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Red to Green or Fast to Slow? Infants' Visual Working Memory for "Just Salient Differences"

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In this study, 6-month-old infants' visual working memory for a static feature (color) and a dynamic feature (rotational motion) was compared. Comparing infants' use of different features can only be done properly if experimental manipulations to those features are equally salient (Kaldy & Blaser, 2009; Kaldy, Blaser, & Leslie, 2006). The interdimensional salience mapping method was used to find two objects that each were one Just Salient Difference from a common baseline object (N = 16). These calibrated stimuli were then used in a subsequent two-alternative forced-choice preferential looking memory test (N = 28). Results showed that infants noted the color change, but not the equally salient change in rotation speed.

"Dynamic" features—how objects in the visual environment *move*—are often contrasted with "static" features, like objects' color and shape. In the developmental literature, infants' use of dynamic versus static features has been contrasted in category formation (Rakison, 2004; Rakison & Poulin-Dubois, 2002), object completion (Johnson & Aslin, 1996; Kellman & Spelke, 1983), and object individuation (Wilcox, Haslup, & Boas, 2010; Wilcox & Schweinle, 2003). The "tendency to attend to moving things over static ones" (e.g., Rakison, 2004, p. 4) has been supported in the infant literature (from Carpenter, 1974, to Dannemiller, 2000) and feeds the conventional wisdom that infants rely more on dynamic features of objects for search, memory, and identification tasks.

While the need for fair comparisons of feature use has been noted (Kaldy & Leslie, 2003; for dynamic vs. static stimuli in particular, see Rakison & Lupyan, 2008; see also Aslin, 2007), they have been notoriously difficult. For instance, if infants are surprised when a briefly occluded, rotating object is revealed with a faster rotation, but not when it is revealed with a different color, can we conclude that infants better remember dynamic features than static ones? What speed change should be chosen for this experiment? What color change? Of course, these choices will affect results. Changes along compared dimensions should be equally "noticeable" and "interesting" to the infant, that is, equally *salient* (Kaldy & Blaser, 2009; Kaldy et al., 2006; see also Koch & Ullman, 1985).

In Kaldy et al. (2006) and Kaldy and Blaser (2009) we introduced interdimensional salience mapping (ISM), a method for calibrating visual salience between feature dimensions. In this study we employ a more general ISM method that allows for the calibration of additional classes of stimuli. We also introduce here the notion of a *Just Salient Difference* (JSD): a perceptual difference minimally sufficient to produce a reliable preference for an object with respect to a particular visual context (as measured by, e.g., allocation of attention or gaze). Experiment 1 used ISM to calibrate a dynamic feature (rotational speed) against a static feature (color): producing stimuli that were each one JSD from a common baseline object. Experiment 2 used these calibrated stimuli in a—now fair—comparison of visual working memory (VWM). Contrary to conventional wisdom, we find infants more readily note when a briefly occluded object undergoes a color change than an (iso-salient) speed change.

Of course, not all studies require salience calibration. If the goal of a study is simply to show that, for instance, infants can use color information in VWM by 6 months, then one need only pick two

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stimuli with a dramatic color difference and perform a classic, brief-occlusion before–after test. But if one would like to investigate whether, say, color memory is better than shape memory at 6 months, that children with ASD have better color memory than typically developing children, or that color memory is better at 9 months than at 6 months, then a calibration should be attempted to tailor the before–after stimuli for each dimension or group.

Experiment 1: Salience Calibration for Color and Motion (Rotation Speed)

The goal of this experiment was to calibrate a set of three objects: a *baseline* object (stipulated to be a green, slow-rotating star), a *color comparison* that differed from the baseline only in color, and a *motion comparison* that differed only in (greater) rotation speed. Critically, the salience of the difference between the baseline and motion comparison should be equal to the salience of the difference between the baseline and color comparison (i.e., one JSD).

