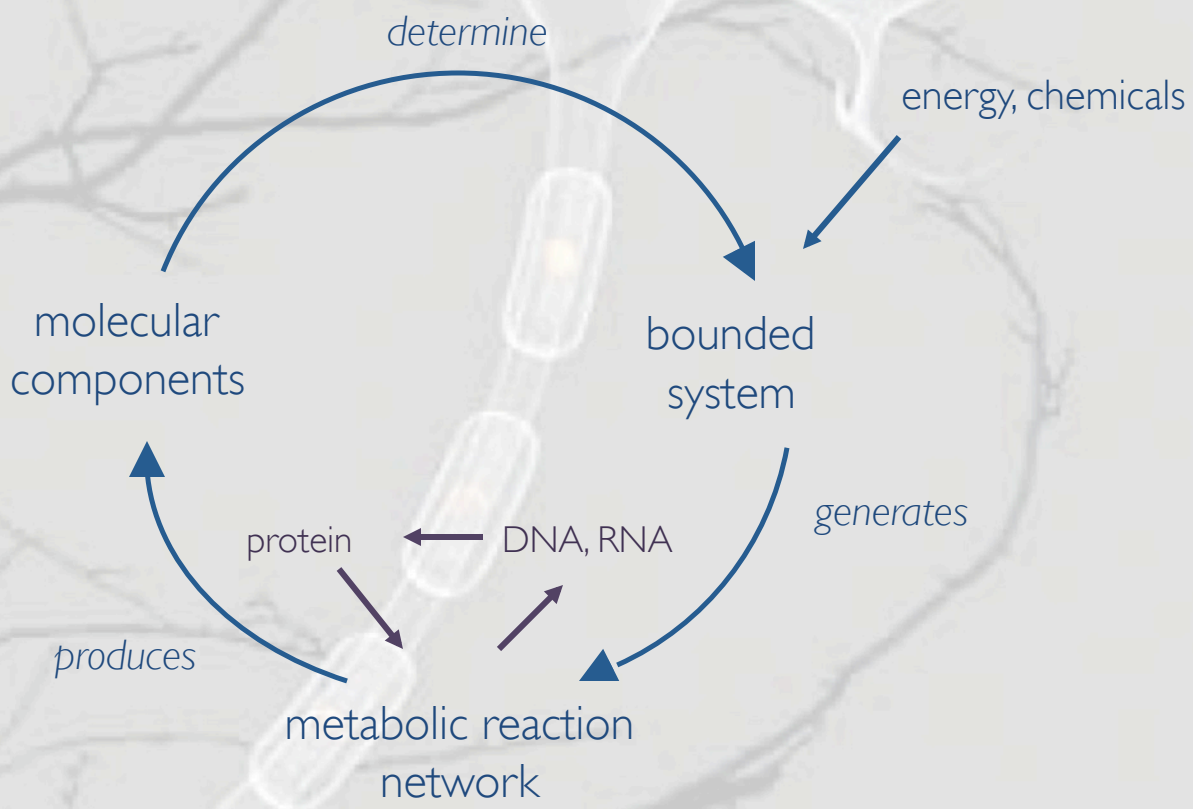
Bachman et al. 1992; Bourgine & Stewart 2004

Adaptivity

- An autopoietic system's capacity to regulate its states and its relation to the environment, such that:
  - tendencies to approach the system's *viability boundary* (beyond which the system loses autopoiesis) are distinguished from tendencies to recede from this boundary, and
  - tendencies to approach the viability boundary are transformed into tendencies to move away from this boundary.

Di Paolo 2005

Canonical autopoiesis (with adaptivity)



Maturana & Varela 1980

Enactive propositions

2. Autopoiesis is the paradigm case of autonomy—the best understood and minimal case of an autonomous organization.

Autonomy

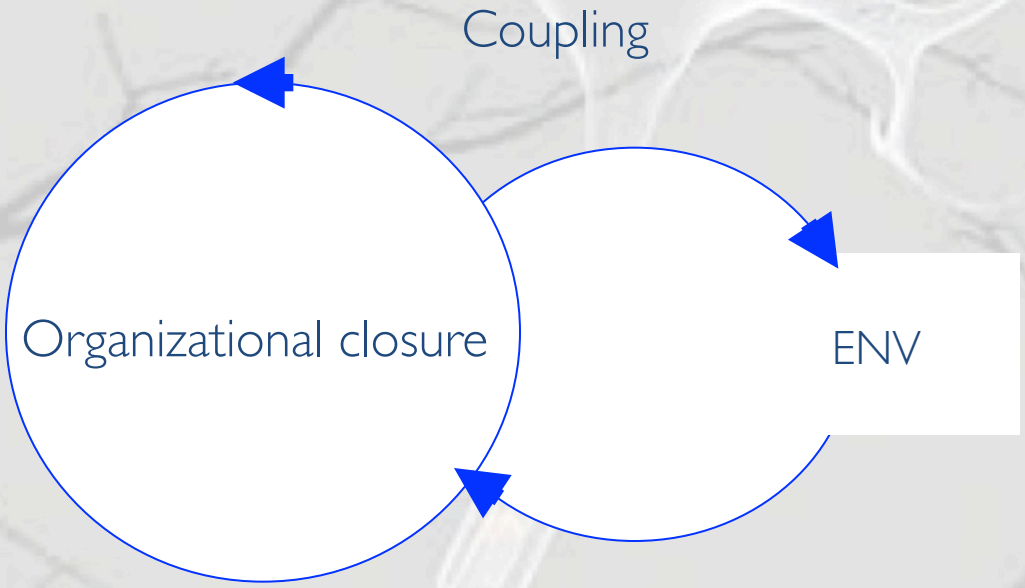
- A system is autonomous when it has organizational closure, i.e., its constituent processes
  - recursively depend on each other for their generation and realization as a network;
  - constitute the system as a unity in whatever domain they exist (e.g., biochemical, neuronal, behavioural).
- Thus the enabling conditions for any network process always include other processes in the network, and the result of any network process is always the modulation or production of another process in the network.

