

Two Stages of Perception

Denis G. Pelli

Department of Psychology and Center for Neural Science

New York University

<http://psych.nyu.edu/pelli/>

Talk given at *Theories of Vision* symposium at New York University, New York City, October 17, 1997.

I'm a scientist. I study visual perception. I'm convinced that when we come to really understand how we see and identify, we'll be able to explain the process as a series of mathematical transformations. Most of my work has had this aim.

Today I want to talk about something that began for me as a detour. Over the course of the summer, putting together the *Thresholds: Limits of Perception* exhibition with Ana Maria Torres, I read a series of interviews of Robert Irwin by Lawrence Weschler. In these interviews, explaining what he was trying to achieve in his work, Irwin described an idea, a dichotomy, that I found very intriguing. He was trying to explain something in esthetics, in art. My training is in science, not art, but there seemed to be a connection to threshold, which is the theme of the exhibition. So I spent the whole summer trying to figure out what he meant, or more precisely, trying to formulate a hypothesis about visual perception that would be consistent with the many examples that Irwin presents to explain his concept. After many months, I think I've succeeded, but I discover that the idea is not restricted to art, and indeed is a tentative description of two stages in visual processing.

This talk has three parts. First I have to backtrack to explain an old dichotomy, in philosophy and psychology, between sensation and perception. Second, I'll present Irwin's dichotomy between physicality and imagery. Finally, I'll present a bit of experimental evidence that bears on this. Let me warn you that the words "sensation", "perception", "physicality", and "imagery" are used rather specially here, and that we'll have to discuss what they mean.

Psychology is a relatively new field, having split off from philosophy about 100 years ago. Since Descartes, philosophers, and now psychologists, have maintained a distinction between "sensation" and "perception". "Perception" refers to our ordinary meaningful experience of a world of objects. "Sensation" is unusual; it's supposed to be a direct experience of the raw stimulus, without meaning, what William James called "sense data". Sensation is supposed to be a pure response to the outside stimulus, without the benefit of all our memories and knowledge of the world. Philosophy and psychology have maintained that this distinction is important because it reflects different kinds of information. Sensation is supposed to be based purely on outside information, whereas perception also incorporates internal

information, our (possibly innate) prior knowledge of the world. This distinction is still taught today in undergraduate perception courses, but there's hardly any evidence that anyone has ever experienced a pure sensation. At University of Minnesota, Dwight Burkhardt, when he teaches perception, maintains that the distinction is important, but admits that he only knows one good example of sensation: a ganzfeld. A ganzfeld is a perfectly uniform field filling the entire field of view. The usual way to produce it is to cut a hole in a ping pong ball, hold it up to your eye, and illuminate it uniformly. Dwight recommends red light, which, for him, produces a pure sensation of red. I think you will agree that, despite the ingenuity of Dwight Burkhardt's example, the situation is somewhat absurd. Putting aside the concern as to whether the experience of red itself can truly be meaningless, it is troubling to have only one example. Looking inside a red ping pong ball is weird in many ways, and it's not obvious which aspects of that situation are relevant to defining the notion of "sensation". It's hard to accept that "sensation" is an important idea in understanding ordinary vision if it only occurs in such artificial circumstances. For all practical purposes, sensation doesn't happen. The traditional distinction made in philosophy and psychology between sensation and perception seems to be a useless prejudice that philosophers had about how vision *ought* to work, with little or no empirical basis. Quine makes a very similar point, arguing against the traditional distinction between analytic and synthetic knowledge.

Now let's turn to Robert Irwin. Weschler published a series of interviews in which Irwin described what he was trying to achieve in his work.

"I remember one time, for instance, seeing this small Philip Guston hanging next to a large James Brooks. Now the Brooks was a big painting on every scale: it had five major shapes in it—a black shape, a red, a green—big areas, big shapes with strong major value changes, hue changes. Next to it was this small painting, with mute pinks and grays and greens, *very* subtle. ... Anyway, my discovery was that from 100 yards away ... I looked over, and that goddamn Guston ... blew the Brooks right off the wall."

