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A Real Science of Mind

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In recent years popular science writing has bombarded us with titillating reports of discoveries of the brain's psychological prowess. Such reports invade even introductory patter in biology and psychology. We are told that the brain — or some area of it sees, decides, reasons, knows, emotes, is altruistic/egotistical, or wants to make love. For example, a recent article reports a researcher's "looking at love, quite literally, with the aid of an MRI machine." One wonders whether lovemaking is to occur between two brains, or between a brain and a human being.

There are three things wrong with this talk.

First, it provides little insight into psychological phenomena. Often the discoveries amount to finding stronger activation in some area of the brain when a psychological phenomenon occurs. As if it is news that the brain is not dormant during psychological activity! The reported neuroscience is often descriptive rather than explanatory. Experiments have shown that neurobabble produces the illusion of understanding. But little of it is sufficiently detailed to aid, much less provide, psychological explanation.

Second, brains-in-love talk conflates levels of explanation. Neurobabble piques interest in science, but obscures how science works. Individuals see, know, and want to make love. Brains don't. Those things are psychological — not, in any evident way, neural. Brain activity is necessary for psychological phenomena, but its relation to them is complex.

Imagine that reports of the mid-20th-century breakthroughs in biology had focused entirely on quantum mechanical interactions among elementary particles. Imagine that the reports neglected to discuss the structure or functions of DNA. Inheritance would not have been understood. The level of explanation would have been wrong. Quantum mechanics lacks a notion of function, and its relation to biology is too complex to replace biological understanding. To understand biology, one must think in biological terms.

Discussing psychology in neural terms makes a similar mistake. Explanations of neural phenomena are not *themselves* explanations of psychological phenomena. Some expect the neural level to replace the psychological level. This expectation is as naive as expecting a single cure for cancer. Science is almost never so simple. See John Cleese's apt spoof of such reductionism.

The third thing wrong with neurobabble is that it has pernicious feedback effects on science itself. Too much immature science has received massive funding, on the assumption that it illuminates psychology. The idea that the neural can replace the psychological is the same idea that led to thinking that all psychological ills can be cured with drugs.

Correlations between localized neural activity and specific psychological phenomena are important facts. But they merely set the stage for explanation. Being purely descriptive, they explain nothing. Some correlations do *aid* psychological explanation. For example, identifying neural events underlying vision constrains explanations of timing in psychological processes and has helped predict psychological effects. We will understand both the correlations and the psychology, however, only through *psychological* explanation.

Scientific explanation is our best guide to understanding the world. By reflecting on it, we learn better what we understand about the world.

Neurobabble's popularity stems partly from the view that psychology's explanations are immature compared to neuroscience. Some psychology is indeed still far from rigorous. But neurobabble misses an important fact.

A powerful, distinctively psychological science matured over the last four decades. Perceptual psychology, pre-eminently vision science, should be grabbing headlines. This science is more advanced than many biological sciences, including

much neuroscience. It is the first science to explain psychological processes with mathematical rigor in distinctively psychological terms. (Generative linguistics — another relatively mature psychological science — explains psychological structures better than psychological processes.)

What are distinctively psychological terms? Psychology is distinctive in being a science of representation. The term "representation" has a generic use and a more specific use that is distinctively psychological. I start with the generic use, and will return to the distinctively psychological use. States of an organism *generically* represent features of the environment if they *function to correlate with* them. A plant or bacterium generically represents the direction of light. States involved in growth or movement functionally correlate with light's direction.

Task-focused explanations in biology and psychology often use "represent" generically, and proceed as follows. They identify a natural task for an organism. They then measure environmental properties relevant to the task, and constraints imposed by the organism's bio-physical make-up. Next, they determine mathematically optimal performance of the task, given the environmental properties and the organism's constraints. Finally, they develop hypotheses and test the organism's fulfillment of the task against optimal performance.

This approach identifies systematic correlations between organisms' states and environmental properties. Such correlations constitute generic representation. However, task-focused explanations that use "representation" generically are not distinctively psychological. For they apply to states of plants, bacteria, and water pumps, as well as to perception and thought.

Explanation in perceptual psychology is a sub-type of task-focused explanation. What makes it *distinctively psychological* is that it uses notions like representational accuracy, a specific type of correlation.