Varela 1979

Autonomy

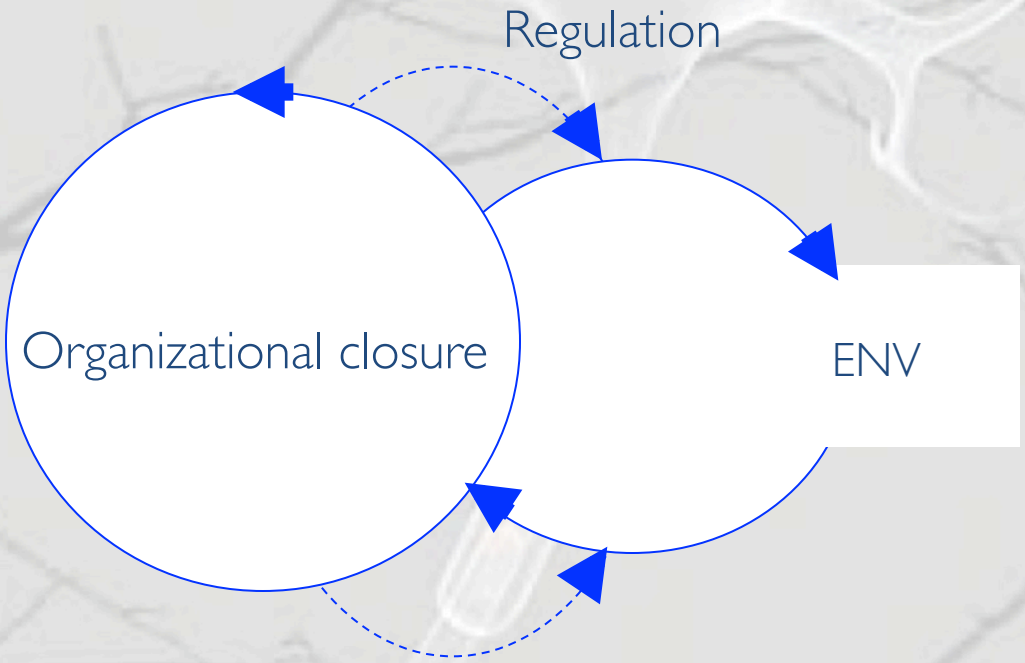
- An autonomous system is self-specifying—it brings forth or enacts a self/non-self distinction in precarious conditions.

Autonomy as self-specifying



Adapted from Froese & Di Paolo 2011

Autonomy and adaptivity



Adapted from Froese & Di Paolo 2011

Enactive propositions

3. Autonomy and adaptivity are individually necessary and jointly sufficient for agency and sense-making.

Agency

- Individuality (system must define its own individuality)
- Interactional asymmetry (system must be the active source of activity in relation to its environment)
- Normativity (system must regulate its activity in relation to norms)

Barandiaran, Di Paolo & Rohde 2009

Sense-making

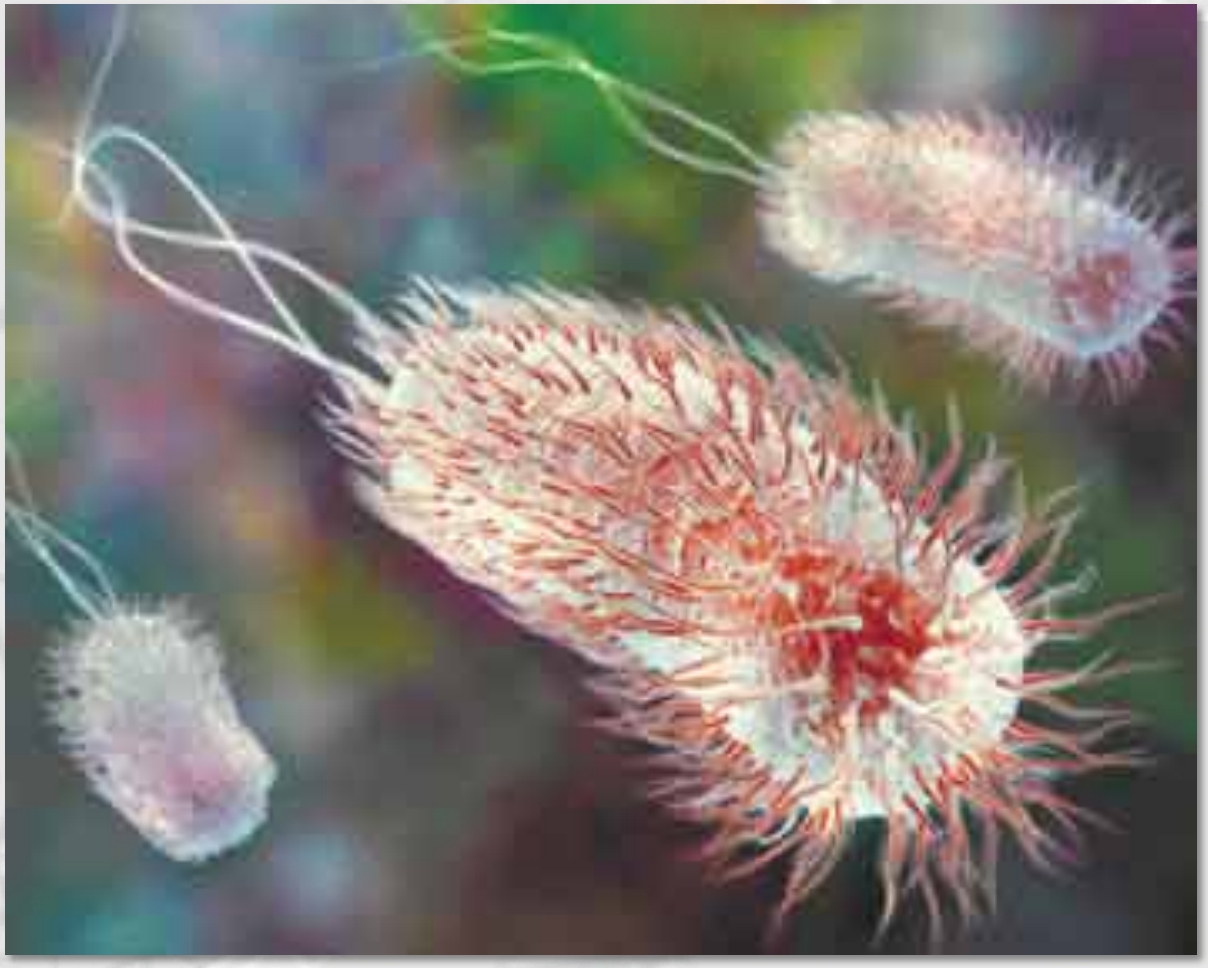
- The enactment of a meaningful world by the system:
- In generating its own individuality and regulating it according to norms, an adaptive autonomous system makes sense out of its encounters; it constitutes a perspective from which the encounters acquire significance.
- The environment thereby becomes a place of significance and valence—a world (*Umwelt*).