Method

Participants. Eight healthy, full-term 6-month-old (age = 149–213 days, M = 184 ± 20 days) infants (four females) participated in color calibration. Seven of the infants were White (two of them Hispanic), one of them African American. For motion calibration, eight healthy, full-term 6-month-old (age = 154–197 days, M = 170 ± 17 days) infants (three female infants) participated. All the infants were White (two of them Hispanic). Two additional infants were tested but excluded due to insufficient data (less than 50% useful data yield from the eye tracker).The average time the eye tracker successfully recorded gaze direction (had "lock") was 75% in the color calibration tests and 79% in the motion calibration tests. Caregivers in both Experiments 1 and 2 were recruited from a commercially available database of the Greater Boston area and received a small gift for participation. None of our infant participants had first-degree relatives with color blindness.

Apparatus, stimuli, and procedure. In our previous studies using ISM, gaze direction was coded by trained observers. In this study, we used a Tobii T120 eye tracker (running Tobii Studio 2.1.8 software; Tobii Technology, Stockholm, Sweden) to measure eye movements, which allowed greater precision and eliminated human coding errors. Participants sat on their caregivers' lap, approximately 70 cm away from the eye tracker's display in a dimly lit, isolated testing area. Caregivers wore occluding spectacles and were asked not to interact with their infants during testing. Before testing, infants performed the default Tobii 5-point infant gaze calibration.

Infants were run either in a 3.5-min block of color or motion calibration tests. In the 27-trial block, there were 20 *salience calibration* trials and seven *location cue* trials (the first three trials of every block were location cue trials and every 5th trial thereafter). In color blocks, on each calibration trial, the *baseline* object (always a green, slowly rotating [22.5 deg/s] star) was pitted against one of three candidate *color comparisons* (a blue, red, or purple star, rotating at identical speed and in the same direction as the baseline); on motion blocks, one of five possible *motion comparisons* (a star rotating at 68, 113, 158, 203, or 248 deg/s, identically colored to the baseline). Color values in 1931 CIE [x, y, fL] coordinates were as follows: background gray [0.353, 0.365, 72], baseline green [0.325, 0.596, 22]; isoluminant color comparisons: red [0.654, 0.336, 22], blue [0.202, 0.218, 22], purple [0.367, 0.207, 22]. The position of the comparison versus baseline (left–right) was randomized across trials. The intensity of the comparison object was chosen randomly, trial to trial, from the alternatives. Each trial was therefore a two-alternative forced choice (2AFC) preferential looking test, with infants either devoting their first look to the baseline or the comparison, similar to the ISM procedures we introduced before (Kaldy & Blaser, 2009; Kaldy et al., 2006). Before each trial, a small fixation cross flew in to the center of the screen to encourage central fixation, accompanied by the sound effect of a passing airplane. During the period while the test stimuli were presented, sounds of a ticking clock were played. All objects subtended approximately 3 × 3° of visual angle.

The critical innovation in this revised ISM method was that the baseline and comparison objects were embedded in a context of baseline objects (see Figure 1). This engages the bottom-up, "feature-contrast" mechanisms that support pop out and visual search. The greater the difference between the comparison and baseline, the more salient, and preferred, the comparison becomes (please see the Revised ISM Method subsection in the General Discussion for further discussion). Several studies have demonstrated that visual search processes that underlie pop out are functional early in infancy (Adler & Orprecio, 2006; Colombo, Ryther, Frick, & Gifford, 1995; Rovee-Collier, Hankins, & Bhatt, 1992). That said, while this method was

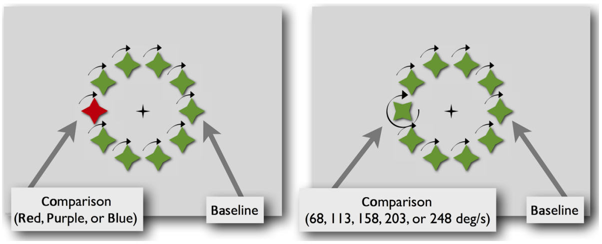

Figure 1. Examples of color and motion calibration test trials (Experiment 1). Here, the comparison item in the left panel (indicated by arrow) was red; all other items were green. Experimental stimuli were isoluminant. (Please see the online version of this article for the figure in color.)

designed to exploit the processes that support visual search, it was explicitly designed not to be a search task per se. Toward that end, the baseline and comparison objects always appeared in the left or right locations (randomly) in the context ring. As well, the first three trials in a block, and every fifth thereafter, was a *location cue* trial where two attention-grabbing objects (looming, rotating apples) appeared at the critical left or right locations immediately after stimulus onset, reducing spatial uncertainty about task events.

