

Predictive Processing And Perceptual Control

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Yesterday's review of *Surfing Uncertainty* mentioned how predictive processing attributes movement to strong predictions about proprioceptive sensations. Because the brain tries to minimize predictive error, it moves the limbs into the positions needed to produce those sensations, fulfilling its own prophecy.

This was a really difficult concept for me to understand at first. But there were a couple of passages that helped me make an important connection. See if you start thinking the same thing I'm thinking:

To make [bodily] action come about, the motor plant behaves (Friston, Daunizeau, et al, 2010) in ways that cancel out proprioceptive prediction errors. This works because the proprioceptive prediction errors signal the difference between how the bodily plant is currently disposed and how it would be disposed were the desired actions being performed. Proprioceptive prediction error will yield (moment-by-moment) the projected proprioceptive inputs. In this way, predictions of the unfolding proprioceptive patterns that would

be associated with the performance of some action actually bring that action about. This kind of scenario is neatly captured by Hawkins and Blakeslee (2004), who write that: “As strange as it sounds, when your own behavior is involved, your predictions not only precede sensation, they determine sensation.”

And:

PP thus implements the distinctive circular dynamics described by Cisek and Kalaska using a famous quote from the American pragmatist John Dewey. Dewey rejects the ‘passive’ model of stimuli evoking responses in favour of an active and circular model in which ‘the motor response determines the stimulus, just as truly as sensory stimulus determines movement’

Still not getting it? What about:

According to active inference, the agent moves body and sensors in ways that amount to actively seeking out the sensory consequences that their brains expect.

This is the model from Will Powers’ [Behavior: The Control Of Perception](#).

Clark knows this. A few pages after all these quotes, he writes:

One signature of this kind of grip-based non-reconstructive dance is that it suggests a potent reversal of our ordinary way of thinking about the relations between perception and action. Instead of seeing perception as the control of action, it becomes fruitful to think of action as the control of perception [Powers 1973, Powers et al, 2011].

But I feel like this connection should be given more weight. Powers' perceptual control theory presages predictive processing theory in a lot of ways. In particular, both share the idea of cognitive "layers", which act at various levels (light-intensity-detection vs. edge-detection vs. object-detection, or movements vs. positions-in-space vs. specific-muscle-actions vs. specific-muscle-fiber-tensions). Upper layers decide what stimuli they want lower levels to be perceiving, and lower layers arrange themselves in the way that produce those stimuli. PCT talks about "set points" for cybernetic systems, and PP talks about "predictions", but they both seem to be groping at the same thing.

I was least convinced by the part of PCT which represented the uppermost layers of the brain as control systems controlling various quantities like "love" or "communism", and which sometimes seemed to veer into self-parody. PP offers an alternative by describing those layers as making predictions (sometimes "active predictions" of the sort that guide behavior) and trying to minimize predictive error. This allows lower level systems to "control for" deviation from a specific plan, rather than just monitoring the amount of some scalar quantity.

My review of *Behavior: The Control Of Perception* ended by saying:

It does seem like there's something going on where my decision to drive activates a lot of carefully-trained subsystems that handle the rest of it automatically, and that there's probably some neural correlate to it. But I don't know whether control systems are the right way to think about this... I think maybe there are some obvious parallels, maybe even parallels that bear fruit in empirical results, in lower level systems like motor control. Once you get to high-level systems like communism or social desirability, I'm not sure we're doing much better than [strained control-related metaphors].

I think my instincts were right. PCT is a good model, but what's good about it is that it approximates PP. It approximates PP best at the lower levels, and so is most useful there; its thoughts on the higher levels remain useful but start to diverge and so become less profound.

The Greek atomists like Epicurus have been totally superseded by modern atomic theory, but they still get a sort of "how did they do that?" award for using vague intuition and good instincts to cook up a scientific theory that couldn't be proven or universally accepted until centuries later. If PP proves right, then Will Powers and PCT deserve a place in the pantheon besides them. There's something kind of wasteful about this – we can't properly acknowledge the cutting-edgeness of their contribution until it's obsolete – but at the

very least we can look through their other work and see if they've got even *more* smart ideas that might be ahead of their time.

(Along with his atomic theory, Epicurus gathered a bunch of philosophers and [mathematicians](#) into a small [cult](#) around him, who lived together in [co-ed group houses](#) preaching atheism and materialism and – as per the rumors – having [orgies](#). If we'd just agreed he was [right about everything](#) from the start, we wouldn't have had to laboriously reinvent his whole system.)