short-term memories do not penetrate the visual system. However, evidence suggests that the ventral stream is not purely perceptual. In delayed-match-to-sample tasks, where a monkey has to indicate whether a sample matches a previously presented cue, V4 responses are often better related to cue responses long after the cue has disappeared and a subsequent sample has appeared (Ferrera et al. 1994). This shows clearly that a cognitive component is present in V4, one not reducible to effects of attention. On the other hand, it is also clear that V4 contributes significantly to visual processing (Schiller & Lee 1991; de Weerd et al. 1996). Thus V4 appears to violate the impenetrability of visual perception. Similarly, the dorsal stream too exhibits delay responses, for example, in the lateral intraparietal area (LIP; Gnadt & Andersen 1998), while being involved in visual processing, such as the representation of salience (Gottlieb et al. 1998). Thus it appears that in addition to attentional effects, short-term memory effects need to be added to the possible cognitive penetration of the visual system.

A further feature that cognitive impenetrability seems to require is that the task being performed only be reflected in how attention is allocated within the visual system (sect. 4.3). In other words, the prediction for PET studies would be that whereas different visual areas may get more or less activated depending on the task, the underlying perceptual network should be quite similar. A network analysis, however, has shown that depending on the task in stimuli can be identified even when subjects know they are simultaneous. The place at which auditory and visual signals converge need not be a ‘central representation. Indeed, neurons in the inferior temporal cortex (IT) respond to auditory stimuli if they are paired with visual stimuli but not otherwise (Gibson & Maunsell 1997), as if IT neurons coded the association of auditory and visual stimuli. This association is not spatial per se, however; rather, it is based on identity. Similarly, responses in area V4 can reflect tactile signals (Maunsell et al. 1991). Thus it seem extraretinal signals can enter the visual system even if their spatial component is not the important feature.

According to the notion of cognitive impenetrability, there is a hard division between early vision and late vision, where only attention is able to affect early vision (sect. 4.3). This division is reminiscent of the one between sensory and motor processing stages. Although this is easy to identify at the level of sensory transducers and of muscles, it is a lot fuzzier closer to the sensorimotor transformation. Evidence from the dorsal stream suggests that even quite early parietal areas already code the intention to make movements (Snyder et al. 1997). [See also Jeannerod: “The Representing Brain” BBS 17(2) 1994.] The ventral stream, on the other hand, is involved in functions that also lead to movements, but at different time scales (Goodale 1998). It appears then, that the brain may not be divided “horizontally” into different processing stages, but rather “vertically” into different parallel sensorimotor circuits, each subserving a different competence that is called upon, depending on the context. Similarly, perceptual and cognitive factors may not be divided by a hard line, but may be interwoven into different sensory-cognitive circuits that can be recalled selectively, depending on the capability required. Most circuits, however, are likely to contain visual components that are cognitively impenetrable.
Pylyshyn's main claim is that there is a discontinuity between "early" vision and cognition. We certainly agree with this. We also agree with his acknowledgement that vision as a whole is cognitively penetrable, being modulated by attentional and decisional factors. However, to illustrate penetration of non-early vision by cognition, Pylyshyn presents rather special cases of visual processing (their being special he himself acknowledges): he refers either to tasks which obviously include problem solving that is, search on difficult-to-perceive stimuli such as fragmented figures, or to the case of trained experts, who are clearly more able than (we) novices to authenticate a Rembrandt or to determine the sex of chicks.

We will argue that cognitive penetration in non-early vision extends far beyond these special tasks, stimuli or observers. Our claim does not concern decisional or response selection processes as examined by Signal Detection Theory or ERP studies (about which we agree with most of Pylyshyn's arguments). Rather, we claim that many situations which do not involve difficult stimuli or require expert skills nevertheless load on high-level, cognitive processes. School learning effects can be used to make this point clear, as they might provide a methodological tool to observe task dissociations which, we will argue, ultimately support the discontinuity hypothesis.

Earlier reports on school learning effects in vision stem mainly from studies, which, under the impact of Vygotsky's approach to cognitive development and of the transactional functionalism and New Look movements (e.g., Bruner 1957; Ittelson 1952), stressed the individuals' social and cultural differences. Yet many cross-cultural studies either examined high-level representations (like the use of functional vs. perceptual categorization criteria, e.g., Greenfield & Bruner 1966), or failed to control for correlated (genetic and environmental) variables (see Derevenskij 1989 and associated commentaries).

Nevertheless, in the last twenty years, many experimental studies have been devoted to a special sort of school learning, namely alphabetization. The consequences of acquiring an alphabetic system for mental representation were stressed in developmental studies (e.g., Liberman et al. 1974) and later in adult studies (e.g., Morais et al. 1979). For our purpose, what matters is that, before that seminal work, no distinction was made between, on the one hand, perceptual discrimination among phonemes (e.g., distinguishing between "cat" and "rat") and, on the other hand, phonemic awareness, namely, the explicit representation of speech as a sequence of phonemes, as demonstrated in phoneme counting, deletion or reversal. This distinction was suggested by the observation that pre-literate children and illiterate adults are unable to perform intentional operations at the level of the phoneme while most literate children and ex-illiterates who learned to read and write as adults succeed in these tasks. Lack of phonemic awareness does not prevent the illiterates from being perfectly able to discriminate between pairs of stimuli that differ only in one phoneme or phonetic feature (Adrián et al. 1995; Scliar-Cabral et al. 1997). This dissociation has led to various theoretical developments (e.g., Kolinsky 1998; Morais & Kolinsky 1994; 1995).

Going back to vision, we suggest that comparing schooled to unschooled people can provide new insights into the distinction between what we call visual perception (early vision, according to Pylyshyn's terminology) and visual cognition (that part of vision penetrated by cognition according to Pylyshyn). Our own studies have shown that unschooled adults have serious difficulties performing tasks like part-verification, dimensional filtering, and orientation judgment, which require that attention is directed to a specific component of the stimuli (e.g., Kolinsky et al. 1990; 1987). By contrast, no difference is observed between unschooled and schooled adults in tasks which do not require such explicit selective attention and analysis, for example, when separability of parts or dimensions as well as line orientation registration are estimated by the occurrence of illusory conjunctions (i.e., errors in which properties correctly extracted from several objects are blended into a new, mentally created object,

We all are Rembrandt experts — or, How task dissociations in school learning effects support the discontinuity hypothesis

Régine Kolinskyab and José Moraisb

aFonds National de la Recherche Scientifique, B-1000, Brussels, Belgium;
bLaboratoire de Psychologie Expérimentale, Université Libre de Bruxelles, CP 191, B-1050 Brussels, Belgium.

rkolins@ulb.ac.be jmorais@ulb.ac.be

Abstract: We argue that cognitive penetration in non-early vision extends beyond the special situations considered by Pylyshyn. Many situations which do not involve difficult stimuli or require expert skills nevertheless load on high-level cognitive processes. School learning effects illustrate this point: they provide a way to observe task dissociations which support the discontinuity hypothesis, but they show that the scope of visual cognition in our visual experience is often underestimated.