Results and Discussion

To measure gaze behavior, we defined circular areas of interest (AOIs) that minimally bounded the two critical objects. Time-to-first fixation (TFF) of the AOIs during the 3.5-s exposure was recorded. The earlier fixated object was considered preferred. As expected, the pattern of results showed that as the speed difference between the comparison and the baseline increased, infants tended to look at the comparison first more and more often (see Figure 2). Color comparisons were designed as categorically distinct from the baseline, and are plotted in increasing order of preference.

Of the three potential color choices, we chose the red comparison object, which was preferred 79% over baseline. (This reflects the iso-salience value closest to, but not below, the 75% level nominally defined as one JSD. In general, the choice of iso-salience level depends on one’s purposes. As we are looking to expose asymmetries in the use of feature information in subsequent VWM tests, a value too high may produce ceiling effects in subsequent tests, giving uninformative, positive results along both dimensions, while a value too low may produce floor effects, giving uninformative, negative results along both dimensions.) The 79% preference level defined the iso-salient motion comparison as 82 deg/s. (It is worth noting here that while continuous stimulus dimensions [like rotation speed] that produce monotonic functions of preference are convenient—for instance, because they allow interpolation—they are not necessary. Indeed, we treat our color dimension here as a nominal scale, only needing to find a color stimulus that was preferred over baseline at around 75%.) Put simply, our calibration method revealed that for 6-month-old infants, given our stimuli, the salience of the difference between 22.5 and 82 deg/s rotation speed was the same as the difference between green and red.

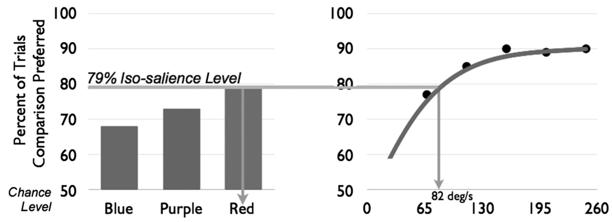

Figure 2. Results of Experiment 1: Color and motion (rotation speed) salience calibration. Graphed here is infants’ preference for the comparison object as a function of comparison color or speed. Color comparisons were categorical. In the case of speed, the data were fit with a cumulative normal function to allow for interpolation. The vertical axis represents the percentage of trials where the comparison was preferred to the baseline (green star rotating at 22.5 deg/s). We found that preference for the color comparison was 68% for blue, 73% for purple, and 79% for red. Preferences for the speed comparisons were as follows: 77% for 68 deg/s; 85% for 113 deg/s, 90% for 158 deg/s, 89% for 203 deg/s; and 90% for 248 deg/s. The 79% preference level, which we used as our Just Salient Difference (see main text) level, is shown by the gray line.

Experiment 2: Visual Working Memory for Color and Speed

Method

The goal of Experiment 2 was to determine whether infants have better VWM for color or motion (rotation speed). The basis of our VWM test is a 2AFC, before–after comparison: Two objects are presented, briefly occluded, and then reexposed with one having undergone a (one JSD) feature change. If and only if infants note this change from the remembered feature will they preferentially look at the changed object. This method is similar to the forced-choice novelty preference method of Chien, Palmer, and Teller (2003) and our own paradigm that we used to study infants’ iconic memory (Blaser & Kaldy, 2010). The main advantage of this method is that many trials can be run and interference between trials forces infants to rely on their working memory.