Varela 1984, 1991, 1997

Enactive propositions

4. Living (autopoiesis & adaptivity) is sense-making in precarious conditions.

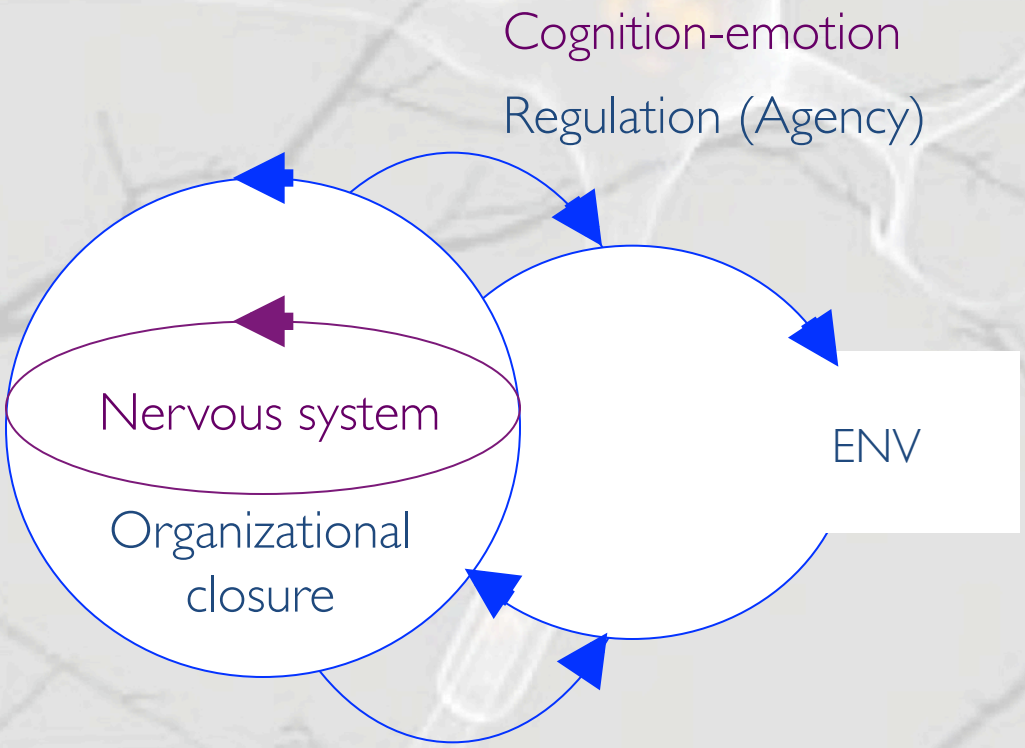
Bacterial (autopioetic) agency and sense-making



Enactive propositions

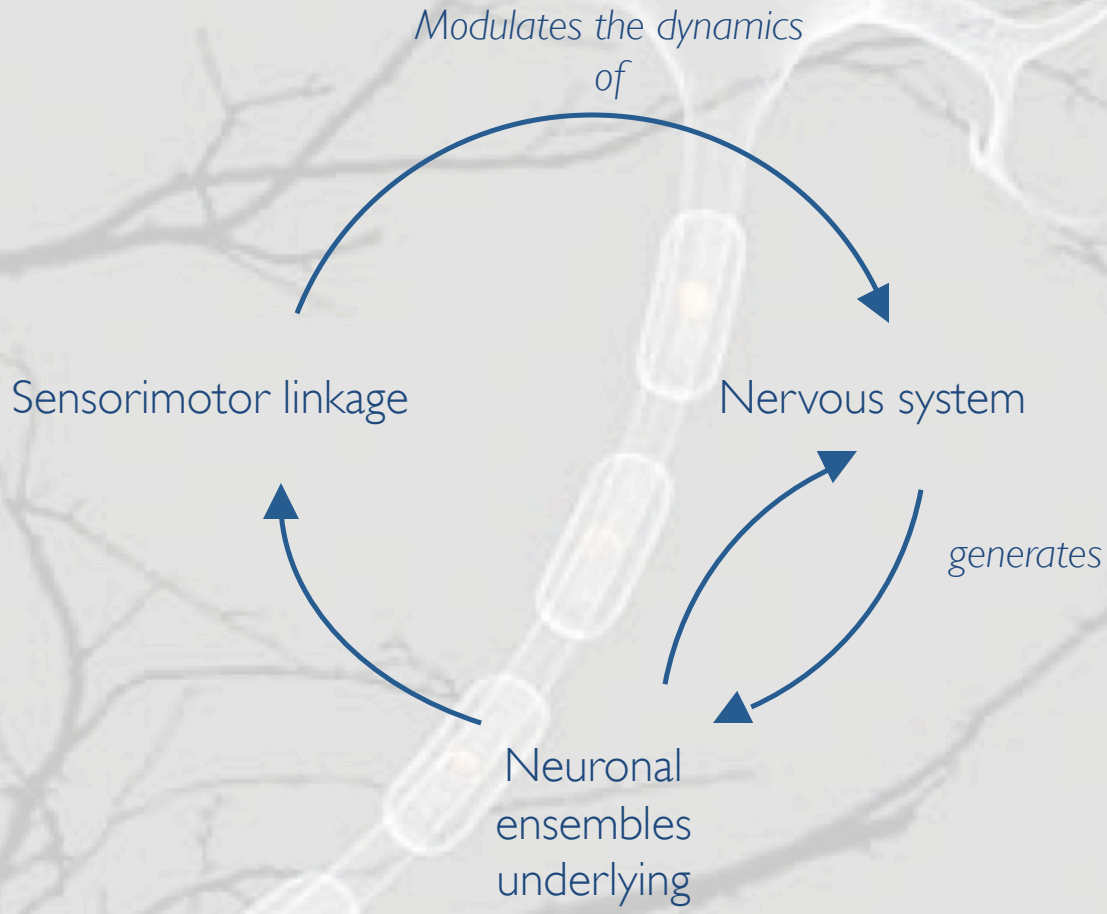
4. Cognition—being directed toward objects as unities-in-manifolds of appearance with spatial (foreground-background) and temporal (past-present-future) horizons—is a kind of sense-making linked to movement and the nervous system.

