A developmental exploration of the role of knowledge and perception on visual object recognition

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From the first moment a human opens their eyes their world is teaming with information, but how we come to recognize the visual objects that we perceive, and the extent to which increasing knowledge informs that recognition remains a point of debate within cognitive science. One view, suggests that recognition can operate absent activation of semantic knowledge based on stored visual representations. Alternatively, perception, recognition and semantic knowledge could be interactively engaged. To gain leverage on this question, researchers have studied adult patient populations who suffer from semantic loss due to neurodegeneration, so that in the degradation of knowledge we may come to understand something of its structure. However, in studies with patient populations, it is difficult to know whether the disease process may have conjointly affected both recognition and knowledge systems. Developmental studies provide an important contrast in which children have intact recognition processes but relatively immature conceptual knowledge.

We describe recent findings within two developmental studies that consider the role that semantic knowledge plays in visual object recognition. In a developmentally-adapted version of the over-regular animal task (OAT; see Figure 1) previously used within studies of semantic dementia patient populations, 3- and 5-year old children were asked to sort two cards depicting line-drawings of animals, presented side-by-side, into either the "real box" or the "silly box". As in the adult semantic dementia patient study, children more accurately sorted those animals that exhibit more domain level regularities (e.g., properties common to animals, like the donkey's flat back; Real>Nonreal) when compared to image pairs wherein the nonreal chimera exhibited more category general properties (e.g., the camel without a hump; Nonreal>Real). That is, young children were more likely to make errors on the camel than the donkey, choosing the flat-backed camel as real (see Figure 2).

So that we could explore this question absent the explicit task demands of label categorization while still allowing visual perception systems to be engaged, we used the same stimuli in a change-detection "flicker" paradigm wherein the individual images are presented for 500 ms with a blank white screen, also 500 ms, between each image. Using a touch-screen tablet within this change-detection design children were given the instruction to touch the part of the picture that was changing as soon as they found it. Children more rapidly detected the same visually and spatially aligned alternating feature (e.g., the hump/flat back) when presented on the more category prototypic animal (e.g., the donkey; Real>Nonreal) than when that same alternating feature was presented on the more category atypical animal (e.g., the camel; Nonreal>Real) a pattern that persisted within a cognitively normal adult sample (see Figure 3). These results converge with our findings from the sorting task, offering further support for the position that children's recognition of objects is influenced by their expanding general knowledge about the category of animals.

Together with work within semantic dementia populations these developmental findings suggest that visual recognition is interactively connected with both visual perceptual processes as well as semantic knowledge.

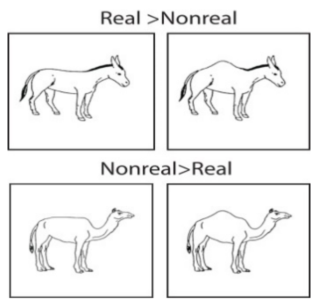

Figure 1. Examples of animal images used in prior research and the proposed studies.