Participants. Twelve healthy, full-term 6-month-old (age = 154–204 days, M = 188 ± 21 days) infants (four female infants) participated in the color memory tests. All of them were White (two of them Hispanic). In the motion memory tests, 16 healthy, full-term 6-month-old (age = 150–218 days, M = 178 ± 18 days) infants (10 female infants) participated. Fourteen of them were White (one of them Hispanic), one Native American, and one African American. One additional infant was tested but excluded due to insufficient data. The average time the Tobii successfully recorded gaze direction was 78% in the color memory tests and 79% in the motion memory tests.

Apparatus, stimuli, and procedure. The apparatus and general setup were the same as in Experiment 1. After gaze calibration, infants were presented with a 4.75-min-long block of 15 memory test trials. Each trial started with a fixation cross that moved in from the upper right part of the screen to the center, accompanied by the sound effect of a passing airplane as in Experiment 1.

Experiment 1 had given us a *baseline* object (a green, 22.5 deg/s rotating star), a red *color comparison*, and a faster, 82 deg/s, rotating *motion comparison*. Here we refer to these stimuli according to their appearance: "slow-green," "slow-red," and "fast-green," respectively. Stimuli were identical in size and shape to those used in Experiment 1.

Infants were run either in a block of color or motion memory tests. In either case, they first saw three familiarization trials that presented a pair of objects (a pair of slow-greens, a pair of fast-greens or slow-reds, and a mixed pair) presented to the left and right of fixation for 4 s, accompanied by sounds of a ticking clock. Next to the outer edge of each object stood a small (6.5 deg × 6.5 deg) gray screen. (The screens' color in 1931 CIE [x, y, fL] coordinates was [0.353, 0.365, 72], identical to the background.) These screens were distinguished from the background by a thin white border and dark drop shadow (see Figure 3). The familiarization trials were followed by 12 test trials.

On test trials, infants were shown a pair of objects, again accompanied by sounds of a ticking clock (on motion test trials, infants were always presented with a slow-green object paired with a fast-green; on color trials, a slow-green paired with a slow-red) to the left and right of fixation (side randomized). After the 4-s initial exposure, the two screens slid inward to cover the objects. Each movement of the occluders was accompanied by mechanical sounds. After 2 s, the screens slid back to their original positions (it took 0.9 s for the screens to slide in or out, so the objects were fully occluded for 2.75 s), revealing two objects for 5 s. A harp trill went along with the exposure of the final outcome. One of the objects was revealed unchanged, while the other was changed (again, with side randomized). Importantly, this meant that the outcome was always two identical objects: in half of the trials two slow-greens, in the other half of the trials two fast-greens or two slow-reds (depending on test). Our independent variable was which of the two objects (the changed, "unexpected" or the unchanged, "expected" one) infants looked at first in the period immediately after the objects were revealed. Infants can only prefer one of the two identical objects over the other if they have stored some information about the features of the objects that were presented there prior to occlusion. In short, we are measuring how readily the infant noted an object's transition from red to green (or vice versa) versus a transition from fast to slow (and vice versa).

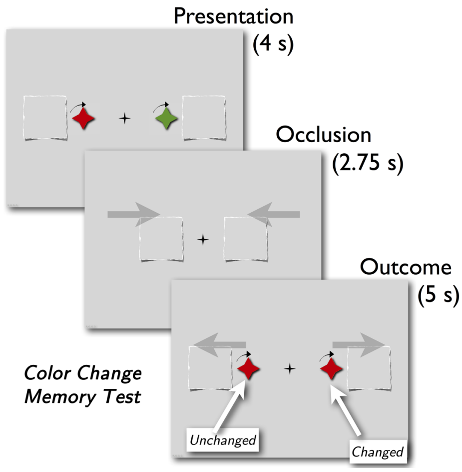

Figure 3. An example of a color memory trial from Experiment 2 (color change condition). During the initial presentation, a red item (here, on the left) and a green item were shown. After a brief occlusion, two identical items (here, red) were presented. Experimental stimuli were isoluminant. (Please see the online version of this article for the figure in color.)

Two attention-grabbing trials were mixed in the block after the fourth and the eighth test trials. Events in these trials were identical to the test trials, but 500 ms after the outcomes were revealed, two looming apple shapes appeared and occluded the test objects.