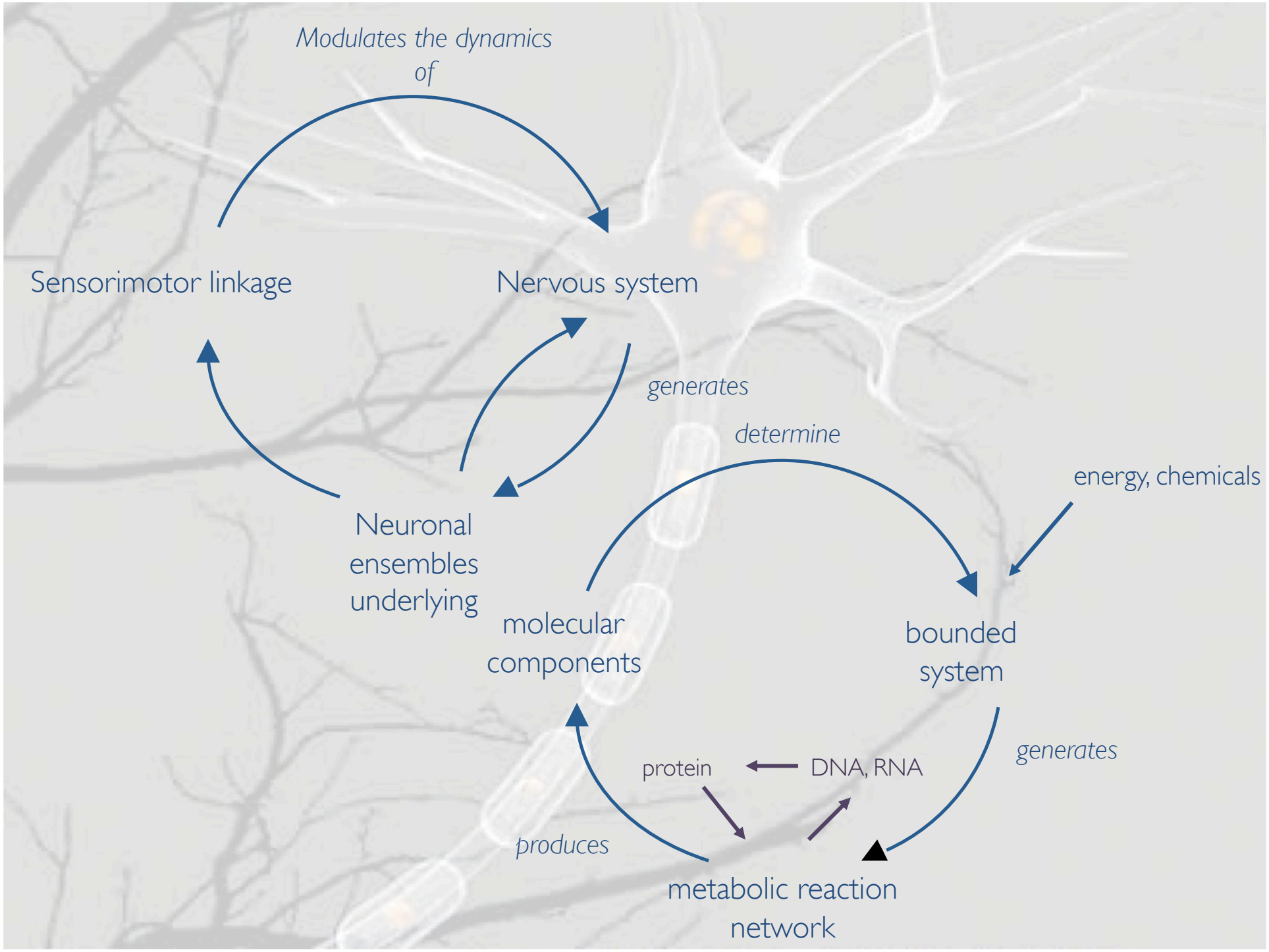
The Nervous System



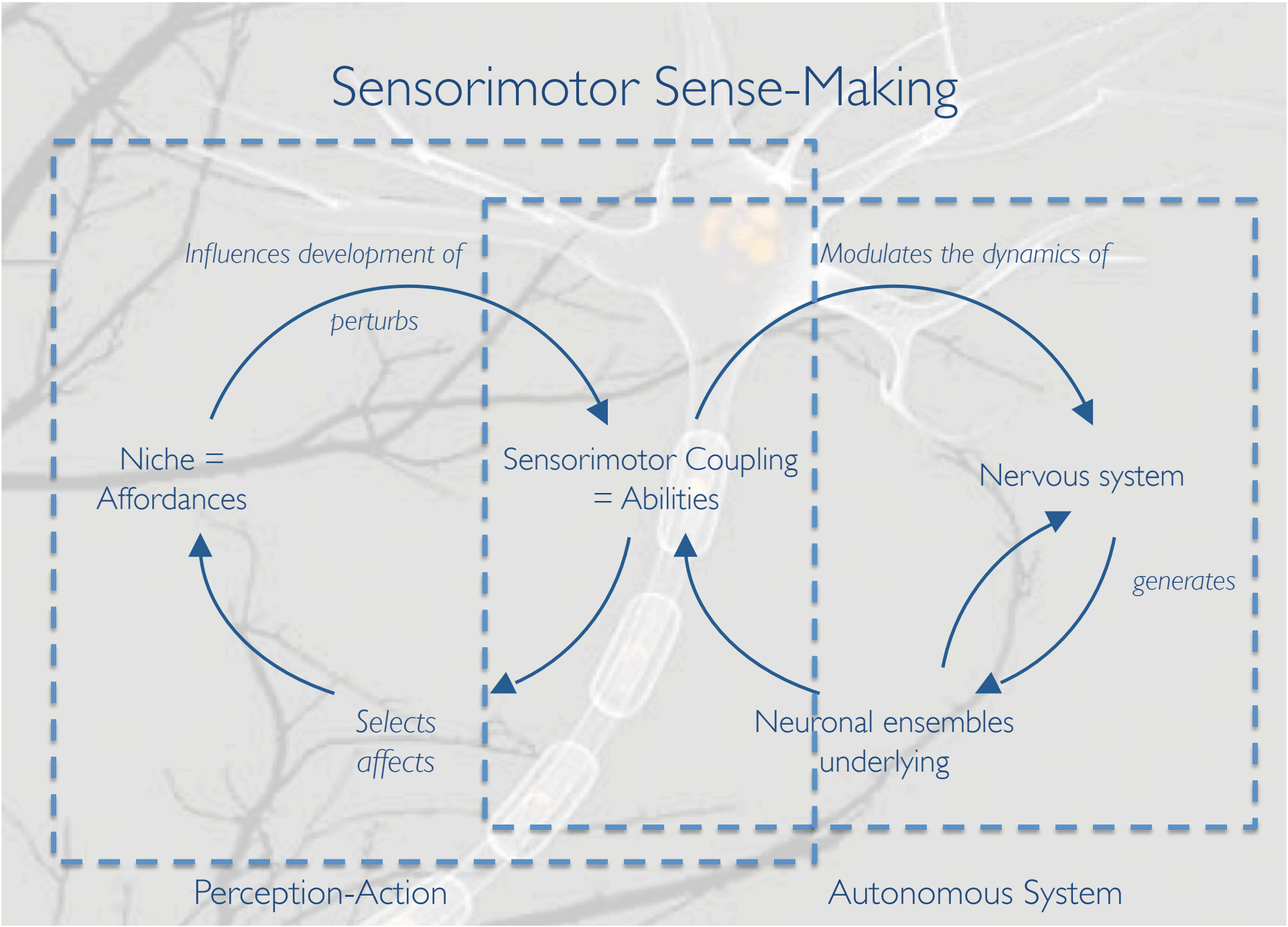
Adapted from Di Paolo

The Nervous System




Modulates the dynamics of
Sensorimotor linkage
Nervous system
generates
determine
energy, chemicals
Neuronal ensembles underlying
molecular components
bounded system
generates
protein
DNA, RNA
produces
metabolic reaction network

Sensorimotor Sense-Making



Adapted from Chemero

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Relation to the SM contingency theory

- The enactive approach and the SMCT are compatible (though individual theorists may diverge on particular issues).
- Nevertheless, from the enactive perspective, the SMCT lacks a proper theoretical grounding.

Thompson 2005, 2007

Relation to the SM contingency theory

Enactive critique:

- The SMCT lacks a proper account of agency and action.
- There is no genuine sensorimotor knowledge and exercise of such knowledge in action unless the system is a sense-making agent, and this requires the system to be adaptively autonomous (have an autonomous organization with adaptivity) – a missile guidance system (O'Regan & Noë 2001) is not an autonomous agent (and hence has no SM mastery).
- The SMCT needs an enactive foundation.

Thompson 2005, 2007

Link to dynamical neuroscience

- The nervous system as an autonomous system both shapes and is shaped by sensorimotor processes.
