Published in final edited form as:

Child Dev. 2019 March ; 90(2): e246–e262. doi:10.1111/cdev.13053.

Familiar Object Salience Affects Novel Word Learning

Ron Pomper and **Jenny R. Saffran**

University of Wisconsin–Madison

Abstract

Children use the presence of familiar objects with known names to identify the correct referents of novel words. In natural environments, objects vary widely in salience. The presence of familiar objects may sometimes hinder rather than help word learning. To test this hypothesis, 3-year-olds ($N = 36$) were shown novel objects paired with familiar objects that varied in their visual salience. When the novel objects were labeled, children were slower and less accurate at fixating them in the presence of highly salient familiar objects than in the presence of less salient familiar objects. They were also less successful in retaining these word-referent pairings. While familiar objects may facilitate novel word learning in ambiguous situations, the properties of familiar objects matter.

The apparent ease with which children acquire words belies the difficulty of the task they face. To efficiently learn new words, children must attend to the correct referents when they are labeled. Children exploit a variety of cues to identify the correct referents of novel words, including speaker gaze, cross-situational statistics, and the presence of familiar objects with known names (e.g., Baldwin, 1993; Markman & Wachtel, 1988; Smith & Yu, 2008). Despite extensive research on how children use these cues to learn new words in experimental settings, less is known about how children use these cues in more naturalistic settings (e.g., Smith, Suanda, & Yu, 2014). One way to address this issue is to incorporate different components of children's natural word-learning environments into our experimental settings. The current research is focused on an important source of variability in more naturalistic settings: the types of familiar objects that are present during novel word learning. In particular, not all objects are equally interesting. In this study, we investigate how the salience of familiar objects influences children's ability to learn novel words.

Correspondence concerning this article should be addressed to Ron Pomper, 1500 Highland Ave. Rm. 537 Madison, Wisconsin 53706, University of Wisconsin–Madison, Madison, WI. Electronic mail may be sent to ron.pomper@wisc.edu.

Supporting Information

Additional supporting information may be found in the online version of this article at the publisher's website:

Figure S1. Images of Stimuli in the High Salience and Low Salience Conditions.

Figure S2. Sequence of Events for a Disengagement Trial.

Figure S3. Mean Proportion of Fixations to the Target Novel Object on Referent Selection Trials Averaged Across the Critical Window (300–1,800 ms) as a Function of Each Child's Peabody Picture Vocabulary Test (PPVT) Standard Score and Condition (the Visual Salience of the Familiar Distractor Object).

Figure S4. Mean Latency (in ms) to Shift From the Distractor Familiar Object to the Target Novel Object on Referent Selection Trials During the Critical Window (300–1,800 ms) as a Function of Each Child's Peabody Picture Vocabulary Test (PPVT) Standard Score and Condition (the Visual Salience of the Familiar Distractor Object).

Figure S5. Mean Proportion of Fixations to the Target Novel Object on Test Trials Averaged Across the Critical Window (300–1,800 ms) as a Function of Each Child's Peabody Picture Vocabulary Test (PPVT) Standard Score and Condition (the Visual Salience of the Familiar Distractor Objects During Referent Selection).

When shown a novel object in the presence of one or more familiar objects, children typically select the novel object as the referent of a novel word (Markman & Wachtel, 1988). This behavior may be the product of a lexical constraint, a preference for novelty, socio-pragmatic reasoning, or a combination of all three (Diesendruck & Markson, 2001; Halberda, 2006; Horst, Samuelson, Kucker, & McMurray, 2011; Markman, 1990; Mervis & Bertrand, 1994). Regardless of the underlying motivation, the tendency to select the novel object in response to a novel word, which we will refer to as *referent selection*, is conducive to word learning. Children's success in referent selection, however, does not guarantee that they will form and retain the novel word-referent pairing over time (Horst & Samuelson, 2008). Indeed, children do not retain a novel word-referent pairing following successful referent selection until 30 months of age (Bion, Borovsky, & Fernald, 2013).

Although children can use the presence of familiar objects in experimental settings to learn new words, the presence of familiar objects in naturalistic settings may be a double-edged sword. Salient familiar objects—like a favorite toy, pet, or food—may draw children's attention away from novel objects and their labels. Children's ability to use familiar objects to aid novel word learning may be affected by the salience of objects and events surrounding them. To provide a first test of this hypothesis, the current experiment examines whether familiar objects with high salience *hinder*, rather than help, children's ability to learn and retain novel words.

