The primacy of ecological realism

William M. Mace
Department of Psychology, Trinity College, Hartford, CT 06106.
william.mace@trincoll.edu
http://www.trincoll.edu/depts/ecopsyc/isep.html

Abstract: Whether or not the correspondence of dorsal stream functions to Gibsonian ecological psychology and the ventral stream functions to “constructivist” hold up, the overall goal of capturing a pragmatic realism should not be forgotten.

The fundamental perceptual question for ecological psychology, as some of us understand the field, is “How does an animal perceive its environment?” (Shaw et al. 1982). In proximal-distal language (which Gibson rejected as incoherent), the question would be, “Why does an animal ever experience the distal?” We have argued that the primary emphasis needs to be on the word “environment,” and that the priority to be emphasized is the problem of reference in perception. Thus, the question of how an animal perceives its environment is to contrast “the environment” with other possible objects of perception. “How is it that the animal perceives its environment, and not something else?” This is the question of realism, and it is a question that can guide empirical research.

The realist emphasis is one that does not come through in Norman’s description of ecological psychology in the target article. He understands correctly that Gibson argued for a far richer view of optical structure than most other researchers, and that the concept of an invariant is important, but does not mention that the point of richer notions is to converge on “the environment,” to make specificity possible. I do not think Norman objects to the realist position, but his focus is elsewhere. The persistent problem of reference (Shaw 2001) is rarely acknowledged by psychologists and neuroscientists, including adherents of Gibson, yet we’ve always taken it to be where Gibson’s insights have contributed the most. In brief, Gibson’s answer to why it is the external world that an animal perceives and not something else, is that the information specific to the environment is different from the information specific to anything else. Gibson’s enterprise of ecological optics, and the consequences of its alternative descriptions, is devoted to finding formulations that are more and more adequate to this scientific goal of principled, specific description of environmental information. We take it that questions of processing and questions of directness and indirectness are subordinate to the question of whether or not the environment is indeed what is perceived. We have maintained that indirect perception of the environment will necessarily be parasitic on direct perception and would be impossible without direct perception.

Gibson’s position is that information (optical for vision) is indefinitely rich in its specificity. A real world is distinct from a surrogate world by virtue of its nested structure at all scales. When one looks closely at the skin of a person, one ultimately gets to cells. When one gets closer to a painting of the same face, one gets to the paint and grain of canvas, not cells of skin tissue. For a digitized photo of the painting, one gets to pixels, not paint and canvas. The scrutiny of the world at a variety of levels, which exist simultaneously, is critical for clarifying what one is perceiving. The convergence of perception on the “real world” in light of indefinitely rich, specific information, is crucial to how Gibson thought about perceiving and its foundations. In pattern recognition, there is an unknown pattern and the task is to make it explicit, to come up with an answer to the question of what it is (Marr 1982). In Gibsonian perceiving, there are no right or wrong answers, but degrees of clarity and sufficiency for the tasks at hand. Perceiving is pragmatic. There is always more to be perceived in any real situation, and obtaining additional information is a criterion of reality. The specific cases of texture gradients, horizon ratios, optic flow, and tau, stimulated by ecological research, need to be thought of as way stations toward increasing understanding of optical information (for vision), and not as ultimate destinations. They represent progress over what came before, and they illustrate what Gibson meant by “higher order invariant,” but they are far from sufficient to specify fully the concrete world that animals (of any kind) live in. They do not, in themselves, capture the nesting type of organization crucial to Gibson. If we were to stop with the inventory we have, we would have “higher order invariants,” but we would still be far short of specificity. Our scientific characterizations have to get richer and deeper, just as Gibson said that perceiving over time does (learning). Scientists need some kind of vision to act as a guide for future work. What I’ve sketched is what I take to be a guiding Gibsonian vision.

Regardless of whether one calls what either the dorsal or the ventral system does “perceiving” or “information pickup,” the question I want to highlight is whether the object of the system, for Norman, is the environment. If recognition and identification are carried out primarily by the ventral system, using long-term memory, what is it that is recognized and identified? If I see someone from a distance, without my glasses, and finally “recognize” the person as my acquaintance, John, what did the ventral system do besides come up with a name? It is one thing to try to identify some relevant brain events, but it is quite another to explain how they refer back to John, the unique person in the world.