- Sense-making and SM knowledge (mastery of SM contingencies) depend on large-scale brain integration via oscillatory rhythms and synchrony (arising endogenously and occuring far from sensors and effectors).

Engel et al. 2001; Varela et al. 2001

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Cognition and emotion

- Sense-making is viable conduct in relation to what has significance and valence—what attracts or repels, elicits approach or avoidance.
- Motivated action tendencies and affect regulation constitute animal sense-making as much as cognition (attention, appraisal, deliberation, planning).

Cognition and emotion

- Appraisal and emotion processes are thoroughly interdependent at psychological and neural levels.
- At the psychological level, they form an integrated and self-organizing emotion-appraisal state ("emotional interpretation")
- At the neural level, appraisal and emotion cannot be mapped onto separate brain systems.

Lewis 2005

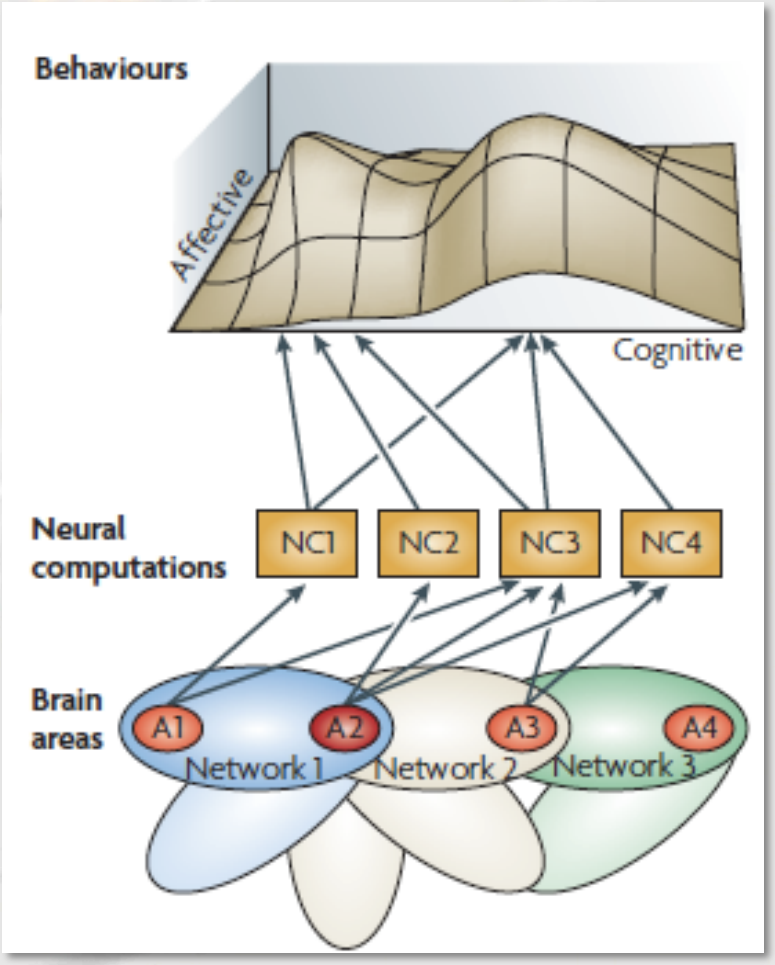
Cognition and emotion

- Brain regions previously viewed as "affective" are also involved in cognition.
- Brain regions previously viewed as "cognitive" are also involved in emotion.
- The neural processes subserving emotion and cognition are integrated and non-modular with respect to each other.

