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Lecture notes on Louise Barrett, *Beyond the Brain*

CHAPTER 1: REMOVING OURSELVES FROM THE PICTURE

ANTHROPOMORPHISM: 1) we tend to think that non-human animals perform similar tasks to us via similar representation-heavy internal mechanisms. (NB: we might not even do a lot of those tasks that way!). So why might misinterpret non-human animals. 2) Our anthropocentrism can mislead us into thinking we are more exceptional than we really are; we might do things like apes do them, but that is as much because we are ape-like as it is they are human-like. (1-6)

> Evan Thompson from Brains Blog:
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> "By "representation" we meant a structure inside the cognitive system that has meaning by virtue of its corresponding to objects, properties, or states of affairs in the outside world, independent of the system. By "enaction" we meant the ongoing process of being structurally and dynamically coupled to the environment through sensorimotor activity. Enaction brings forth an agent-dependent world of relevance rather than representing an agent-independent world. We called the investigation of cognition as enaction the "enactive approach." "
>
> "I think that "representation" is the most over-used word in cognitive science. Sometimes it means something in the brain that structurally and causally covaries with something else—as in the case of retinal ganglion cell firings and visual stimuli, or topographic V1 neurons and the retinal array. *Of course, I don't object to this idea of causal/structural covariance.* But using words like "representation" or "model" or "information" here is confusing, because it runs the risk of conflating causal/structural covariance with meaning. Any semantic use of representational talk that's meant to be explanatory, and not merely as-if talk, requires a semantic theory for representations. It's rare that we see "representation" used in a way that makes its meaning rigorously specified in terms of a clear statement of what is the representational vehicle or format, what is the representational content or semantics, what is the function that takes us from brain activity to representational vehicle, and what is the function that takes us from representational vehicle to meaning. Although theorists talk in terms of representations all the time, there are very few theories of how meaning is supposed to be coded in the brain that would make this talk rigorous."

ULTIMATE VS PROXIMATE EXPLANATIONS (or, functions vs mechanisms). Many traits can be explained as adaptations: possessors of those traits in the ancestral populations had fitness advantages. We have to beware using straightforward cognitive language here: ancestral frogs didn't "want" to attract mates by calling. Humans might have proximate psych mechanisms that involve beliefs and desires ("if I go to the gym, I'll have a pleasing physique which will help me get a date with this person I like" – NB: that might be a false belief!) but that doesn't mean non-human animals have such mechanisms to produce behavior fulfilling the function of mate attraction. (6-7)

However, if we are careful, we might do some "mock anthropomorphism" by a self-conscious adoption of the intentional stance: we can predict some behavior by asking what would happen if an animal had such-and-such beliefs and desires: but that's not explaining the actual psych mechanisms by which such behavior is produced. Our predictive use of belief-and-desire folk psychology in the intentional stance doesn't mean other animals use that in coordinating their behavior with one another. (7-8)

When we do look to animal cognition qua coordination of stimulus and response, we have to look to their body types (including brain and nervous system, if present) and their connections to the environmental niches they occupy. (11)

Evolutionary parsimony (related organisms probably share psych mechanisms as evolution is parsimonious – doesn't like to reinvent the wheel) overlooks the way that evolution isn't just parsimonious: it also generates novelty. Cognitive parsimony really means we should exhaust all other explanations before saying a non-human animal accomplishes a task by psych mechanisms like ours (or like we think we have!). (11-17)

So COGNITION = HOW AN ANIMAL COMES TO KNOW AND ENGAGE ITS ENVIRONMENT. (17)

Deepest problem is thinking complex behavior requires complex (internal) mechanisms (18).

CHAPTER 2: THE ANTHROPOMORPHIC ANIMAL

ANTHROPOMORPHISM MIGHT BE AN ADAPTATION. We tend to see human forms everywhere, and we tend to attribute beliefs-and-desires to non-human entities. These might be adaptations: better for our ancestors to have the tendency for the false negative of thinking a non-living thing (a swaying tree branch in the night, let's say) is alive and dangerous than the false positive of not recognizing a living thing with bad intentions (a very jaguar crouched in a tree branch). In the false negative case, they might have had a little fear jolt for nothing, but in the false positive case they might not have recognized a predator! (20-22)

So perception is not about an accurate picture; it's about serving our needs and enabling actions. Thus we shouldn't so sharply distinguish perception and cognition. (22)