The difference between functional correlation and representational accuracy is signaled by the fact that scientific explanations of light-sensitivity in plants or bacteria invoke functional correlation, but not states capable of accuracy. Talk of accuracy would be a rhetorical afterthought. States capable of accuracy are what vision science is fundamentally about.

Why are explanations in terms of representational accuracy needed? They explain *perceptual constancies*. Perceptual constancies are capacities to perceive a given environmental property under many types of stimulation. You and a bird can see a stone as the same size from 6 inches or 60 yards away, even though the size of the stone's effect on the retina differs. You and a bee can see a surface as yellow bathed in white or red light, even though the distribution of wavelengths hitting the eye differ.

Plants and bacteria (and water-pumps) lack perceptual constancies. Responses to light by plants and bacteria are explained by reference to states determined by properties of the light stimulus — frequency, intensity, polarization — and by how and where light stimulates their surfaces.

Visual perception is getting the environment right — seeing it, representing it accurately. Standard explanations of neural patterns cannot explain vision because such explanations do not relate vision, or even neural patterns, to the environment. Task-focused explanations in terms of functional correlation do relate organisms' states to the environment. But they remain too generic to explain visual perception.

Perceptual psychology explains how perceptual states that represent environmental properties are formed. It identifies psychological patterns that are learned, or coded into the perceptual system through eons of interaction with the environment. And it explains how stimulations cause individuals' perceptual states via those patterns. Perceptions and illusions of depth, movement, size, shape, color, sound localization, and so on, are explained with mathematical rigor.

Perceptual psychology uses two powerful types of explanation — one, geometrical and traditional; the other, statistical and cutting-edge.

Here is a geometrical explanation of distance perception. Two angles and the length of one side determine a triangle. A point in the environment forms a triangle with the two eyes. The distance between the eyes in many animals is constant. Suppose that distance to be innately coded in the visual system. Suppose that the system has information about the angles at which the two eyes are pointing, relative to the line between the eyes. Then the distance to the point in the environment is computable. Descartes postulated this explanation in 1637. There is now rich empirical evidence to indicate that this procedure, called

"convergence," figures in perception of distance. Convergence is one of over 15 ways human vision is known to represent distance or depth.

Here is a statistical explanation of contour grouping. Contour grouping is representing which contours (including boundary contours) "go together," for example, as belonging to the same object. Contour grouping is a step toward perception of object shape. Grouping boundary contours that belong to the same object is complicated by this fact: Objects commonly occlude other objects, obscuring boundary contours of partially occluded objects. Grouping boundaries on opposite sides of an occluder is a step towards perceiving object shape.

To determine how boundary contours should ideally be grouped, numerous digital photographs of natural scenes are collected. Hundreds of thousands of contours are extracted from the photographic images. Each pair is classified as to whether or not it corresponds to boundaries of the same object. The distances and relative orientations between paired image-contours are recorded. Given enough samples, the probability that two photographic image-contours correspond to contours on the same object can be calculated. Probabilities vary depending on distance — and orientation relations among the image-contours. So whether two image-contours correspond to boundaries of the same object depends statistically on properties of image-contours.

Human visual systems are known to record contour information. In experiments, humans are shown only image-contours in photographs, not full photographs. Their performance in judging which contours belong to the same object, given only the image-contours, closely matches the objective probabilities established from the photographs. Such tests support hypotheses about how perceptions of object shape are formed from cues regarding contour groupings.

Representation, in the specific sense, and consciousness are the two primary properties that are distinctive of psychological phenomena. Consciousness is the what-it-is-like of experience. Representation is the being-about-something in perception and thought. Consciousness is introspectively more salient. Representation is scientifically better understood.

Where does mind begin? One beginning is the emergence of representational accuracy — in arthropods. (We do not know where consciousness begins.) Rigorous *science* of mind begins with *perception*, the first distinctively psychological representation. Maturation of a science of mind is one of the most

important intellectual developments in the last half century. Its momentousness should not be obscured by neurobabble that baits with psychology, but switches to brain science. Brain and psychological sciences are working toward one another. Understanding their relation depends on understanding psychology. We have a rigorous perceptual psychology. It may provide a model for further psychological explanation that will do more than display an MRI and say, "behold, love."

Additional Reading:

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