Pessoa 2008

Cognition and emotion

"Complex cognitive-emotional behaviours have their basis in dynamic coalitions of networks of brain areas, none of which should be conceptualized as specifically affective or cognitive" (Pessoa 2008, 148).



Pessoa 2008

Cognition and emotion

- From the enactive perspective, cognition as sense-making is fundamentally a matter of adaptive self-regulation in precarious conditions, not abstract problem-solving.
- The narrow cognition of problem-solving presupposes the broader emotive cognition of sense-making [cf. relevance and the frame problem].

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The enactive view

- Cognition as emotive sense-making implies that cognition is not body neutral:
  - The body strongly shapes how and what an organism cognizes.
  - There is no clearly definable interface between strictly cognitive processes and extracognitive (e.g., somatic) processes.

The body and the EC thesis

- The cognitive role of the body is exhausted by its playing a certain functional role in an problem-solving organization that extend across brain, body, and world.
- It is merely a contingent fact that the body is living in the sense of being a metabolic system.

Clark 2008a, 2008b

Enactive criticisms

- The cognitive role of the body nowhere includes emotion.
- Cognition extends to include the sensorimotor body (characterized in functional/computational terms), but remains compartmentalized in relation to the physiological (metabolic) body of emotion.

Enactive criticisms

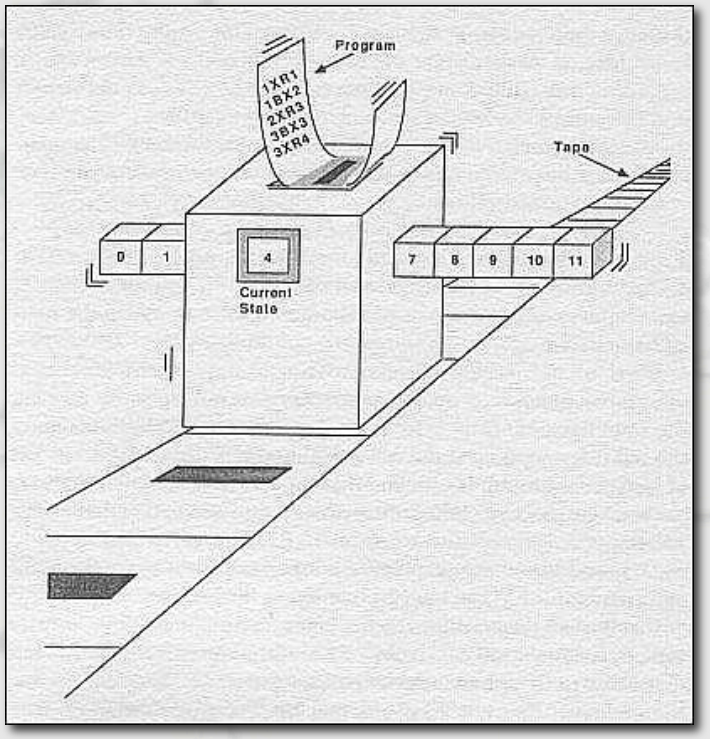
- Is it merely a contingent fact that the body is a metabolic system?
- In other words, is the cognitive role of the body multiply realizable, such that it can be realized in a nonmetabolic "body"?

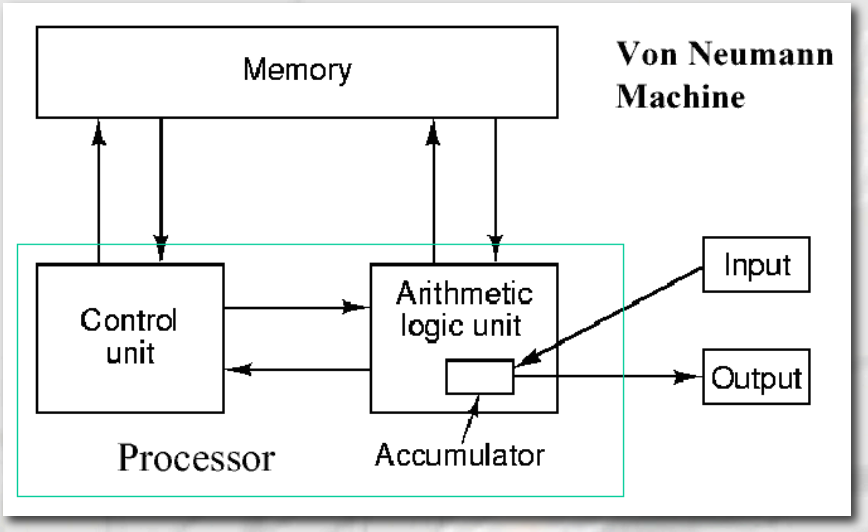
Multiple realizability revisited

- Multiple realizability is supposed to mean that the same functional property can be implemented or realized in different physical media.
- But is that enough for genuine multiple realizability? Let's consider some examples…

Shapiro 2004

The functional property of being a corkscrew is multiply realizable: it can be implemented in different physical mechanisms (double lever or fulcrum) that perform the same function.





The functional property of being a digital computer is multiply realizable: it can be implemented in different mechanisms (Universal Turing Machine, Von Neumann Machine) having different causal properties.

Multiple realizability revisited

- Physical realizations of a functional kind count as different only when they differ in the mechanisms and causal properties by which they perform their defining function.
- Mere difference in physical composition isn't enough for genuine multiple realizability -- the compositional difference must entail a difference at the level of mechanisms and causal properties.
- Otherwise stated: compositional plasticity (admitting of different material compositions) is neither equivalent to nor sufficient for multiple realizability.

