The touch of knowledge:
A developmental exploration of the impact of conceptual knowledge on visual recognition in a touchscreen change-detection paradigm

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Short abstract:
We investigated the role of semantic knowledge on object recognition using a touchscreen change detection task. Previously we found a developmental change in children's identification of animals as "real" versus "silly", with younger children choosing animals with more regular forms (e.g., a camel with no hump, a rhinoceros with no horn) as real. To ensure that our findings were not specific to the task of deciding which animals are "real", we used the same animal stimuli within a change detection task that had children locate a changing feature. On each trial, children (4 – 7-years-old) viewed a pair of line drawn animals that were identical except for a single feature that appeared and disappeared (e.g., a camel with and without a hump) and were instructed to touch the changing part as fast as they could. Children were faster to find changes when the feature appeared on more typical animals (e.g., a hump on a donkey) than less typical animals (e.g., hump on the camel). In accord with prior findings, we suggest that children's knowledge of animals informs their perception of the images, and that this knowledge is subserved by the covariation of shared features that come to shape a conceptual category.

Long abstract:
From the first moment a human opens their eyes their world is teaming with visual information, but how we come to recognize and understand the visual objects that populate our world remains an open question. Does visual perception support knowledge with no impact of knowledge in turn guiding perception? 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. Those studies suggest that both perceptual processes and semantic knowledge subserve visual recognition. 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.

The current research builds on our recent findings that 3- and 5-year-old children's recognition was influenced by their semantic knowledge in a two-alternative forced choice ("real" vs. "silly") task. In this study, two cards were presented side-by-side in front of the child, and the child was instructed to "put the real one in the 'real' box and the silly one in the 'silly' box". The two animals depicted on the cards always differed by only a single feature (e.g., a camel with versus without a hump on its back; a donkey with versus without a hump on its back). Across trials, the pairs were classified as either Real>Nonreal, wherein the real animal exhibits more domain-level regularities (e.g., properties common to animals, like the donkey's flat back), or Nonreal>Real in which the real animal exhibits specific characteristics (e.g., properties present in few animals, like the camel's humped back). As in the adult patient samples, children were more accurate in recognizing and sorting the real animal in the Real>Nonreal pairs compared to the Nonreal>Real pairs; that is, young children were more likely make errors on the camel than the donkey, choosing the flat-backed camel as real. This pattern of judgment, shared by both children and adult patients, in which line-drawn images of animals that exhibit features common to the categorical

domain of animals are more systematically recognized as “real”, suggests that semantic knowledge plays a critical role in visual recognition.

One potential limitation in the interpretation of these findings concerns the task instructions given to sort each contrasting animal image into labeled categories. Given the young age of our participant group, to accommodate our developmental cohort’s known vocabulary we instructed children to sort the images into categories of “real” or “silly”; however, the necessity to perform the task based on these labels may have resulted a different interpretation of the task than was present within the adult patient sample. Based on this concern, we developed a new experimental method that did not require verbal label assignment and therefore would not depend on children’s interpretation of “real” versus “silly”.

Change-detection requires neither “real” nor “unreal/silly” category selection and has been shown to have a roughly linear increase in abilities in-line with age. However, detection of a visual change is often based on the verbal self-report of participants. To address this potential confound, the described study employed a tablet-based changedetection research design. This provides a novel adaptation eliminating the need for selfreport, while also enhancing the basic measure of detection latency with a spatially informative touch-based indication of feature detection. By adapting a change-detection paradigm to a tablet-based interface we were able to address two key questions: (1) In the absence of the requirement to explicitly categorize or label images, will children’s time to detect a changing feature suggest a privileged status for animals that share compositional features common to the domain of animals? (2) Or, given the paired nature of the changing features (i.e., a hump presented on both the donkey and camel), will children demonstrate an equal ability to detect the change in visual representation, suggesting no impact of underlying visual feature regularities?

We assessed performance in participants aged 4 to 7 years (preliminary $n = 12$), using the same animal images used in the previous patient research and our prior study. In this “flicker” task, children were instructed that it was their job to find the “new” part of the picture, based on the images changing feature. Using the touchscreen tablet children were instructed to touch the “new” part as soon as they see it. Children located the changing feature on 3 practice trials, followed by 27 test trials. On each trial, the tablet collected both location (accuracy) and reaction time data. Between each trial, children were told to place their hands on an outline of two handprints on the experiment table, to avoid the influence of different hand positions on our reaction time measure. We compared the RTs across conditions (Real>Nonreal, Nonreal>Real) in children aged 4 to 7 years. After adjusting for each participants’ individual differences in overall RT, results showed a pattern wherein children selected the changing feature more quickly when it appeared in the Real>Nonreal images than Nonreal>Real animal depictions (paired- sample $t(11) = -2.42$, $p = .03$). That is, children were faster to find the hump on the donkey than the camel. 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. So that we can better understand how this increase in knowledge impacts recognition, we are currently recruiting additional participants across both our initial target age range (4 to 7 years), as well as older children (8 to 10 years) and adults, allowing analysis of the effect of age on performance across development. With this interest in mind, we have begun design modifications to the change-detection task interface that may allow younger children (2 to 3 years) to be included in future analysis.