Without an account of reference, I do not see how an indirect theory can succeed, and I can’t see that associating the constructivist approach with the ventral system helps. The problems that constructivist approaches fail to address are still not addressed when one associates them with the ventral system.

What is to be said about the data reviewed by Norman? How are we to understand the two streams? There is much to be understood and he is persuasive that the labor is worthwhile. The development of Gibson’s ideas toward more traditional “cognitive” topics was started by Gibson himself (see Mace 1986) and is being pursued seriously by Robert Shaw (Shaw 2001) by careful examination of intentionality and choice. As these efforts mature, I’m guessing that alternative interpretations of the functions of the ventral system will emerge and that we can fruitfully discuss and debate these alternatives with Norman.

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NOTE
1. The word “environment” is used broadly here to include the self, in accord with Gibson’s stipulation that “to perceive is to be aware of the surfaces of the environment and of oneself in it . . . . These are existing surfaces; they are specified at some points of observation . . . . The full awareness of surfaces includes their layout, their substances, their events and their affordances” (Gibson 1979/1986, p. 255).

The dual route hypothesis in visual cognition: Why a developmental approach is necessary

Denis Mareschal and Jordy Kaufman
Centre for Brain and Cognitive Development, School of Psychology, Birkbeck College, London WC1E 7HX, United Kingdom. d.mareschal@bbk.ac.uk
http://www.psyc.bbk.ac.uk/staff/dm.html
j.kaufman@psychology.bbk.ac.uk
http://www.psyc.bbk.ac.uk/cbcdn/people/jordy.html

Abstract: Norman presents intriguing arguments in support of a mapping between ecological and constructivist visual cognition, on the one hand, onto the dorsal ventral dual route processing hypothesis, on the other hand. Unfortunately, his account is incompatible with developmental data on the functional emergence of the dorsal and ventral routes. We argue that it is essential for theories of adult visual cognition to take constraints from development seriously.
Commentary/Norman: An attempt to reconcile the constructivist and ecological approaches

Norman reviews an impressive amount of evidence in support of his claim that dual route visual processing reflects the distinction between constructivist and ecological approaches to visual cognition. Unfortunately, while he makes a convincing case, he fails to address an important part of the literature: the developmental literature. Although from the onset Norman declares that a true developmental approach is beyond the scope of the target article, his proposal rests on the assumption that the dorsal route functions are innate or largely mature very early in infancy, whereas the ventral constructivist functions are largely developed later in life. Norman cites a paragraph from Kellman and Arterberry (1998) in support of this claim (see target article, sect. 5.2.1).

However, a wide range of behavioural and electrophysiological data does not support this assumption. The dual route visual processing paradigm is playing an increasingly important role in the study of infant perceptual and cognitive development (e.g., Atkinson 1998; Berthenthal 1996; Mareshal et al. 1999). One of the questions raised in developmental circles is whether the dorsal or the ventral route functions develop first during infancy. The general conclusion to this question is that if there are differences between the developmental rates of the ventral and dorsal routes, then the dorsal route is likely to be developmentally delayed with respect to the ventral route (e.g., Atkinson 2000).

We list here just a few pieces of evidence in support of this claim (a full review can be found in Johnson et al. 2001). Studies measuring Evoked Response Potentials (ERPs) to face images indicate that the ventral pathway can be activated at 6 months (albeit with some further specialization to take place: De Hann et al., in press). In contrast, ERP evidence suggests the dorsal pathway is still not influencing eye movement control at that age (Csibra et al. 1998). This ERP evidence is interpreted as suggesting that at least this aspect of dorsal pathway function is somewhat slower to develop than the ventral pathway. Other evidence arises from behavioural infant studies. While babies show sophisticated facial discrimination abilities (a canonically ventral function) from a very early age (De Hann & Halit 2001), body-centred spatial representations that guide eye movements develop gradually over the first year of life (Gilmore & Johnson 1997).