I haven't seen those paintings, but I have seen subtle images overpower louder ones. I was intrigued by the idea that Irwin could say what it was about the subtle painting that gave it its power. Scientific vision theory fails here; it predicts that the factors that Irwin identifies—size, contrast, objects—would make the Brooks the stronger visual stimulus.

Irwin says he realized at this point, in the late 1950's, that every image has both a "physicality" and an "imagery". And that, for him, "the moment a painting took on any kind of image, the minute I could recognize it as having any relationship to nature, of any kind, to me the painting went flat." Since that realization, he says that he's always tried to maximize the energy of physicality, and to minimize the imagery.

This physicality vs imagery distinction sounds a lot like sensation vs perception, if we can equate "relationship to nature" with having meaning.

That's as far as Irwin goes, in these interviews, in explicitly defining the dichotomy. By itself, I find this definition just as useless as the one in psychology. However, unlike psychology, Irwin goes on to illustrate the idea by a long series of compelling examples. These examples seem to me to describe a crucial aspect of visual perception that's been missed in the scientific study of vision. Irwin's examples seem to specify a coherent observation. Let me warn you, though, that they are *not* consistent with his definition ("relationship to nature"), so forget the definition and concentrate, as I did for the past three months, on trying to extract the idea from the examples themselves.

Irwin describes how he made his dot paintings. He starts with a large white canvas, 7 feet square, and every quarter inch he paints a red dot, about the size of a map pin, until the whole canvas is filled by an evenly spaced array of red dots. Then he goes back and, between every pair of red dots, he paints a green dot, the opposite color. Viewed from sufficiently far away, the oppositely colored dots are mixed optically by the eye, yielding a perfectly white canvas, except that minor variations in dot size result in imperfect cancellation, resulting in a faint residual pattern. One observer, Philip Leider, describes walking into the gallery, seeing a blank canvas, standing there a minute, two minutes, three minutes, and gradually seeing a "an indistinct irregularly shaped mass" emerge. William Wilson says the paintings "blush".

Irwin did a series of line paintings. He painted two lines on each canvas. Over a period of two years he produced ten paintings. As he puts it, in two years of very intense work, he painted 20 lines. Weschler says, "One of the things about looking at those paintings is that they have no existence beyond your participation. ... They only 'work' immediately; they command an incredible presence—a rich floating sense of energy ... —but only to one who is in fact *present*."

Irwin gives several more examples, but let me recount just one. At one point, he decided to give up painting. Having nothing else to do, he drove around the Southwest desert. He talks about how he'd be driving down the highway, through the desert, nothing special going on, and quite suddenly the landscape would "stand up and hum", becoming incredibly, magically, beautiful. Two miles down the road, it would be gone. Returning a year later, the same energy would be there, at the same place.

I've experienced something like this. When we were visiting ancient Native American sites in New Mexico and the temple at Delphi, my mother, Diana Balmori, pointed out to me that many of these sites seem to be specially chosen. As you approach them through the landscape, something special seems to happen when you arrive. Even standing with your back to the site, so you don't see the artifacts, there seems to be something magically beautiful about the particular place. (I haven't returned, so I don't know if it'd be the same again.) An odd feature of these examples is that I'm utterly unable to give any visual description of what was so special about these

places. Irwin too, in describing these special situations in the desert, doesn't say what made them special.

Remember that I said that Irwin's examples aren't consistent with his definition. He said that any image that had any imagery, any relationship to nature, went completely flat. Yet the desert landscape, which *is* nature, can "stand up and hum" for him. [To be fair, remember that Irwin's words are taken from separate interviews assembled in Weschler's book; Irwin didn't have the opportunity of imposing consistency.] But don't worry about that; I think Irwin's examples are all consistent with each other.

In my own work, I've spent a lot of time asking people to identify very faint letters. When John Robson and I developed the Pelli-Robson chart we tested many people with it. We consistently find that people quickly and accurately read off the easily visible letters and then stop, saying there's nothing else there. However, if they keep looking for a minute or so, eventually they see a few more letters. This is surprising, since we have nothing in vision theory to explain it. All the processes we know about are fast, taking a fraction of a second. I have no idea how to account for the 30 second and longer delays that we routinely observe for people identifying letters at their contrast threshold.