The salience of familiar objects is determined by both visual features (e.g., orientation, motion, luminance and color-contrast; Nothdurft, 2000) and higher level categorical features (e.g., newborns' preference for faces; Farroni et al., 2005; Johnson, Dziurawiec, Ellis, & Morton, 1991; Simion, Valenza, Cassia, Turati, & Umiltà, 2002). In the current experiment, we manipulated familiar objects' salience using both visual and categorical features. Familiar objects with *high salience* were animals, vehicles or foods that were brightly colored and contrasted sharply against a gray background. Familiar objects with *low salience* were household objects that were dull colored and did not contrast sharply against a gray background.

To succeed in referent selection involving a pair of objects (one novel and one familiar with a known name), children must systematically fixate and reject the familiar object before selecting the novel object as the referent of a novel word (Halberda, 2006). This process of elimination (also known as disjunctive syllogism) requires children to disengage their attention from the familiar object to shift to the novel object. Children's ability to disengage their attention from the familiar object during referent selection may be affected by that object's salience: Children may be slower and less accurate in disengaging their attention from a familiar object with high salience compared to low salience. Moreover, children's ability to disengage their attention from the familiar object in referent selection may vary based on individual differences in sticky visual attention. Prior research on familiar word recognition has found that children with stickier visual attention (measured by their performance in a visual disengagement task) are slower and less accurate in shifting from a distractor familiar object to a target familiar object (Venker, 2017a, 2017b).

By influencing children's attention during referent selection, the salience of a familiar object may have downstream consequences for word learning: The more accurate children are in identifying the referent of a novel word, the more likely they are to succeed in learning and remembering the word-referent mapping. Prior research suggests that manipulating children's attention to the novel object during referent selection influences their ability to learn and retain the novel object's name. Across several studies, children only successfully remembered the name of a novel object when it was labeled in the presence of relatively few familiar objects, when the same familiar object was repeatedly used across labeling events, or when their attention was directed away from the familiar object and toward the novel object (Axelsson, Churchley, & Horst, 2012; Axelsson & Horst, 2014; Horst, Scott, & Pollard, 2010). Individual differences in children's fixations to the novel object during referent selection predicted their success in word learning; children who were more accurate in fixating the novel object during referent selection were also more accurate on subsequent tests of word learning (Bion et al., 2013).

In contrast to the familiar objects typically used in laboratory tests of referent selection, the salience of familiar objects in children's natural environments will vary greatly across time and settings. The current experiment was designed to address two hypotheses concerning the effect of this variability in familiar object salience during referent selection. First, when children are shown a novel object and familiar object and hear a novel word, the salience of the familiar object will influence children's ability to identify the novel object as the referent of a novel word (referent selection). We predicted that after the onset of the novel word, children will be slower and less accurate in fixating the target novel object when the distractor familiar object has high salience compared to low salience. Second, the salience of the familiar object will influence children's ability to learn and retain the novel object's name (word learning). We predicted that when tested on their retention of novel word-referent mappings, children will be less accurate for novel objects that were initially labeled in the presence of a familiar object with high salience compared to a familiar object with low salience.

Furthermore, the current experiment was designed to address hypotheses about individual differences in children's visual behavior. First, children with stickier visual attention (measured using a visual disengagement task) will be slower and less accurate in referent selection, and this relation will be stronger when the familiar object has high salience compared to low salience. Second, children who were more successful in fixating the target novel objects during referent selection will be better at learning and retaining the names of the novel objects.

To test our hypotheses, 3-year-olds were given the opportunity to learn the names of four novel objects. On each referent selection trial, a novel object was labeled in the presence of a familiar object with a known name. The key manipulation concerned the salience of the familiar object. Two of the novel objects were always paired with familiar objects with *high* salience (high salience condition). The other two novel objects were always paired with familiar objects with *low* salience (low salience condition). Immediately after the referent selection phase, we tested whether children had successfully mapped the labels to their referents using the same paradigm. On each test trial, children viewed a pair of novel objects, and heard speech labeling one of the objects. The novel object pairs were yoked such that both objects were in the same condition during referent selection. We measured children's referent selection and word learning by tracking their fixations to objects while listening to sentences labeling the objects (Fernald, Zangl, Portillo, & Marchman, 2008). In addition, we measured children's sticky visual attention using a visual disengagement task (Landry & Bryson, 2004; Venker, 2017a, 2017b). We chose to test 3-year-olds because younger children have difficulty retaining novel object names after referent selection experiences (e.g., Bion et al., 2013; Horst & Samuelson, 2008).