FACE PERCEPTION: is there a dedicated brain area? Or is it fine-tuning of a general capacity for judging individuality of cases? It might be there are multiple brain areas, but that they are more sensitive to faces; thus we are predisposed to faces as we have evolved for sociability. Babies seem to hone in on top-heavy stimuli; as faces are like that, experience guides them to fine-tune a general evolutionary preference for top-heavy stimuli. (26-31)

THIS IS AN ILLUSTRATION OF A GENERAL PRINCIPLE OF GENES FOR "EXPERIENCE-EXPECTATION": Why go to the evolutionary trouble of genetic coding for early brain development for faces, when you can do a quick fix for top-heavy stimuli not needing so much brainpower and then let the social environment do the fine-tuning for faces? [Brain size = big fetal heads, which is an anatomical problem, but also a metabolic problem: keeping a fetus growing inside is more calorie-intensive than feeding a newborn.] (31)

In turn, that's a subset of AN EVEN MORE GENERAL PRINCIPLE OF "EXTERNALIZATION" for Barrett: "let the world do as much of the work as it can." That is, why bother with costly internal means (psych representations; elaborate gene structures) when reliably appearing environmental features can take up some of the slack?

SELECTION FOR SOCIABILITY. Primate brain changes: neocortex and visual cortex related to social living. Two visual pathways: dorsal for movement detection in all mammals; ventral (connects to amygdala) for emotions. The latter (parvocellular) pathway especially in primates. With more emotional info we also need neocortex to interpret those emotion-laden signals. (A lot of the brain is involved with processing of internal brain traffic.) (32-34)

SOCIAL BRAIN. Mirror neurons. Vygotsky: we learn to posit an inner life on the basis of being immersed in a social interpretation practices. That is, we are taught how to recognize meaningful actions and to interpret them as the result of beliefs-and-desires particular to our culture. When it comes time to interpret our own actions, then, we ascribe beliefs-and-desires to ourselves as we have heard them ascribed to others ("why did **I** kick the wall? That's just like Uncle Charlie when mom yelled at him. I must have been 'angry' too!"). (36-38)

CHAPTER 3: SMALL BRAINS, SMART BEHAVIOR

When we look to the interaction of simple rules and environmental features we can often explain complex behaviors. No need to load up on complex internal psych mechanisms. (Hence, another example of "externalization.") (42)

Examples of robot behavior. Negative and positive feedback. (Cybernetics concepts.) Negative feedback returns a system to a set point; positive feedback produces runaway behavior. (44)

Emergent behaviors among two or more systems: not pre-planned in any one component. (45) Clustering is emergent property of simple self-organizing process of coupling of component behavior and relation of that behavior to environment. (49)

Very important: a mechanism need not resemble the behavior it produces or the function that behavior fulfills. Indeed, the "mechanism" is often the *interaction* of brain, body, and worldly components, and the functions fulfilled can be multiple, as in cricket phonotaxis. (50)

Enactive sense-making: crickets only respond to those things relevant to them. So they enact a *world* by selection (or "subtraction") from the environment. (52-53)

CHAPTER 4: IMPLAUSIBLE NATURE OF *PORTIA*

Tthe spider eye is a filter; thus anatomical structure saves on neural processing (the brain is expensive, so if you can offload work onto non-neural body parts, do it). (63)

Because of emergent behavior from offloading some work onto environment we need to see brains in their ecological context. (70)

CHAPTER 5: WHEN DO YOU NEED A BIG BRAIN?

MIND IN LIFE: even unicellulars need to detect, contact, and exploit relevant resources (they need to enact a world of "first-person" relevance – food / poison – by subtraction from the environment a third-person observer might see (various chemical gradients). In other words, "sugar" is just a chemical; you need the relation to an organism for it to be "food." (72)

Some "INSTINCTS" are produced by a predisposition for some stimuli plus rapid learning capacity (73); some allow for intra-uterine learning via singularities amniotic fluid (75).

DEVELOPMENTAL SYSTEMS THEORY ("DST"): the whole developmental system, including reliably recurring environmental features, is the unit of inheritance (77). Changes in that system, not just changes in allele frequency, should be what's tracked in evolution.

NICHE CONSTRUCTION: self-organizing diachronic emergence or co-evolution of organism and the organism-effected changes to the environment, which change selection pressures for succeeding generations: often in the direction of sensitivity and adaptability to those very organism-effected enduring changes (78).