Results

First, we analyzed infants' looking patterns during the delay period. In 66.0% of the trials infants made at least one fixation at the central fixation cross during the delay. Infants rarely kept their eyes on one of the two screens during the delay (only 6.8% of all trials). Most often, they looked at the central fixation point and typically looked at both screens during the delay. There were no differences in these trends between the color and the motion tests.

In the outcome phase we defined minimally binding circular AOIs for the outcome pair. Fixations on these two AOIs were analyzed during the final 5-s outcome interval (starting from the first frame where any part of the objects became visible). We were interested in which of the two objects infants fixated first (TFFs).

Figure 4 shows the proportion of first looks to the changed object for individual participants and the group averages. We conducted binomial tests to find out whether performance was significantly different from chance. In the color memory test, infants looked first to the changed object in 82 of the 130 trials (63.1%, 95% CI [54.1%, 71.4%]), which is significantly different from chance (p = .0036, two-tailed test). In the motion memory test, infants looked at the changed object in 81 of the 184 trials (44.0%, 95% CI [37.1%, 52.1%]), not significantly different from chance (p = .121, two-tailed test).

It is also informative to analyze how infants' preference for the comparison object changed over the course of the 12 test trials. An advantage of our procedure is that we can collect many trials. However, fatigue in later trials may dilute effects. We found that in the color memory test, infants had even higher performance in early trials (66.2% average performance for first 6 trials, highly significantly different from chance, p = .01, two-tailed test) but decreased in the second half (58.7% performance, not significantly different from chance, p = .21). For the motion memory test, there was no similar trend: Results were indistinguishable from chance in both the first and second halves of the block: 42.7% and 45.4%, respectively (supporting the finding of a negative result in the case of motion memory).

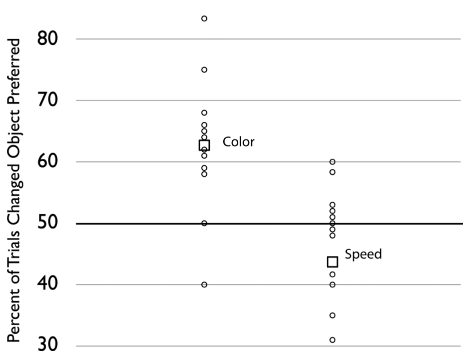

Figure 4. Results of Experiment 2. The figure shows the percentage of preference for the changed object by individuals (circles) and the group averages (squares) in the color versus motion (speed) memory tests. Infants significantly preferred the changed object when it changed color, but not when it changed speed.

Discussion

We showed here that it is possible to compare VWM for a static and a dynamic feature of an object. Our results showed that infants reliably noted when a briefly occluded object changed color, but not when it changed rotation speed. Crucially, this was a fair test, as the perceptual differences in these to-be-detected changes were known to be equally salient (each comparison object was a single JSD from a common baseline). In this case, the static feature trumped the dynamic.

Integration times do not affect the results. It is conceivable that the poorer VWM for motion could reflect, in part, potentially longer integration times for motion versus color stimuli. Under this idea, infants do not have time to fully compute the speeds of both objects after they are revealed before they, irresistibly and randomly, make their first eye movement. One way to test this is too look at the mean TFF, averaged over the two objects in the outcome phase, for color versus motion trials. If outcome influences integration time, these values may differ. However, these values were not significantly different: 992 ms in motion test and 953 ms in color test (two tailed t test: t = .397, ns). A better test for the effect of integration time on performance though is to separately analyze trials with short versus long TFFs. We bisected both the motion and color data sets by the median TFF (700 and 560 ms, respectively). We then compared infants' performance in the longer than median set to the shorter than median set. If integration time were a factor, then the longer TFF data set should show higher performance than the shorter TFF one. However, performance was indistinguishable: 64.0% versus 63.3% in the color test and 42.0% versus 43.8% in the motion test; chi-square tests showed that these values were not significantly different: $\chi^2(1)$ = .006, ns, $\chi^2(1)$ = .047, ns, respectively. This strengthens our conclusion that 6-month-olds have superior VWM for color than rotational speed.

