From General to Specific:
A Developmental Exploration of the Influence of Conceptual Knowledge on Visual Recognition

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Short abstract:
The degree to which perceptual and recognition processes are independent of conceptual knowledge remains an open question. A few case studies have documented syndromes wherein object recognition appears intact while semantic information about the object is degraded, suggesting some independence. However, studies of semantic dementia patients suggest this pattern depends on target items being visually prototypical, while distractor items are visually unusual. 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. If patients' impairments arose through impaired visual recognition, children may show different patterns of performance from patients. In contrast, if the pattern arose through loss of semantic knowledge, children should show a similar profile to patients, identifying visually prototypical distractors as real over unusual-looking real items. By adapting the "over-regular animal task" we assessed recognition and naming in 3- and 5-year-olds, and found that young children tended to incorrectly choose visually prototypical chimeras as "real" items over their less prototypical (but presumably more familiar) counterparts providing support for the interdependence of perception, recognition and knowledge.

Long abstract:
A pervasive question for cognitive science concerns whether perceptual and recognition processes are independent of conceptual knowledge about the recognized objects. One view posits that recognition provides the gateway to knowledge, but does not depend upon knowledge to operate. Alternatively, perception, recognition, and knowledge could be interdependent and interactive. These questions have driven considerable research in neuropsychology, with equivocal results. A few case studies have documented syndromes in which object recognition appears intact while semantic information is degraded, suggesting some independence. However, this pattern depends on targets being visually prototypical, while distractor items are visually unusual. For instance, when shown an image of a donkey and a chimeric donkey with a humped back, patients choose the donkey as real. When shown a camel and a chimeric camel lacking a hump, however, the same patients incorrectly choose the chimeric item, which is more typical of animals. Indeed, the same patients can appear to show either completely intact or degraded object recognition, depending upon the structure of the testing items. This suggests that recognition draws upon semantic knowledge. This position is difficult to assess through neuropsychology alone, however, because the disease process may have conjointly affected both recognition and knowledge systems.

We attempt to adjudicate these positions by testing children's visual recognition using a task similar to the "over-regular animal task" used with neuropsychological populations. The task requires children to decide which of two line drawings is "real" and which is "silly". As in the patient work, trials involve either visually prototypical animal targets with visually atypical chimeric distractors (as in the donkey example), or visually unusual real items paired with more prototypical distractors (as in the camel example). If the recognition impairments in neuropsychological groups arise because the disease has spread to the visual

recognition system, children may show different patterns of performance from patients. In contrast, if the patient pattern arose through loss of semantic knowledge, children should show a similar profile to patients, choosing visually prototypical chimeras over unusual-looking real items.

We assessed recognition and naming in 3- and 5-year-old children using this task. Stimuli were paired across two within-subjects conditions. In the Real>Nonreal condition, the real animal was visually more prototypical than the nonreal item (as in the donkey example). Each such trial was paired with a trial in the Nonreal>Real condition, constructed so that the two items differed in the same part, but with the Nonreal item more visually prototypical than the Real item (as in the camel example). Items were matched for name frequency, adult-rated familiarity, and age of name acquisition. The central question was whether children's accuracy differed across conditions: if young children behave like patients with degraded semantic knowledge, they should show better performance when targets are prototypical and distractors are not (Real>Nonreal), but worse performance when distractors are more prototypical than targets (Nonreal>Real). In contrast, if children learn properties that differentiate basic-level categories (e.g., the camel's hump) first, they should perform equally in the two conditions.

On each trial, children were given two line drawings printed on laminated cards, one depicting a real animal (e.g., camel) and the other depicting a chimeric version of the animal (e.g., camel with no hump). Children were instructed to place the silly picture in the silly box (labeled "Silly" with a picture of a silly face) and the real picture in the real box (labeled "Real" with a picture of a happy face). Following their choice, the experimenter picked up the card in the "Real" box and asked the child to name the animal. At the end of the experiment, the experimenter selected the real animals that had been placed in the "Silly" box, then asked the child to name each in turn. This allowed us to assess (a) whether children recognized all the real animals sufficiently well to name them, as well as (b) what children thought the item were that had been incorrectly sorted into the "Real" box.

We compared the proportion of correct choices across conditions (Real>Nonreal, Real>Nonreal) and age groups (3 years, 5 years) for trials on which the child correctly named the animal. Results showed the same pattern as patients: greater accuracy for Real>Nonreal items (M=0.81) than Nonreal>Real (M=0.73), driving a significant main effect ($F_{1,\ 107}$=7.50, p=.008), with no difference across age groups (M_{3y}=0.77, M_{5y}=0.78). Thus, there was evidence for an "over-regular" concept in which distinguishing features were not robustly represented, even for items that children recognize sufficiently well that they can name them.

These results parallel the patient data: young children tended to incorrectly choose visually prototypical chimeras as "real" items over their less prototypical (but presumably more familiar) counterparts. The pattern cannot be due to lack of familiarity because items were matched for familiarity and age of acquisition, and also because the same patterns were observed even considering only those items that children were able to name. We consider two possible explanations for our results. First, children could have robust knowledge of domain-level regularities (e.g., properties common to animals) but weak knowledge of specific regularities (e.g., properties of camels). In this case children should show similar performance for any visual property, as is the case with semantically impaired patients. Alternatively, children may have difficulty attending to or integrating the different parts that compose each target and distractor item. For instance, when attending to one item with a hump and one without a hump, they may fail to notice the other features and simply choose the part that is more typical of the domain. In this case, the pattern arises because the target and distractor possess many different parts, only one of which differentiates them. We are currently conducting a follow-up study in which the targets and distractors differ only in color. If the results from our first study arose because young children do not have refined intermediate-level concepts, the same effect should be observed with color. If those results arose because children have difficulty processing multiple object parts, we might observe a different pattern with colors.