Background

Our visual perception enables us to organize and process information in our environment. Indeed, we are surrounded by a nearly infinite amount of stimulation but are able to selectively attend to relevant input in everyday tasks, such as when driving a car, catching a baseball, or finding our keys. Research in cognitive science suggests that several factors contribute to this selective attention, such as perceptual saliency, abrupt onsets, and novelty (Chun & Jiang, 1998), and recent studies have demonstrated that non-obvious features such as repetition and familiarity also play a powerful role in this process. For example, some of the studies showing this effect have demonstrated that familiar (repeated) cues directly guide our attention to relevant information by constraining visual search (Brady & Chun 2007).

Chun and Jiang (1998) studied the familiarity phenomenon with a visual search paradigm by presenting participants with various configurations of stimuli. Half of the configurations were novel and half were repeated throughout the experiment. The task used the letter T as a target and the letter L as distracters surrounding the target. Results indicated that participants were able to find the target faster when configurations of distracters were repeated, indicating a contextual cueing effect in which learned information guides attention to the target. This effect is robust and has been replicated by a number of research findings.

Though the effect is robust in adults, it is unclear whether the effect is present in children, whose memory and attention are more limited. Studies conducted by Vaidya, Huger, Howard and Howard (2007) showed no effect among typically developing children 6 to 13 years old, but more recent work by Barnes et al. (2008) documented the effect with typically developing children 7 to 14 years, as well as children 8 to 14 years with Childhood Autism Spectrum Disorder. As these
studies have focused on older children, little is known about the role of visual context in young children.

Although contextual cueing has been rarely studied in children, recent developmental research suggests that children are sensitive to contextual information in some domains, such as early word learning, which is considered to be one of the initial developmental hurdles children face. This sensitivity makes it possible to discuss similarities between the contextual cueing effect and word learning. For example, at a very basic level, both word learning and contextual cueing rely heavily on selective attention and attentional shifting. To learn an object label, for example, a child must attend to relevant information, such as its shape. Indeed, Yoshida and Hanania (2007)'s work studying very young children (2 year olds) suggests how repeated visual features such as the shape of objects may guide children's attention to a target property while learning adjectives, and other studies suggest how familiar shape and its kind helps guide children's attention to a target property while learning new words (Imai, Gentner & Uchida, 1994). In this regard, the early-learned (thus familiar) shape may act as a context which helps shift children's attention to another property (e.g., color) when they learn more advanced lexical categories such as adjectives. Similarly, contextual cueing requires children to map contextual information to the target location. The configurations of distracters could be considered shapes that allow participants to selectively attend to the location of the target in much the same way as familiar shapes help children to guide their attention to a target property.

Word learning and contextual cueing may also be similarly affected by repetition. It has been demonstrated that children benefit from multiple exemplars when learning novel words (Mintz & Gleitman, 2002). For example, if a child is exposed to an apple in different contexts (in a tree, at the grocery store, in the refrigerator, etc.), then the relevant aspects of the label "apple" (e.g. shape, skin color, texture) are more likely to be learned. Similarly, when configurations of
stimuli are repeated in the contextual cueing task, relevant information (in this case the target locations) are more likely to be learned.

More specific to these phenomena, a form of mutual exclusivity may influence both word learning and contextual cueing. In word learning, mutual exclusivity occurs when a novel referent is assumed to refer to something other than a previously learned label. For example, if an English-speaking child is shown a blue cup that is covered in a novel texture and told "Look! This is daxish!" the child is likely to ignore the color blue and the shape of the cup and assume that the word "daxish" refers to the novel texture since he or she already knows the labels for those properties. Hansen and Markman (2009) found that children are better able to learn labels for novel parts of familiar objects than unfamiliar objects, indicating that mutual exclusivity helped children to correctly localize their attention. A form of mutual exclusivity could also contribute to the contextual cueing effect. It has been demonstrated that only a localized, limited portion of the repeated context is encoded during the contextual cueing task (Brady & Chun, 2007). Repeated context, then, may allow attention to be shifted away from the entire context to a more limited, relevant portion in much the same way that mutual exclusivity allows children to shift their attention away from a whole object to a specific dimension such as a target part of the whole object or a target property. Although the research involving contextual cueing and early word learning focus on similar mechanisms, the two fields have remained distinct.