General Discussion

In this study, we used our ISM procedure to determine iso-salient differences along the dimensions of motion and color. These dimensions were chosen in light of the ongoing interest in infants' relative use of static versus dynamic properties in object cognition, combined with the heretofore lack of formalized methods of comparison (see Rakison & Lupyan, 2008, for a discussion). Using ISM, we determined a rotational speed difference (22.5 vs. 82 deg/s) and a color difference (red vs. green) that each was one JSD from a common baseline (22.5 deg/s, green). These contrasts—from fast to slow, red to green—were then compared in, now fair, VWM tests. These VWM tests showed that infants' memory for color changes was better than that for speed changes. This is a proof of concept that dynamic and static features may be calibrated against one another and fairly compared in subsequent tests, and highlights the fact that dynamic features should not be thought to always trump static ones.

Revised ISM Method

In our earlier work (Kaldy & Blaser, 2009; Kaldy et al., 2006), we calibrated salience by placing a baseline and comparison item side by side and adjusting a feature value of the comparison (between trials) to produce a psychometric function of preference as a function of this value. For instance, as the comparison item got brighter, more highly saturated in color, or more complex in shape it was preferred more and more relative to the baseline. Comparison items with iso-salient differences from baseline (say, all preferred 75% of the time) could then be compared, fairly, in subsequent tests of VWM.

This earlier version of the salience mapping procedure, though, can only calibrate feature manipulations that render one item more salient than the other in that head-to-head competition. For example, the method would likely not be useful for calibrating orientation. Pitting comparison lines of various tilts against, say, a baseline horizontal line would not produce a meaningful psychometric function—for example, even the most extreme comparison, a vertical line, may be iso-salient to the horizontal comparison. As well, pitting various color comparisons against a green baseline item would likely not result in a useful psychometric function using this method either. However, even if there is no noticeable preference for, say, a blue comparison item versus a green baseline using the previous method, there is of course still a significant perceptual difference between blue and green. It is this perceptual difference that will influence memory tests and that our current, revised method is designed to isolate and measure.

In this study, our goal was to match the perceptual difference between two objects, slow-green and slow-red, to the perceptual difference between two other objects, slow-green and fast(er)-green. To do this, we needed to create a context where these perceptual differences have a *consequence*. For color, this can be done by embedding the slow-green baseline and slow-red comparison items in a context of slow-green items. Now the greater the perceptual difference between the comparison and baseline stimuli, the greater the relative salience—the greater the "pop out"—of the red comparison; this will drive preferential looking. (With the present feature dimensions and values, we would expect that the roles of baseline and comparison could have been swapped; for example, a green comparison in a context of baseline red stars would produce the same preference. This may not hold true for all stimuli.) We can then repeat this procedure for rotation speed, embedding the slow-green baseline and a fast(er)-green comparison again in a context of slow-green items. The speed of the comparison can be manipulated to produce a psychometric function of preference. From this we can then choose a perceptual difference that matches what was found for the color test. It should be noted that the use of this specialized display does not detract from the generalizability of the measurements. Analogous to an isoluminance calibration (see, e.g., Anstis & Cavanagh, 1983; Wagner & Boynton, 1972, for infants: Anstis, Cavanagh, Maurer, & Lewis, 1987), the display is optimized for isolating and calibrating a particular quality of the stimuli (in this case, "perceptual difference"), which is then applied in other displays. (Like matching wrestlers by weight class, the scales may be in the locker room, but the measured weights are still valid in the ring.)