Shapiro 2004

Two competing hypotheses

- Multiple Realizability
  - Human cognition can be realized in a wide variety of systems.
- Embodied Mind
  - Human cognition is compositionally plastic (e.g., neural plasticity), but not multiply realizable: it can be realized only in systems having the causal properties of the human body and brain.

Shapiro 2004

Cognition and emotion again

- The inseparability of cognition and emotion (affect regulation, motivated action tendencies, mood) counts as evidence favouring the embodied mind hypothesis over the multiple realizability hypothesis.

Andy Clark's EC view of the body

The body is just one element in a kind of equal-partners dance between brain, body, and world, with the nature of the mind fixed by the overall balance thus achieved.

Clark 2008a, 2008b

Enactive reply

The body (including the brain) leads in this dance because it is what realizes the adaptively autonomous organization necessary for sense-making and intentional agency [cf. the asymmetry requirement for agency].

Thompson & Stapleton 2009

Enactive reply

- The EC view lacks a theory of what a body is, so its conception of embodiment is empty and theoretically ungrounded.
- Minimally, a body is a self-constituting and sense-making system (adaptive autonomy in precarious conditions).
- As such, it is the precondition for having a meaningful world (Jonas, Merleau-Ponty).

Enactive reply

- Both the brain and body are compositionally plastic – they can alter their structure and dynamics by incorporating processes, tools, and resources that go beyond what the biological body can metabolically generate.
- Such incorporation can happen thanks to the body's adaptive, self-constituting dynamics.

Thompson & Stapleton 2009

Summary

Enactive

- Provides a theory of the body
- Compositional plasticity
- Incorporation
- Cognition-emotion as adaptive self-regulation in precarious conditions (sense-making)

Extended

- Lacks a theory of the body
- Multiple realizability
- Extended functionalism
- Cognition as problem-solving

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Enactive research question

- Can cognition-emotion (sense-making) be realized by nonmetabolic systems?
- Is adaptive autonomy achievable (at some level) without autopoietic (metabolic) grounding?

Standard enactive view

- Sensorimotor adaptive autonomy can be implemented directly without autopoiesis, e.g., in robots or animats that do not depend for their functioning on metabolic subsystems.

Questioning the standard enactive view

- Sense-making requires a self-constituting system that can adpatively regulate its sensorimotor interactions in precarious conditions.
- This implies the system must bring forth its own sensors, effectors, and their internal organizational link on the basis of its self-constituting operations.
- So far no one has been able to generate artificially such a system.
- It may be that only a metabolic (autopoietically based) system could instantiate this kind of autonomy and sense-making.

Froese & Ziemke 2009

Compare Jonas on metabolism

- A mode of being in which the system's being is its own doing (metabolic self-construction).
- The constitution of a meaningful perspective by that process for that process:
  - Emergence of a distinct individual in precarious conditions.
  - Basic normativity in relation to which events are good or bad for the continuation of this individual.
- A world of significance is encountered only by such systems whose being is their own doing (living bodies).
- Metabolism is the basis of concern (enacting a world).

Jonas 1966

Life-mind equivalence thesis

- Life is sufficient for mind (mind is necessary for life):
  - any living system is a cognitive system.
- Life is necessary for mind (mind is sufficient for life):
  - any genuine cognitive system must also be a living system.

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Mike Wheeler's argument

- If being a living system is necessary for being a cognitive system and cognitive extension is possible, then an extended cognitive system must also be a living system.
- But the boundaries of a living system are the boundaries of the organism.
- The boundaries of an extended cognitive system are not the boundaries of the organism.
- Hence the living (autopoietic) system cannot be an extended cognitive system.

Wheeler 2010

Boundary issues

- The boundary of an autopoietic system is defined not just by the physical membrane but also and more fundamentally by its organizational boundary (its topological boundary as a network).
- In principle, the self-producing network can incorporate processes outside the membrane.
- In this way, the living system can extend beyond the membrane into the environment.

Extended life

Some water bugs breathe underwater using a plastron that holds a non-collapsible thin film of air along the body surface.

Di Paolo 2009

Enactive reply

- In cases of incorporation, the body extends beyond its metabolically generated boundaries.
- In this sense, there can be extended life, extended sense-making, and hence extended cognition.
- So it is not the case that cognition enacted cannot be cognition extended.

Di Paolo 2009; Thompson & Stapleton 2009

Internalism vs externalism

- Internalism: explanations of what constitutes cognition need appeal only to internal factors.
- Externalism: some explanations need to appeal to external factors (as constitutive of cognition).

Internalism vs externalism

Fodor (2009): "Externalism needs internalism; but not vice-versa. External representation is a side-show; internal representation is ineliminably the main event."

Hurley (2010): "Internalism claims to characterize all mental states, and externalism denies this claim without itself claiming to characterize all mental states. Externalism thus has a lower burden of proof than internalism: externalism is vindicated by providing counterexamples to internalism, but internalism is not vindicated by providing counterexamples to externalism."

Enactive response

- Both positions presuppose some boundary that they do not account for.
- Adaptively autonomous systems generate what counts as the boundary and this boundary is dynamic and extendable through incorporation.

Enactive response

- Cognition (sense-making) belongs to the relational domain in which the system as a unity relates to its milieu (not the operational domain of the system's internal states).
- As strictly relational, cognition is neither "internal" nor "external" [cf. the phenomenological notion of intentionality].

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The problem of consciousness

- Is consciousness embodied in the sense that it is minimally realized by the body and brain working together and not just the brain?
- Or is the body only causally supportive (and not constitutive) of the biological basis of consciousness?

Andy Clark's extended cognition thesis

- The extended cognition thesis does not apply to consciousness.
- The minimal physical basis for consciousness is the brain and does not include the (nonneural) body and the environment.

Clark 2008a, 2008b, 2009

Andy Clark's extended cognition thesis

- "the external environment may well *matter* insofar as it drives the neural systems [causation], but the key effects [conscious contents] may then be occurring at time-scales that are possible only within the neural apparatus itself. If this were so, then everything that involves subsequent motor actions or bodily actions… will be 'screened off' (by the bodily 'low-pass filter') from the neural/CNS mechanisms that actually produce [constitute/realize] the conscious experience."

