Simple Conscious Percepts Require Complex Unconscious Processing

Review of *Indirect Perception* By Irvin Rock

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REVIEW OF: Irvin Rock (1997) *Indirect Perception.* Cambridge, MA: MIT Press. 396pp. ISBN: 0262181770. Price: US$40 hbk.

The thesis of this work, and of Irvin Rock's career, is that perception is not automatic; it requires extensive computation and intelligence to succeed. This computation can take place quickly and effortlessly, but is complex and sophisticated nonetheless -- drawing inferences, guessing from experience, basing one perception on another. It is just because these processes are so important for the functioning of animals and humans that they are unconscious: they are built in to the very basis of our perceptual brains, and they have been evolving for so long that their operation is taken for granted. One might even propose an inverse law of psychological effort -- the more fundamental a problem is to the basis of brain function, the fewer people are working on it. The complex inferences and processes required for something so fundamental as lightness perception, for instance, are the monopoly of a handful of specialists worldwide. But reading, a late addition to our cognitive capacities that had no time to evolve at all, and must be based entirely on pre-existing capabilities, occupies a small army of researchers. Reading seems difficult, and takes years to learn, yet machines are much closer to doing a good job with reading than they are with defining lightness and surface properties.

It is a commonplace in psychology that the performances of the most sophisticated computers when it comes to recognizing objects and surfaces in complex environments

are dwarfed by the perceptual feats of every 3-year-old. But the consequences of that fact are summarized here in a way that makes us appreciate the complexity of the task, and provides tantalizing glimpses of the mechanisms by which nature accomplishes these feats. And after reviewing the evidence, it is difficult to disagree with the conclusions, a fact that Rock would have found satisfying.

An example is a classic experiment by Rock and Brosgole, done in the 1960s and reprinted here. The Gestalt psychologists of a generation before Rock had demonstrated several rules of perceptual grouping, beginning with a simple rule of proximity -- objects that are close together tend to be grouped into perceptual units. For example, an array of dots will be perceived as a group of columns if the vertical spacing is closer than the horizontal spacing. But Rock looked more closely, and asked whether "closer" meant closer on the retina, as the Gestalt psychologists had assumed, or closer in 3-dimensional space. In a simple experiment, he found out. If the dot array was rotated about a vertical axis, subjects would continue to perceive columns even when perspective foreshortening brought horizontally neighbouring dots closer together than vertically neighbouring dots.

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Subjects saw this pattern, though, only if they had good perceptual information specifying that the second pattern was slanted in the 3rd dimension. This is what Rock means by indirect perception, that one perception depends on another. Perception of the vertical grouping depends on perception of the slant of the surface. As Rock removed cues for slant, for instance by having the subjects view the arrays with one eye, the retinal pattern became progressively more likely to dominate. This is Rock's unique flair for experimental design, approaching a problem from several directions until his conclusion seems inevitable. The subjects were not aware of these calculations of perceptual geometry, but only of the results of the calculations. Perception seems direct and immediate, but Rock showed with this and a host of other experiments that complex processing of information, requiring several steps, often precedes the conscious percept.

Similar principles govern other aspects of perception. Perceived lightness of a surface depends not only on the intensity of light entering the eye from that surface, but also on the perceived orientation of the surface, and on the other surfaces that are visible. Perceived size depends on perceived distance and visual context as well as retinal size. Observers are conscious only of the lightness or the size, not of their dependence on prior

calculations of other variables. The component processes are unconscious because they would only get in the way of a faithful perception of the properties of the world.

By indirect perception Rock means that processing must occur before we can recognize objects, surfaces, people. He contrasts his view with the direct perception view of J. J. Gibson, for whom invariants are detected by some sort of resonating process. But Gibson's followers sometimes exaggerate his stance. Gibson never denied that there was complicated processing going on -- he simply wasn't interested in it. Gibson carried a hearing aid in his shirt pocket, with a prominent volume control. If you started talking about mechanisms, he would simply turn off his hearing aid, and that would be the end of that. For him, finding out what in the environment made perception possible was more than enough challenge for a lifetime, and he made us aware that the perceptual world affords more information than others had imagined. But for Rock that isn't enough: he wants to know not only that things work, but how they work. Here too Gibson had more to say than many psychologists think, for his idea of resonance is more than arm-waving. Resonance, in fact, is a simultaneous query of many mechanisms at once, in parallel, just as a vibrating tuning fork can query many strings about their resonant frequencies at the same time. The idea requires both parallel processing, a radically modern idea in Gibson's time, and a group of mechanisms to resonate with. The fact that Gibson didn't discuss what those mechanisms are, and professed to be uninterested in them, does not deny their existence. The concept of parallel processing was not developed in Gibson's era of behaviorists and their sequential models, and the neurophysiology of the time perhaps offered too little to perceptual theorists. So in these areas Gibson and Rock were perhaps closer than they seem from our present perspective, and each always valued and respected the other's work.

The present work is almost as much Steve Palmer's as it is Irvin Rock's, and Palmer's foreword occupies nearly as much space as Rock's introductions. The book is really a series of carefully chosen articles, some of them more than 30 years old, that describe and support Rock's principal theoretical ideas, together with introductions by Rock that tie the articles together. Most of the papers are by Rock or his students and immediate collaborators. In every case, in sections on perceptual organization, shape, motion, lightness and other issues, the articles demonstrate the indirectness of even the most elementary perceptions. Often one perception depends on another, such as the judgements of surface albedo (reflectance) that are influenced by the perceived depth and orientation of surfaces. Thus the structure of surfaces in a space must be resolved before lightness values can be assigned to the surfaces. Other examples abound in Rock's work. A perception about the shape of a pattern partly occluded behind another pattern requires a process of inference much like the operations of formal logic, except that the process is fast, automatic, unconscious, and performed easily even in those who have never heard of formal logic. The operations are evolved algorithms that are constantly working on our sensory input, and normally they work very well.

Rock traces his use of unconscious inference to Helmholtz, who in turn borrowed his ideas from the 12th-century Arab Al-Hazen. The articles assembled here make an

overwhelming case for the validity of Al-Hazen's prescient ideas, and the value of careful experiment in deciding issues of the workings of the mind.

This book is Irvin Rock's last major work, the capstone of a long and exceptionally productive career. Up until his death in 1995 he remained active and engaged in projects with colleagues and students. One cannot help wondering what this volume would have been like had Rock had a few more months to work on it.