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

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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.

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 Artberry (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; Berthental 1996; Mareschal 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 no 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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