Within the context of this commentary we wish to remain agnostic with regards to (i) whether the two routes do actually develop at different rates, or (ii) whether they both develop at comparable rates during infancy. The important point is that neither of these interpretations of the data are inconsistent with Norman’s proposals.

So, where does this leave us with regard to Norman’s hypothesis? We do not have a problem with the mapping that Norman is trying to make between the dorsal/ventral dual route hypothesis and the ecological/constructivist debate in perception. In fact, we are generally sympathetic to many of his arguments. What we do wish to do, however, is to argue that any theoretical account of perception and cognition must take developmental constraints seriously (this was well understood by Gibson 1969). It is not in use coming up with a theory of adult performance that is incommensurate with developmental evidence. Otherwise, one is stuck with the unwelcome task of explaining how one behavioural system is magically transformed into another at an unspecified point in development.

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One visual system with two interacting visual streams

Jason S. McCarley* and Gregory J. DiGirolamo*

*Beckman Institute, University of Illinois at Urbana, Champaign, IL 61801; *Department of Experimental Psychology, University of Cambridge, Cambridge, CB2 3EJ England. mccarley@uiuc.edu gjd277@cam.ac.uk

Abstract: Norman’s aim to reconcile two longstanding and seemingly opposed philosophies of perception, the constructivist and the ecological, by casting them as approaches to complementary subsystems within the visual brain is laudable. Unfortunately, Norman overreaches in attempting to equate direct perception with dorsal/unconscious visual processing and indirect perception with ventral/conscious visual processing. Even a cursory review suggests that the functional and neural segregation of direct and indirect perception is not as clear as the target article would suggest.

Norman’s argument falls short in part by failing to provide evidence that direct perception is generally unconscious. A number of the studies cited as demonstrations of direct perception are in fact demonstrations of direct conscious perception. Gibson’s discovery of texture interception and the horizon ratio as invariants allowing size constancy was spurred by a study involving verbal reports of perceived size. Norman’s (1989) own experiments required participants to report with a button press which of two objects appeared larger. Clearly – indeed, almost by definition – responses in these studies were based on observers’ conscious percepts. While it may be true, then, “that certain invariant ratios were picked up unawares by the observers and the size of the retinal image went unnoticed” (Gibson 1979, p. 160; 1986), the result was nonetheless conscious perception of distal size. Unless we redefine the notion of conscious perception to include only instances in which an observer is capable of verbalizing the information and processes leading to the percept – by which definition almost all perception, including the unconscious inferential processes like those posited by Rock (1983), would be excluded – these studies do not buttress the claim that direct perception is largely unconscious. Norman wishes to circumvent this objection by suggesting that directly but unconsciously perceived information “can enter consciousness via the ventral system after the event” (target article, sect. 5.1). He gives no compelling reason, though, for us to reject the more parsimonious alternative that conscious perception may itself be direct.

Norman likewise gives very little evidence that dorsal function cannot be constructivist, often appearing instead to simply term the information used for visuomotor control as “invariant” with no independent evidence to justify the label. Nor is his argument rescued by an appeal to differential susceptibility of conscious perception and visual-motor behaviour to illusions. Assuming that illusions are evidence of a constructivist process, Norman suggests that action should be largely impervious to visual illusion, other than when behaviour must be guided by a remembered stimulus representation from a ventral (conscious/constructivist) store. A multitude of studies examining the effects of the Mueller-Lyer illusion on eye movements have consistently found an influence of illusion length on saccade programming; saccades to the endpoint of the subjectively longer end overshoot their target, and saccades to the endpoint of the subjectively shorter end undershoot it (e.g., Delabarde 1897). Importantly, these effects are obtained even when the stimulus remains visible throughout saccade preparation and execution; hence, the influence of the illusion on the movement was not produced by a memory-guided ventral stream representation. In studies of eye movements and the M-L illusion, subjects have generally been asked to saccade from end to end of the figure; movements have therefore been strictly voluntary. Our own data (DiGirolamo et al. 2001) suggest that there are differences in the influence of illusions based on the type of saccade required. Voluntary saccades are as influenced by the illusion as the conscious perception, while reflexive saccades (saccades to a flashed cue at the endpoint of a M-L segment) show modest ef-