FLEXIBILITY / INTELLIGENCE is relative to the organism-environment system; the organism need not "know" what it's doing (i.e., it need not have awareness of internal representations qua semantic entities with meaningful correspondence relations to organism-independent features of the environment [crudely, representations as pictures or models], though it will have states that causally co-vary with environmental changes). (79)

The *UMWELT*: organisms enact worlds of relevance by subtraction or filtering the environment. (80) So any "flexibility" is organism / task specific. As we can see from the famous wasp / nest experiment (82-83). The wasp can only start at the beginning; it has no model of "home" so no alternate behaviors if the “expected” world features aren’t there. Thus the world is temporal as well as spatial: if it changes too fast, the organism is stuck in its behavioral rut.

Of course, if the change lasts long even and reliably recurs across generations, you can get selection for adaptation to new circumstance (84). So that’s like a new form of “knowledge” qua adaptive fit of organism / world.

But you can also get selection for flexibility of response / independence from brute circumstance; the organ for that is the brain (85).

Long-leash vs short-leash controls (85-87): long-leash is just basic goals and general purpose mechanisms vs short-leash detailed programming. But long-leash is on top of retained short-leash mechanisms. PLUS, the more long-leash learning capacities you have the more you need predispositions to keep you from following too many tangents too far. You need to do a sort of natural selection in your behavior: try out some variants, see what works for your needs, retain them and discard the others.

When we talk about systems of brain – body – world coupling, we have to account for ability to adapt to diachronic body changes. So “we should abandon talk of brains altogether and talk about the increasing size and complexity of the nervous system as a whole” (92).

CHAPTER 6: THE ECOLOGY OF PSYCHOLOGY

Noë principle: like a dance, cness is something we do, not something we have; it’s an attunement to the world (94).

Gibson’s ecological psychology: affordances: we perceive things as what we can do with them: we detect action-oriented information which changes as we move (95-96). Hence perception / behavior is sensori-motor coupling or as Dewey says, an integrated loop of action and perception (97). Sensory systems are more like tentacles probing the world than they are like microphones or cameras recoding the world.

Affordances are organism-action relative: we see the chair as “sittable” but a cat sees it as “scratchable” (98).

Perceptual control theory (100) animal behavior is aimed at maintaining stability of perception in order to maintain homeostasis of internal states and the right range of environment conducive to that goal.

Gibson rejects processing of sensation to produce models / representations (101). This tends to anthropomorphize brains which do all sorts of “inferences” and so on. But animals perceive; brains don’t (102).

By contrast, Gibson upholds "direct perception" of organism-relevant affordance-information extracted from the "invariants" in the "ambient optic array" [e.g., relation of angles of table will be invariant even as we receive lots of different looks as we move] (104-105). This means we don't have to do so much processing as the world has structures we can detect (106). It also means animals can improve the quality of the ambient array for their purposes (you can tilt your head or squint your eyes) (106).

Gibson isn't totally anti-representationalist (e.g., in imagination or memory) even though he upholds direct perception. Also, just because eyes aren't cameras and brains aren't photo labs, doesn't mean brains aren't part of organismic operation. Instead of being photo labs, brains and bodies are more like radios being attuned to signals from the environment (109-110).

Back to our "externalization" or "offloading" principle: why built an internal model when the world has reliable information just sitting there? What NS does is select for detection mechanisms of worldly information relevant to organismic need rather than for accurate modeling of organism-independent environmental features. (110-111). That's not to say we don't have "ideas" qua pictures; but that we have them in order to use them to navigate the world. (111) [There's a lot to be said about science here, and whether we want to go the full pragmatist route about scientific knowledge, or whether we want to maintain some use-independent accurate correspondence model of scientific knowledge.]

CHAPTER 7: METAPHORICAL MIND FIELDS

In this chapter, Barrett re-reads the Turing machine, compares GOFAI and dynamic systems models of cognition, ending with Andy Clark's "dynamic computationalism" in which brains can alter their internal information flows.

Behaviorists look to organismic stimulus – response relations from outside (they "blackbox" the mind), whereas cognitivists show you have to take some internal processes into account. At the time of the cognitivist revolution, the computer metaphor (brain as information processor) was taking hold. (112-116) Computationalism: 1) sensory input, 2) cognitive processing as rule-bound manipulation of discrete symbols so that syntax allows semantics of these internal representations, 3) behavior-controlling output commands.

