Iso-salient color and luminance information in object identification

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Summary

What type of information can infants use to identify physical objects? Are certain features easier to use than others? How can we compare differences along two separate featural dimensions? In the present series of experiments, we studied object identification in young (6.5-month-old) infants using computer-generated stimuli. We contrasted two perceptual features: **color** and **luminance.**

First, a **preferential looking study** was conducted to determine the luminance difference that is equally salient to a predetermined color difference. This step represents a novel application of a well-established method to approach the elusive concept of **salience**.

Calibrating iso-salient stimuli is essential for sound comparison across different featural dimensions.

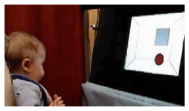
The second step consisted of the **memory test** for the **iso-salient** color vs. luminance pair. Our results show that infants at this age are **capable of identifying objects by color, but not by luminance**, where, crucially, the perceptual differences along those dimensions were equally salient.

Why salience?

Studies of infants' use of different features in object cognition (Wilcox, 1999; Kaldy & Leslie, 2003) faced difficult choices: for example, what kind of color change can be compared to a particular shape change? Differences in **visual salience (bottom-up priority value)** of objects constrained the interpretation of these earlier findings. Here we show a novel method to eliminate this problem and **create stimulus pairs where the featural differences are equally salient.**

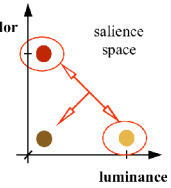
General method

Infants sat on their parent's lap and watched a computer-animated movie on a 17" LCD screen. Viewing distance was approx. 60 cm.



Step 1. Calibrating iso-salience

Using a preferential looking paradigm, we designed two stimulus pairs with **equally salient differences**:
- a brown-red (isoluminant) color pair and
- a brown-yellow (isochromatic) luminance pair.



Method

In each trial, infants saw two disks on a uniform brown background: a standard red disk (isoluminant to the background) and a lighter brown comparison disk (randomly chosen from 5 predetermined luminance levels).

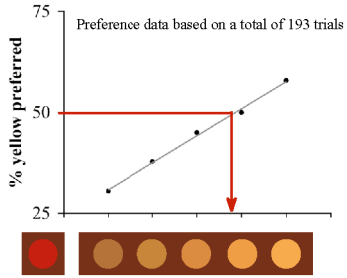
Stimuli were presented for 2 seconds, and were followed by a central fixation cross (2 s). A sound cue signalled the beginning of each trial. First looks (left/right) were coded by an experienced observer who was blind to the experimental stimuli. A max. number of 35 trials were run. The average number of trials completed by infants was 21.4 trials.

Subjects

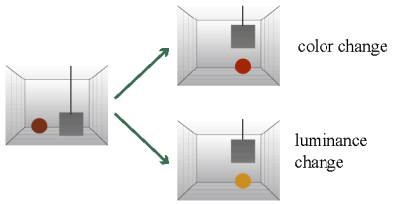
9 full-term infants (5 females) participated in the study (age range: 6 months, 0 days - 6 months 30 days, mean age: 6 months 14 days). 3 infants were excluded from the study due to observer error or fussiness.

Results

Preference ratios for the different luminance level disks (against the red standard) are shown below. From this psychometric function, the luminance value of the iso-salient (50% preferred) item can be determined.



Step 2. Comparing identification by color and by luminance



We tested object identification by color and by luminance with the violation-of-expectation method using the calibrated object pairs.

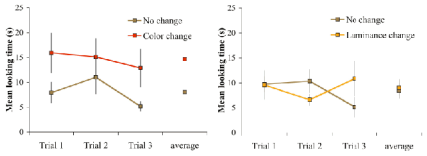
Method

Subjects were first familiarized to a pair of objects that differed in either color (brown vs. red) or luminance (brown vs. yellow). 4 familiarization trials (with alternating objects) were run. The color/luminance of the object in the first trial was counterbalanced. The familiarization trials were followed by 3 test trials. In these trials infants were shown one of the two objects in the familiarization pair, which then disappeared behind a screen. After a 2 second delay, either this same object, or the other object from the pair was revealed. The color/luminance of the hidden object alternated and their order was counterbalanced. Looking times were measured by two independent observers who were blind to the experimental conditions.

Subjects

40 full-term infants (17 females) participated in the study (age range: 6 months, 0 days - 6 months 30 days, mean age: 6 months 11 days), 10 in each condition. 6 infants were excluded from the study due to observer error or fussiness.

Results



significant memory for color
p = 0.029

no evidence for memory for luminance
p = n. s.

No other effects (age, sex, first object seen) were significant.

Visual salience is a crucial yet often neglected factor in infancy studies. Here we showed that this factor can be experimentally controlled using psychophysical methods.

Our results showed that (1) young infants can identify objects based on color, (2) color and luminance information are processed differently in infants' visual working memory.

We speculate that infants' better memory for color is adaptive, since the color of an object is a more reliable identifier than its luminance. Results of psychophysical studies with adults match our results (Sachtler & Zaidi, 1992; Wichmann et al., 2002).

While local changes in luminance are not good indicators of luminance...

local changes in color usually correspond to object boundaries.

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References

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