This fissure in the literature between the robust ability of adults to utilize visual context and children's sensitivity to repeated shapes during word learning is the motivation behind this thesis. The purpose of this thesis will be to verify children's ability to learn visual context, identify conditions which are necessary for the effect to become manifest, and to determine when this capacity develops. This will open a dialogue between the two areas of research that should be beneficial to both groups in determining the mechanisms behind children's learning.
**Proposed Research**

To study these research questions two (possibly three) experiments will be conducted. The first experiment will test whether older children (10-13 years) are able to demonstrate a standard contextual cueing effect. Adults will also be tested for purposes of comparative analysis. In addition to 1’s and L’s, the researcher will use alternative sets of stimuli consisting of broken/whole crayons. One possible reason why children have produced ambiguous results in the contextual cueing task is that 1’s and L’s are not child-friendly. As such, stimuli that are more colorful and interesting to children may produce better results. In addition, using alternative stimuli will enable an analysis of the effect of stimulus complexity. 1’s and L's are simple contours of intersecting lines. It may be that children need a higher level of complexity in order to encode the locations of stimuli. Broken and whole crayons are more complex than 1’s and L's and may provide additional contextual information that children need to encode the relevant information. Pilot data with a very limited sample size have suggested that children do demonstrate a contextual cueing effect in the crayon condition and a moderate effect in the 1’s and L's condition.

A second experiment will further examine the role of stimulus complexity. The procedure will be similar to that of the first experiment except that stimuli will now consist of cracked and whole eggs. Eggs are also more child-friendly and familiar to children than 1’s and L's, but unlike crayons, eggs may offer less complexity than 1’s and L's and may actually be more difficult for children to encode as context. Comparing the results between the first two experiments should determine whether stimulus complexity plays a role in children's ability to learn visual contextual information. Pilot data suggest that children do not show a contextual cueing effect in the egg condition.

A tentative third experiment will attempt to determine when children develop the ability to
utilize repeated visual information by testing a contextual cueing-like task on children 2-7 years of age. A pilot study used an interactive procedure in which children were asked to find a target (a sea horse) among heterogeneous distracters (various sea creatures). Half of the configurations were repeated and half were novel. Data analysis failed to reveal a difference between conditions (familiar v. novel configurations). The inclusion of this experiment in the thesis will be dependent on the results of efforts to modify the procedure in order to find an effect.

Implications:

It may seem counterintuitive to attempt to draw connections between the adult phenomenon of contextual cueing and children's word learning because these seem to pertain to highly separate, specific domains. Despite this, many modern researchers of cognitive science have begun to suggest that learning may be much more universal across domains than previously assumed. Basic tools such as memory and attention may work together to guide development in highly similar ways across behaviors, perceptions, and regions of the brain, as in the case of mutual exclusivity. This thesis will attempt to provide evidence that memory and attention interact similarly across different ages and domains. If nothing else, this thesis will begin a discussion of how visual search and word learning may be attributable to the same, basic cognitive mechanisms.
References:


Thesis Timeline

August-September 2009

- Collect data for experiments 1 and 2
- Analyze data for experiments 1 and 2
- Develop method for experiment 3, begin data collection and analysis
- Literature search
- Topics:
  - Children's and adults' implicit learning
  - Children's performance in visual search tasks
  - Contextual integration in children
  - Children's physiological brain development in terms of visiospatial and contextual integration capabilities.
  - The role of context in word learning
  - The role of repetition in word learning
- Sample of questions guiding search:
  - When does children's ability to utilize contextual information develop?
  - What are some reasons (physiological, conceptual, etc.) why children would or would not be able to use contextual information to facilitate efficient search?
  - Are children less efficient at implicit learning tasks than adults, and if so, why?
  - What are the limits of children's implicit memory systems compared with those of adults?
  - What is the effect of the complexity of stimuli on visual search for children? For adults?
  - What is the effect of perceptual salience on visual search for children? For adults?
  - Is contextual cueing primarily a top-down or bottom-up phenomenon?
  - Does contextual cueing act as a map that guides attention to the target or as a filter that ignores distracter locations?
  - Contextual cueing and word learning both depend on associations (between configurations and target locations and between target words and target referents, respectively), but how are these associations similar or dissimilar?
October-November 2009

• Write first draft of introduction and conclusion of thesis
• Complete data collection for experiments 1, 2 and 3
• Continue literature search

December 2009-January 2010

• Revise introduction and conclusion
• Write first drafts of methods and results sections
• Complete data analysis for experiments 1, 2 and 3
• Review literature search February-March 2010
• Revise thesis as needed
• Review literature search April 2010
• Give thesis defense