Key Terms and Ideas

Embodied Approach = Theories that seek to understand cognition and experience in terms of their **relationship to perception (sensory) and motor system interactions**, specifically action-perception arc.

- Based on known constraints of neural interactions. Namely, 1) no direct access to outside world (mediated by sensory organs input and effectors) and 2) input source = upstream neurons.
- Goal of embodied approach is to understand the principles and dynamic rules that instantiate information intrinsic to the closed-loop system. Not as Harnad put it, “parasitic on meanings in our heads."
- Information (embodied) = output-driven sensory feedback // as opposed to association between neural patterns and a priori knowledge of stimulus/action properties.

Grounding = purported **fundamental scheme of meaning or sense making based on perception (sensory) and motor system interactions** . A training or shaping process (likened to model updating) that is **the result of output-driven sensory feedback** that occurs when closed-loop system interacts with environment and self-generated actions.

Action-Perception Arc = Stimulus, neural interactions, motor actions, and efference copy.

- Also **requires comparator** between incoming sensory signals and efference copy signals.

***Note:** What still needs to be accounted for is reward mechanisms. **What determines if output-driven sensory feedback is useful, optimal, or successful?**

Efference copy = **Internally generated sensory “input" sent from motor system simultaneously with action execution**. Thought to **represent predicted sensation of self-produced motor actions** (e.g. Why you cannot tickle yourself. Efference copy, in a sense, sends information to somatosensory cortex for what to expect when motor action (tickle) is executed. Also, efference copy from super colliculus or frontal eye fields for saccade execution sent to early visual processing regions to compare against incoming sensory signals self generated movement of visual field (saccade) does not lead to discontinuity or disruption of visual processing and ensures stability of visual world model).

Related concept: **Corollary discharge mechanism** (see diagram) - Note: Corollary = Efference Copy, also includes Reafferent and Exafferent signals in mechanism.

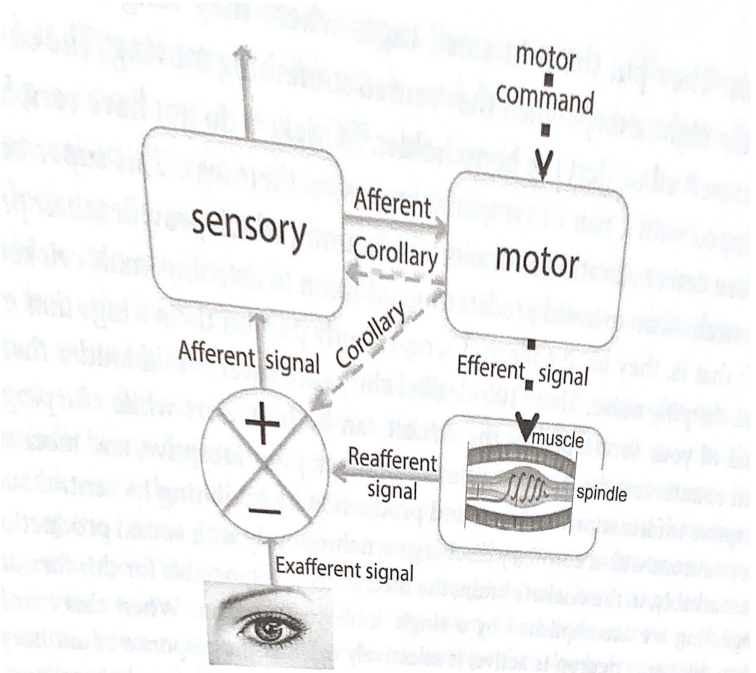

Figure 3.1. Schematics of the corollary discharge mechanism. *Motor command signal* is sent from the motor areas to eye muscles (efferent signal). *At the same time, corollary* discharge (*dashed arrows*) is also sent to comparator mechanisms *in the sensory system.* The comparator performs a subtraction or divisive normalization on the external (exafferent) signal determined by the corollary discharge. *In addition, the magnitude* of the reafferent signal from the tension sensor in the muscle can exert a *delayed affect* on the sensory signal. Projections from motor cortex to sensory cortical areas are a common architectural feature in all mammals.

Key Terms and Ideas Continued

Semantic Grounding Problem - How are **symbol tokens linked to actions, referent objects, and concepts**? How do these links form a semantic system that is **flexible** and **intrinsic to the system**?

Two important features of semantic processing in the human brain:

1. **Neuroanatomical constraints:** Multimodal convergence of sensory input in areas along arcuate fasciculus (though not limited to). **Multimodal convergence zones bridge action-perception arcs in human brain given major pathways between primary sensory cortex and primary motor cortex.**
2. **Neurophysiology**: Action-perception circuits formed through Hebbian learning 2.0.

- **Fire-together wire-together (co-occurrence strengthens synaptic weighing) out-of-link desynch (presynaptic fire without postsynaptic fire or visa-versa weakens synaptic weighting)**

Embodied semantic system = encompassing perception and action systems

- **Referential Semantics** = linking word form to perceived objects or actions.

Disembodied semantic system = **does not** encompass perception and action systems.

- Proposed Mechanisms for Disembodied
    1. **Multimodal convergence (plus Hebbian principles) -** Word form to referential semantic systems with high variability in terms of features.
    2. **Computation of probability of word form co-occurrence in speech -** (**Combinatorial Semantics**/symbolic theft)

Cell Assembly Theory – Functional unit is **neuronal group** that is shaped based on correlational learning principles. (*Additional consideration is how neurons are embedded in the action-perception arc)

- **Neural Darwinism (Gerald Edelman)** = One account of how neuronal groups become functional units.