Re-reading the Turing machine. Turing machines became popular philosophical concept because it allows functionalism: if cognition is information processing, then it's the software that matters, not the hardware (= "wetware" of brains). Anything can do computations: pieces of plastic moved about a table top, brains, silicon chips, whatever. (118)

But let's look at Turing's purposes: he was trying to see what human "computers" do: adding sums. This is usually misinterpreted by putting the whole thing inside our heads: the tape = memory, and so on. But, Barrett says, the tape is part of the environment: it's the equivalent of the scratch paper "computers" used to do their sums. The machine-head = the whole person doing the sums. The state of the “mini-mind” and contents of the tape = “configuration.” In this re-reading, the Turing machine is a Gibsonian ecological setup; it’s about a person in an environment (of pen and paper). (120-22)

Computationalism really takes its metaphor from von Neumann architecture of input (keyboard / mouse), processing (CPU, hard drive memory for stored programs, and RAM to allow working programs), and output (screen / printer / data storage). (121)

GOFAI took one thing people do (computation qua symbolic manipulation) and made it the essence of all cognition. But remember when Barrett said behavior need not specify the mechanisms producing the behavior? We don’t necessarily compute trajectories to catch a Frisbee. (123-24)

Another “DST”: dynamical systems theory: all about coupling of rates of change of moving parts rather than picturing states of world via internal representations upon which we perform computations. (125-29) You can even say computations are a subset of dynamic systems (they have state-dependent changes) (130).

Wheeler shows 1) dynamic computation requires symbols, but there are non-symbolic / non-representational dynamic systems. Also, 2) in computation, time is only a sequence or ordering of events; but in noncomputational dynamic systems you can get “richly temporal” phenomena: linkage of rates of change to other rates of change. (130-31)

Andy Clark points out that brains can alter internal information flows so you can get richly temporal effects in computational systems (not just noncomputational ones). (131-32)

CHAPTER 8: THERE IS NO SUCH THING AS A NAKED BRAIN

Dynamical systems theory: state space, equations and trajectories, parameters (changes in their values change the system but they are not changed in return), attractors, basin of attraction, singularities. (135-38)

Walter Freeman is a pioneer in dynamic systems analysis of how brain, body, and world are dynamically coupled. He emphasizes perception and action working together as organism searches for and then pursues environmental features favorable to its well-being. (138)

Nerve-cell assemblies fire together (Hebbian learning) and can amplify low-grade signals (139). You get new chaotic attractors for new odor-reward pairings, and each new one reworks the layout of the older ones, thus changing reception for future pairings (141). It’s important that the attractors represent the pairing of odor-reward, not just the odor stimulus. In this way, the brain is recording what is significant for the organism, the way it’s linking body (nose), brain (attractors), and world (food sources; that is, the organism detects the food-affordances in its world). 142 So the organism can achieve better states without representing goals: it moves in the direction that provides lowered tension.

Andy Clark reminds us of “representation-hungry” problems. So we can go off-line when we need to; we aren’t always on-line as simpler organisms are. 144-45

Sperry experiments show the difference between frog’s first-person experience and scientist’s third person observations; also that nervous systems are part of the entire organism-world coupling, so messing with them will change behavior, but not because they change internal representations. 145-48

Heidegger and “being-in-the-world.” We are normally smoothly coping with a world of meaningful relations: example of the ready-to-hand tool fit into a workshop of “in-order-to” relations. Only the broken hammer shows up as present-to-hand object with properties. We can systematize this objectifying process as science, but that’s derivative or “privative” with regard to the everyday practical relations that constitute the world (as opposed to the “environment” if you like). 150-51.

CHAPTER 9: WORLD IN ACTION

Let’s adopt Clark’s notion of “action-oriented representations” for plans to engage the world, though with the caveat that most animals directly perceive and act in the world, and so don’t have an inside / outside distinction between plans and experience of acting. 153

Robot rat example: “map” = storing the combination of movement and sensation at different times generates “expectations” for “goal.” But there’s no separate cognition; “the map is its own user” says Clark. Example of dart-throwing with adaptive glasses: specific to the trained motion; not transferable, so no separation of perception / cognition / action; instead a loop. 154-55.

Rodney Brooks and “cheap, fast, out of control” robots. 157. CPU robots can’t cope with changes. So Brooks looked to insects for inspiration (CPU structures do things humans can do: compute). 158. As human internal cognition is late in the day of evolution, they must be implemented on top of simple sensori-motor coping mechanisms older organisms had developed; it might even be that human computation depends on our animal bodily sensori-motor mechanisms. 159

Subsumption architecture: task-specific modules arranged in layers w/o overall integration. No need for expensive internal memory / cognition as “the world is its own best model” 159.