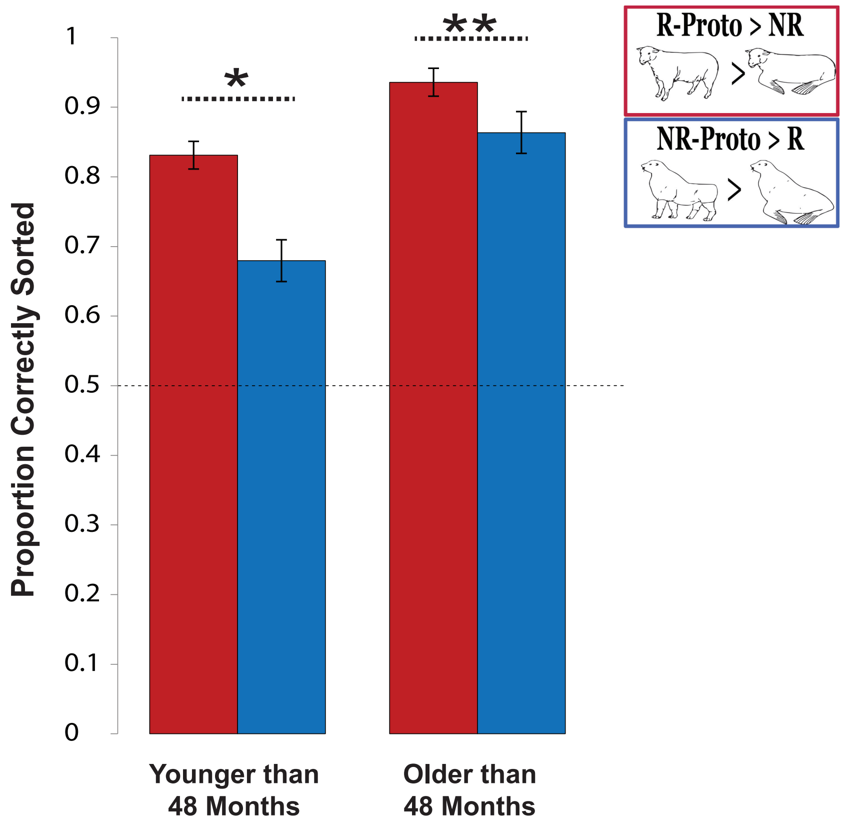

Figure 2. Behavioral results: Developmental OAT Experiment. Error bars show 95% confidence intervals of the mean.

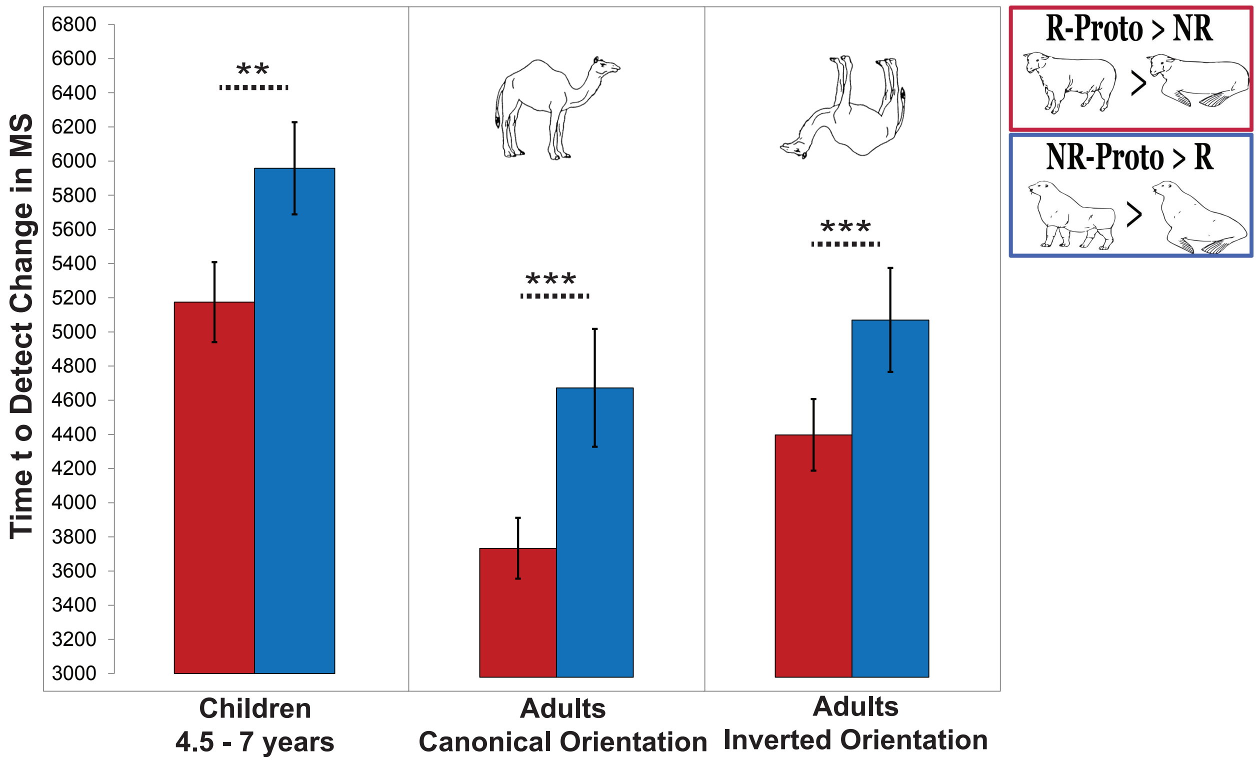

Figure 3. Behavioral results: Touch-screen Change-detection Experiment. Error bars show standard error of the mean.