PHIL 4941 Spring 2018

Fred Keijzer, "Moving and sensing without input and output: Early nervous systems and the origins of the animal sensorimotor organization," *Biology and Philosophy*, Feb 2015, accessed via ResearchGate.

INTRO: distinction btw input-output and coordination views on early nervous systems (NS). Input-output: connecting sensors and effectors; simplest model is single connecting neuron; closely linked to modern thought on complex nervous systems. Coordination: enable motility by multicellular organisms; simplest model is diffuse net w/ significant number of neurons spread over large portion of animal body; modern example is *Hydra*.

The Skin-Brain Thesis (SBT) is a form of the coordination view. This article will stress sensing as well as motility; hence we are in the "animal sensorimotor organization" (AMSO) area: full intertwining of sensing and motility. Relations to embodied and to sensorimotor theories; in my terms: 3-fold notion of "sense-making."

PRECAMBRIAN ROOTS. Complex prey-predator dynamics drive Cambrian explosion of complex behavior and morphology. But this complex behavior requires pre-Cambrian evolution of NS. This is difficult to reconstruct, but we can try some "lineage explanations," where you posit a series of phenotypic stages with small differences so that minor modifications can account for the changes over time. This way you don't need details on the adaptive conditions or the particular animal in which the changed mechanisms occurred. You do need a sequence of changes, and a mechanism for a "plausible adaptive task" for each stage.

INPUT-OUTPUT VIEW. Fits the linear processing view dominant in cog sci; feedback and so on doesn't really change the basic linearity whereby NS mediates sensors and effectors, and the animal body is a stable "platform" whose inter-relations enable and constrain animal behavior capacities. List of features 1-8 on p. 6 should be familiar to us by now.

SBT AS COORDINATION. Contraction-based motility is "kernel of NS and AMSO." Motility by cilia is constrained by size and efficiency limits; only contractile tissue can account for movement by Cambrian and post-Cambrian animals. Contraction-based motility requires integration of distributed contractions across the body. This in turn requires electrically excitable cells and chemical signaling, and epithelial organization.

> **Epithelium** is one of the four basic types of animal tissue, along with connective tissue, muscle tissue and nervous tissue. Epithelial tissues line the cavities and surfaces of blood vessels and organs throughout the body. An example is the epidermis, the outermost layer of the skin.…All glands are made up of epithelial cells. Functions of epithelial cells include secretion, selective absorption, protection, transcellular transport, and sensing

SBT stresses spontaneous activity w/in organism (as opposed to passivity in input-output model). It also distinguishes synapses (contact communication) from axodendritic processes (long-range communication). Mechanisms for synaptic signaling already within single cell organisms.

Phase 1: excitable myoepithelial: contractive properties and electrical conductance, so that the tissue is both coordinator and effector. Early forms would be "protoneurons" with chemical transmission by "exocytosis" (= pushing out of the cell). So you would get a sheet with local signaling to neighbors.

Phase 2: evolution of specialized cells with elongated axodendritic processes allowing non-local communication and hence a diffusively connected nerve net. Variation in morphology possible here and contractile tissue can move from surface to interior (as muscle), and NS can cluster and be internalized as well as brain separated spatially from contractile tissue.

PANTIN PATTERNING INSTEAD OF OUTPUT. Skin brains are nerve nets intertwined with contractile surface instead of separate controlling system; you also need to think in terms of generating patterns of contraction / extension in a specific surface. This patterning is "Pantin patterning"; e.g. jellyfish ball. Here we can use Pantin patterning as a diagram or abstract machine that is differently actualized. NS is not about enabling sensing and behavioral functions but about inducing patterns of activation in a surface. Compare with Maturana and Varela's distinction of structural coupling (organism and world) vs physiology (operational closure or membrane-metabolism recursivity). So it's all about focusing on the animal's operational dynamics, rather than on abstractly considered "tasks" like mating or feeding. So, it's not about connecting external stimuli to tasks but about coordinating operations via self-organizing dynamics. All in all, Pantin patterning doesn't look like "output" (p. 10).

SENSING BODIES RATHER THAN INPUT. Sensing here is Gibsonian detection of organism-relative information: contact with environment changes internal processes enabling different behavior toward that environmental feature. The picture here is active exploration rather than passive reception. Self-induced movements caused systemic changes in sensing that the animal becomes attuned to qua "sensorimotor contingencies." (e.g., if I shift my head I can predict how it will change my visual field.) Early on then the whole body is a sensing device in relation to movement. SBT says nerve nets are sensitive to internal Pantin patterning they generate; they also then become sensitive to the environmental features that impinge on and change the patterning. Analogue to blind person and cane. Nice drawing on p. 14. SBT is an early evolution foundation for sensorimotor contingency theory.

> the formula given by Alva Noë in his Action in Perception (2004). Noë writes, "The basis of perception, on our enactive, sensori-motor approach, is implicit practical knowledge of the ways movement gives rise to changes in stimulation" (8). Thus, failures of perception are due to a "breakdown in our mastery or control over the ways sensory stimulation changes as a function of movement" (10). Noë goes on to contrast his equation of "implicit practical knowledge" with "mastery or control" with Kant's famous line, "intuitions without concepts are blind" (11). As we know, Kant's theory of perceptual experience is a hylomorphic process in which formless intuitions are the material input to a production process; they are given form from transcendental sources, first by space and time as forms of outer and inner intuition, then by schematized concepts of the understanding. By contrast, Noë's formulation is that what completes intuition is "knowledge of the sensorimotor significance of those intuitions." This "knowledge" is not linguaform or conceptual, but is "sensorimotor bodily skill" (11). Deleuze would agree here, and the latter's notion of virtual can help us understand the ontological status of perceptual capacity as sensorimotor skill. Our perceptual capacity or sensorimotor skill is the ability to modulate the relation of the two processes of movement and sensation. As we recall, Deleuze suggests the term "virtual" for these sorts of purely differential structures. Perceptual capacity is a skill that enables us to navigate the differential elements, relations, and singularities involved in the multiplicity linking movement and sensation.

CONCLUSION. Nice table summarizing differences of input-output and ASMO.