Clark 2009

Clark's argument

- The (extra-neural) body acts as a low-pass filter for signals coming from the environment.
- The contents of conscious experience require certain fast time-scales (e.g., for temporal/feature binding).
- As a matter of fact, the only locus where such high-speed operations occur is the brain (and does not span the brain-body-world).
- So the minimal physical substrate for consciousness lies entirely within the brain (does not extend to include the nonneural body).

Clark 2009

A (not so interesting) problem

- The time it takes for visual stimulation to pass through the lens and reach the first stages of neural processing is a fraction of the time it takes for neural systems to build up any correlated activity (from retina to early visual areas in recurrent loops with higher visual areas and frontal and parietal regions).
- So the "band-pass" argument as stated does not work.

Thompson & Cosmelli 2012

A (more interesting) problem

- Clark's treats the problem of consciousness as the problem of explaining phenomenal state consciousness for a given sensory modality.
- The more fundamental problem is to explain creature consciousness (sentience, the feeling of being alive and having a world), which is domain-general, not modality specific.
- Clark's argument targets phenomenal contents and neglects the phenomenal structure of being a body-in-the-world—the lived body.

Thompson & Cosmelli 2012

A (more interesting) problem

- Can creature consciousness or the lived body be explained only in terms of neural processing "screened off" from the body?
- This seems unlikely.
- Life-regulation and sensorimotor coupling are not strictly neural phenomena.
- They are system features of adaptive autonomy (which spans and interconnects brain, body, and environment).

Cosmelli & Thompson 2010; Thompson & Cosmelli 2012

Putting life back into consciousness

The enactive working assumption:

The minimal realizing system for creature consciousness (the lived body) is not the brain (or some neural subsystem), but rather a whole living system, understood as an adaptively autonomous system made up of some crucial set of densely coupled and nonseparable neuronal and extraneuronal subsystems.

Cosmelli &Thompson 2010; Thompson & Cosmelli 2012

Putting life back into consciousness

This proposal transforms how we think about the explanatory gap.

Thompson 2007

Putting life back into consciousness

- The explantory gap is no longer between the mental (defined as not fundamentally physical) and the physical (defined as not fundamentally mental).
- It is rather the gap between the living body and the lived body.
- How does a living body become also a lived body?
- The body-body problem.

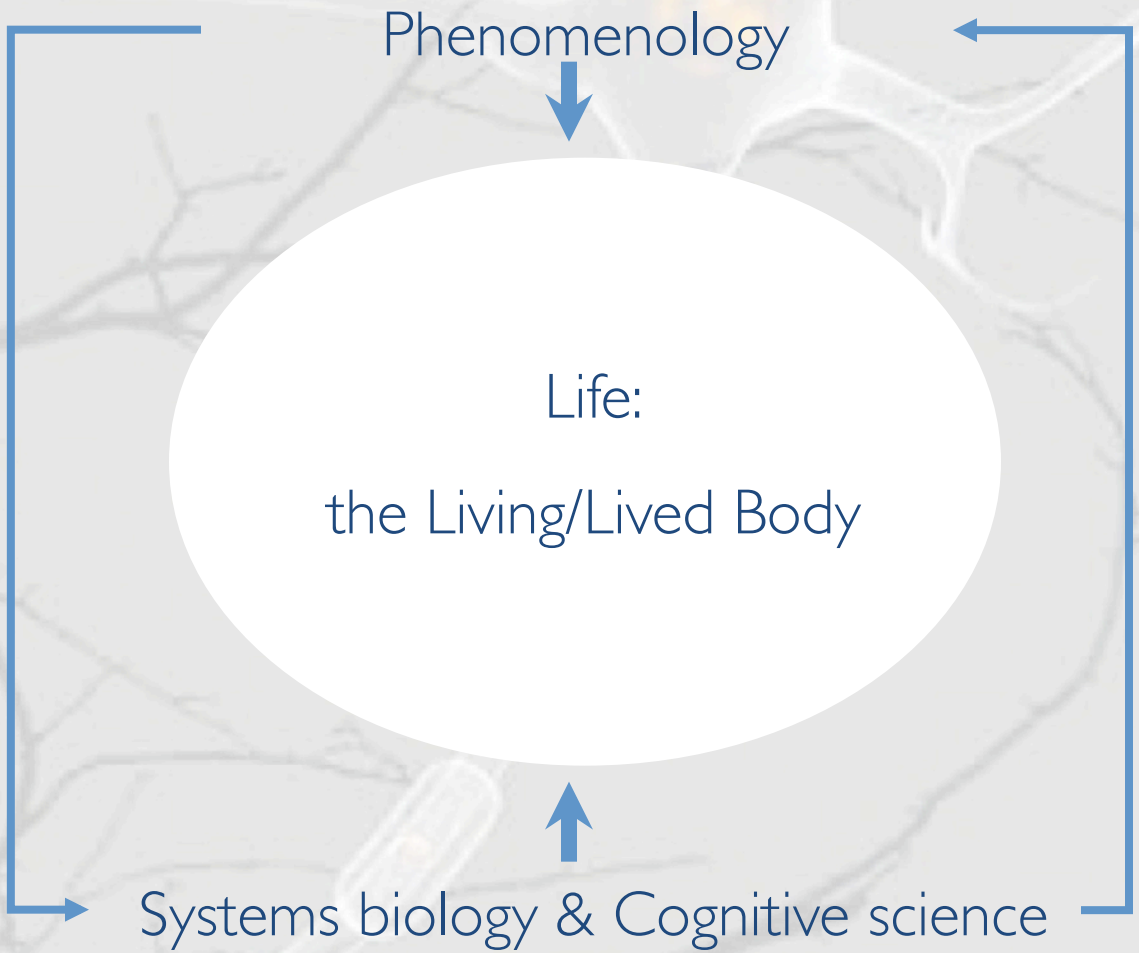
Thompson 2007

The task before us

To understand the emergence of living subjectivity from living being and the reciprocal shaping of living being by living subjectivity.

Thompson 2007

Mutual enlightenment & reciprocal constraints



Thompson 2007; Varela 1996: Varela, Thompson & Rosch 1991

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