It seems to me that this example might be describing the same process that Irwin is describing. I'm not claiming that the faint letters are beautiful; they're not meant to be. But there are two distinct stages to the experience. Initially the observer sees nothing or perhaps an indistinct changeable form that is hard to describe. Eventually the letter appears. During the initial period, the observer is seeing, but unable to identify, unable to classify the stimulus as a letter from A to Z. This limbo can be an intense experience, tantalizing or frustrating, but it ends abruptly when the letter is finally categorized. From then on it's just an "A", or whatever. No longer interesting. You can try this for yourself by reading the contrast sensitivity chart in Fig. 1.

PELLI-ROBSON CONTRAST SENSITIVITY CHART
Distributed by **HS** Clement Clarke



Figure 1. Pelli-Robson Contrast Sensitivity Chart.

The idea here is that vision proceeds in two stages, before and after categorization. The period before the categorization is normally very brief, but can be prolonged by making things hard to see, near threshold. I think this pre-categorical period corresponds to Irwin's physicality. The categorization provides us with an identification, which is memorable and is crucial for any practical response to an environmental stimulus. I think the period after categorization corresponds to what Irwin calls "imagery".

In these interviews Irwin doesn't say anything about time, nothing about a temporal sequencing of physicality and imagery. So if you hate that idea blame me, not him.

The description of seeing Irwin's dots seems sufficiently like the example of identifying faint letters (excepting the beauty) that it seems reasonable to suppose that they are the same phenomenon. The connection to the lines and deserts seems more tenuous. However, we could suppose that there is a subtle aspect of the stimulus, the configuration of the lines or landscape, that is sufficiently strong for us to experience, yet not strong enough for us to recognize and identify. Conceivably one could study these configurations and learn to identify them. Following Irwin, though, we'd predict that this expert observer, gaining the categorization, would lose the magic of the prolonged "physicality" of the uncategorized experience.

These examples, mostly self-selected introspections, hardly constitute a proof. Yet, to the extent to which you can recall similar experiences of your own, you may agree that there is something to be explained, in which case you may allow that the pre- and post-categorization phases seem to match Irwin's physicality-imagery dichotomy. However, even if you generously allow all that, we still have a problem. Why is Irwin so allergic to imagery? Why does the categorization make the image "go flat" for Irwin?

I struggled with this all summer, talking about it with any friend that would listen. I read them Irwin's examples, mentioned my experience of faint letters, and asked them if they got it, since I didn't. One friend, Cecelia Schmidt, a photographer, supplied the answer, "The categorization erases it." After the categorization we are left with only the category, and lose the ineffable pre-categorical experience of the stimulus.

This idea is not far fetched. Indeed, there's experimental evidence for it. In his thesis in the 60's, George Sperling developed the partial report technique. In these experiments observers were briefly shown a large array of letters, and were then asked to report them. The observers could only report four or five letters. However, they said that initially they saw many more letters, but that as they began to report them, the rest disappeared. This is literally what Cecelia suggested: the process of identifying the stimulus erases it.

References

Pelli, D. G., Robson, J. G., and Wilkins, A. J. (1988) The design of a new letter chart for measuring contrast sensitivity. *Clinical Vision Sciences*, 2, 187-199.

Pelli, D. G. and Torres, A. M. (1997) *Thresholds: Limits of perception*. New York: NY Arts Magazine.

Quine, W. V. O. (1951) Two dogmas of empiricism. *Philosophical Review* (January). Reprinted in Quine, W. V. O. (1980) *From a Logical Point of View*. Cambridge, MA: Harvard University Press.

Sperling, G. (1960) The information available in brief visual presentations. *Psychological Monographs*, 74, 498-.

Weschler, L. (1982) *Seeing is forgetting the name of the thing one sees. A life of contemporary artist Robert Irwin*. Berkeley: University of California Press.