Method

Participants

The final sample included 36 full-term children (19 female) with a mean age of 3 years and 4 months (range = 3;2–3;7). Parents reported that their children heard fewer than 10 hr per week of languages other than English and had normal hearing and vision. Eleven additional children were excluded because they did not have enough useable data for one or more experimental conditions ($n = 9$) or due to technical error ($n = 2$). No children in the final sample showed a side bias (i.e., looking at a single side of the screen for more than 80% of the time before target word onset across all trials). Children were recruited from a database of interested families living in or near a mid-sized city in the Midwestern United States. The demographics of the final sample included 31 children who were Caucasian, two who were Asian, one who was African American, and two who declined to report. All parents provided written informed consent and children provided oral assent. All experimental protocols, including the procedures for obtaining informed consent, were approved by the University of Wisconsin–Madison Institutional Review Board (IRB). Data were collected between March 2015 and August 2015.

Measure of Language Comprehension

Children's referent selection and novel word learning were assessed using the looking while listening procedure (Fernald et al., 2008). On each trial, children saw two pictures of objects displayed in silence for 1,000 ms. They then heard a sentence labeling one of the objects by name followed by a generic attention-getter phrase. The pictures remained on screen in silence for an additional 1,000 ms.

Visual Stimuli—Pictures consisted of four novel objects selected from the Novel Object & Unusual Name Database, 2e (NOUN; Horst & Hout, 2016) and 12 familiar objects (see Supporting Information). The novel objects were selected to be visually distinct from one another and roughly matched in visual salience. The familiar objects were selected such that their labels were highly familiar to children in our age range (MacArthur-Bates Communicative Development Inventory norms). Six of the familiar objects were both visually salient (brightly colored) and engaging (animals, vehicles, or foods). The other six familiar objects were less visually salient (dull colored) and less engaging (household objects). We experimentally validated our salience manipulation by comparing children's baseline fixations (see Results). The familiar objects in the high salience and low salience conditions were matched based on two measures: the proportion of 30-month-olds reported to say each word according to MacArthur-Bates Communicative Development Inventory (CDI) norms and the frequency with which each word occurred in the CHILDES database (see Table 1). In general, the objects' labels were slightly more familiar and more frequent in the high salience condition compared to the low salience condition. This small difference is unlikely to affect our results, and would run counter to our predicted effects.

Auditory Stimuli—Speech stimuli on each trial consisted of two sentences: a carrier phrase with the target word in the final position (e.g., "Find the pifo"), followed by an attention getter (e.g., "That's cool!"). Target words included 12 familiar words (the labels for each familiar object) and four novel words that were selected from the NOUN Database (Horst & Haut, 2016). Two of the novel words were monosyllabic (*sprock* and *jang*) and two were disyllabic (*pifo* and *tever*). The assignment of novel words to novel objects was counterbalanced across children. A female native speaker with a local Midwestern accent recorded multiple tokens of each sentence. Tokens were selected to have similar intonation contours and were edited using Praat to match duration and intensity (65 dB).

Trial Type—There was one warm up trial to familiarize children to the task. On this trial, children were shown two pictures of fireworks and heard a sentence directing their attention to the pictures ("Hey look at that! That's cool!"). The referent selection trials and test trials followed immediately thereafter. Children saw all referent selection trials before the test trials.

On *referent selection trials*, children were shown a pair of pictures depicting a novel and familiar object. On 12 trials, children heard a sentence labeling the novel object (e.g., "Find the pifo"); each novel object was labeled on three trials (e.g., see Figure 1). On an additional 12 trials, children heard a sentence labeling the familiar object (e.g., "Where's the cat?"); each novel object was a distractor on three trials. Trials with familiar object labels were not included in our analyses, but were necessary to ensure that children did not learn to ignore the familiar objects over time. Children did not receive any feedback about which object was the intended target. Two novel objects were assigned to the high salience condition and were always paired with familiar objects that had high salience. Two novel objects were assigned to the low salience condition and were always paired with familiar objects that had low salience. The assignment of novel objects and labels to the salience conditions was counterbalanced across participants. Referent selection trials were presented in pseudorandom order such that the same object was never the target on two consecutive trials and the location of the target object was not on the same side for more than three consecutive trials.