Separately controlled components can achieve coordinated behavior by being loosely coupled to each other via environmental interaction. 161. Importance of body plan to achieving behavior via environment: pointy structure of rats as “offloading” allowing savings on cognition. 163

We see this in human walking: we don't control swing of the leg: we let gravity, friction, and momentum do the work. 164. Our anatomy allows springiness of tendons and muscles to produce stride length given just an initial impulse (no continuous control: you just fire your glutes, hams, and quads and the legs do the rest). 165. All this body contribution via materials and shape undercuts brain-in-vat idea in which body is just passive input and output for the important controlling brain. 167. Rather, the body is taking up a lot of what would otherwise be brainwork: more offloading and saving of expensive cognition.

At 167 we see the brain as master and body as slave metaphor. Which is literal in Aristotle:

> Aristotle: Politics 1254a —because in every composite thing, where a plurality of parts, whether continuous or discrete, is combined to make a single common whole, there is always found a ruling and a subject factor, and this characteristic of living things is present in them as an outcome of the whole of nature, …; but an animal consists primarily of soul and body, of which the former is by nature the ruling and the latter the subject factor. … Hence in studying man we must consider a man that is in the best possible condition in regard to both body and soul, and in him the principle stated will clearly appear 1254b: since in those that are bad or in a bad condition it might be thought that the body often rules the soul because of its vicious and unnatural condition. But to resume—it is in a living creature, as we say, that it is first possible to discern the rule both of master and of statesman the soul rules the body with the sway of a master, the intelligence rules the appetites with that of a statesman or a king and in these examples it is manifest that it is natural and expedient for the body to be governed by the soul and for the emotional part to be governed by the intellect, the part possessing reason, whereas for the two parties to be on an equal footing or in the contrary positions is harmful in all cases. … Again, as between the sexes, the male is by nature superior and the female inferior, the male ruler and the female subject. And the same must also necessarily apply in the case of mankind as a whole; therefore all men that differ as widely as the soul does from the body and the human being from the lower animal … these are by nature slaves, for whom to be governed by this kind of authority [20] is advantageous…

Soft assembly allows profiting from local variation 172-73. Example of bidding among printers.

CHAPTER 10: BABIES AND BODIES

Piaget and Vygotsky: action in world is source and cause of our internal psych mechanisms: constructivism, in which we learn to inhabit our bodies as they interact with the environment. 175-76.

Gallagher and body schema as system of sensori-motor capacities allowing us to be oriented in our places / spaces (not "in space" as some geographical grid). 176-77. As bodies differ, we learn to exploit our singular makeup. 177.

Thelen and Smith examples of babies learning to walk: they stop stepping because they need strength to move mass of their legs. 179. Baby variation: some are energetic and need to calm down; others are passive and need to start moving around. 180 Thelen and Smith are externalizers: the "beliefs" of babies are emergent properties of soft-assembled dynamic systems, not internal semantic representations. 185 (There is pushback here from other scientists.)

Time-locking of multimodal sensory inputs. 186.

Fundamental grounding of abstract symbolic knowledge of objects in our capacities for bodily interaction with them. 190

Redundancy allows degeneracy: any one function has multiple realization mechanisms, which allows behavioral flexibility (and resilience after damage) 191.

Smith: concepts are posits to explain behavior, but we can also see if we can do w/o them as explanations by looking at sensori-motor coordination, "morphological computation" (materials and shape of limbs can offload a lot of work, saving brainpower), dynamic coupling, and soft assembly and seeing if they can help account for flexible, adaptive, richly temporal behavior. 193.

Clark and language as cognitive resource: it's a huge offloading as we don't have to rethink everything – we'll see this with Henrichs. 194-95.

CHAPTER 11: WIDER THAN THE SKY

Clark / Chalmers: extended mind. 197-200.

Extensions of body schema. 200-203.

Transforming tactile into visual perception. 203-204.

217: extended mind thesis wants us to rethink cognition: it's not about its location, inside or outside the head; it's about seeing cognition as guiding action (how does Otto navigate NYC?).

217: pragmatic acts achieve a task; epistemic acts help us with cognition. For instance, a bartender lines up different types of glasses to offload remembering exact drink orders. Instead of remembering words ("martini, then scotch, then beer") you just fill up the martini glass, then the scotch tumbler, then the beer mug.

219: other animals might do this as well, but we are the champions at such epistemic niche construction; this is cultural transmission: we are smart because we can read off the storage of thousands of years of stored knowledge. Henrichs shows this in his stories of Euro explorers dying off if they don't adopt native customs, which are huge storehouses of knowledge. 222.