There are choices to be made about display parameters (size, configuration, and spacing of the context items) that may affect measurements. While it is beyond the scope of this study to document the influence of these parameters (our immediate goal was to establish a proof of concept for this version of the salience calibration method), there is some literature that can guide these decisions. It seems wise to create a context that maximizes the salience, "pop out" effect that accompanies the perceptual difference between the baseline and comparison items. Nothdurft (2000) found that the salience of both a motion- or a luminance-defined singleton is maximized when the spacing of contextual items is about 1–3°; ours was spaced at about 1.77°. The only study with infants that looked at the same question (Dannemiller, 2005) tested motion-defined targets and found that in 4.5-month-olds, sensitivity monotonically increased as spacing decreased (within the tested range, to a minimum spacing of just under 3°). That said, more work needs to be done to specify the impact of these parameters. As well, in general, our approach to salience calibration—leveraging pop out to quantify perceptual differences—may be further validated against calibration methods that emerge from other laboratories, and by corroborating findings from studies using ISM calibrated stimuli to findings from other paradigms (e.g., other direct tests of speed vs. color in object cognition). Even acknowledging these caveats, employing salience calibration is more prudent than choosing stimuli informally, as it compels and guides a rationalization of stimulus choices.

Ecological Principles

Our VWM results are consistent with our *ecological principles* hypothesis, which holds that features that are more diagnostic of object identity will be better remembered (Kaldy & Blaser, 2009; Kaldy et al., 2006). Shape and color seem relatively stable, diagnostic features, while luminance and (rigid) motion do not (subject as they are to the vagaries of shadows and viewpoint): A lemon can undergo quite a range of lightness changes and still remain a lemon, but modest changes in hue or shape can quickly render it a lime or grapefruit. (While the ecological principles hypothesis allows for a principled standpoint from which to make predictions about the relative use of features in object cognition, it can only be a working hypothesis, as research on the statistical properties of natural scenes [Rosenholtz, Li, & Nakano, 2007] and formal modeling of objects' feature space [Feldman & Tremoulet, 2006] is ongoing.) The present results dovetail with our previous work that showed that 6.5-month-old infants have better VWM for color than luminance (Kaldy et al., 2006) and that 9-month-olds have better VWM for both shape and color than luminance (Kaldy & Blaser, 2009). As well, our current results are consistent with the findings of a classic study by Burnham and Day (1979). Although they used uncalibrated stimuli and tested long-term memory with a familiarization paradigm, their results showed memory for color (a change from a red to a green cross shape), but not motion (84 deg/s vs. stationary, or 84 vs. 42 deg/s; Burnham & Day, 1979).

The Just Salient Difference

Here we introduce the notion of a JSD, the minimum feature difference at which an object is reliably (nominally, 75%) preferred to a competitor (in a particular context). While analogous, the JSD is different from the Just Noticeable Difference (JND) of psychophysics (Weber's law; Weber, 1834/1978). The JND is best understood as determined by the signal-to-noise ratios in the sensory organs and low-level perceptual limitations. The JSD, though, is appropriate for differences that are suprathreshold, where the limiting factor is not perceptual, per se, but attentional. Clearly, both our red, 22.5 deg/s rotating star and green, 82 deg/s star are many JNDs away from our 22.5 deg/s green baseline, but they are both one JSD. The JSD is more general as well, useful where JNDs are ill defined; one could measure JSDs for an upside-down face versus a right-side-up one or a moving stimulus versus a static one. Differences aside, treating the JSD as a "unit," similar to the JND, makes obvious some interesting questions for later research: Are all JSDs the same size, following Fechner's law, or might they differ in size in different ranges of the feature dimension, thereby following Stevens' power law?

Here we showed how the JSD rationalizes choices for VWM stimuli, allowing us to compare memory for a one JSD color difference to memory for a one JSD motion difference. We anticipate applications in other areas as well. For instance, it may be useful to compare conjunction search performance when it has been established that each of the two sets of distractors is a single JSD from the target. In object identification studies, it may be informative to see when a single JSD change in *appearance* precipitates a perceived change in *identity* (e.g., is a single JSD change in, say, shape sufficient to convince a participant that a briefly occluded object has undergone an identity change, as opposed to just a change in appearance? What of a one JSD change in texture pattern or size?). However formalized, leveraging salience to measure the "size" of a perceptual difference provides a useful way to calibrate stimuli for use in fair tests of object cognition.

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