On *test trials*, children saw pictures of two novel objects and heard a sentence labeling one of those objects (e.g., see Figure 1). Both novel objects were always in the same salience condition during referent selection (e.g., both were paired with familiar objects with high salience during referent selection). There were eight test trials, with each novel object being labeled on two trials. Therefore, there were four test trials for novel objects in the high salience condition and four test trials for novel objects in the low salience condition. These test trials were interspersed with filler trials containing two familiar objects. Test trials were presented in a pseudorandom order such that the same object was never the target on two consecutive trials and the location of the target object was not on the same side of the screen for more than three consecutive trials.

Quantifying Fixations—Children's looking behavior was video recorded and eye movements were coded on a frame-by-frame basis (33 ms increments) by trained coders blind to target side. To determine reliability, 25% of the final sample was independently recoded using two measures: (a) the proportion of all frames on which coders agreed on the gaze location and (b) the mean proportion of shifts in gaze on which coders agreed within one frame. Reliability was 98.5% for the first measure and 96.1% for the second measure.

Mean accuracy: Children's accuracy was quantified as the proportion of time spent fixating the target object out of the total time spent fixating both the target and distractor objects. We calculated accuracy during two windows: a baseline window before the onset of the novel word (−1,633 to 0 ms) and a critical window after the onset of the novel word (300–1,800 ms; Fernald et al., 2008). Individual trials were excluded if the child was not fixating either object for more than 33% of the critical window (500 ms) or if the child was talking during the onset of the target word.

Latency: For the subset of trials on which children were fixating the distractor object at target word onset, we measured their latency to initiate a shift in fixation to the target novel object. Because reaction times (RTs) could only be measured for a subset of trials, these analyses include fewer trials than the accuracy analyses. For our RT analyses, we only included children who had at least two useable RTs in each condition. When applying these criteria to referent selection trials, nine children from our final sample were excluded, leaving a subsample of 27 children. When applying these criteria to test trials, 31 children from our final sample were excluded, leaving only a subsample of five children to calculate test trial RTs. Fewer children met the criteria for test trials, because there were fewer test trials (four in each condition) compared to referent selection trials (six in each condition). Due to the lack of data available to compute RTs for the test trials, only referent selection trials were included in the RT analyses.

Measure of Sticky Visual Attention

Individual differences in children's sticky visual attention were measured using a visual disengagement task (Venker, 2017a, 2017b). In this task, colorful, dynamic shape patterns are displayed on a center monitor and two side monitors. On *shift trials*, the central stimulus disappears before a stimulus appears on one of the side monitors. On *disengagement trials*, the central stimulus remains, whereas a stimulus appears on one of the side monitors (see Supporting Information and Venker, 2017a, 2017b, for detailed information). Because we were interested in measuring individual differences in children's sticky visual attention, our analyses focused on the disengagement trials (Venker, 2017a, 2017b).

Quantifying Sticky Visual Attention—Children's eye movements were recorded and coded on a frame-by-frame basis (33 ms increments) by trained coders. Children's sticky visual attention was quantified using two measures.

Latency: For trials on which children shifted from the center stimulus to the side stimulus, we measured their latency (in ms) to initiate a shift in fixation away from the center stimulus. We excluded latencies shorter than 100 ms, since they were likely to have been planned before the onset of the side stimulus. Latencies were averaged across all trials for each child, yielding a measure of their speed in visual disengagement. Consistent with prior research, we log-transformed latencies to adjust for a positively skewed distribution (Venker, 2017a, 2017b).

Time-outs: On some trials, children did *not* shift to the side stimulus, but remained fixating the center stimulus until the end of the trial. For each child, we calculated the proportion of valid trials that were time-outs. We used proportions rather than the raw number of timeout trials, because individual children varied in their number of valid trials. This proportion represents children's likelihood of *not* disengaging.

Measure of Receptive Vocabulary

Children's receptive vocabulary was measured using the Peabody Picture Vocabulary Test, 4th ed. (PPVT–IV; Dunn & Dunn, 2007). On each trial, children were shown four line drawings and asked to point to the picture that best matched the meaning of a spoken word. We used age-adjusted standard scores as our measure of receptive vocabulary. The pattern of results is unchanged if we instead use children's raw scores.

Procedure

Each session began with a 5-min briefing, during which the experimenter obtained written consent from the caregiver and verbal assent from the child. Both child and caregiver were then seated in a soundproof booth where the child completed the language comprehension task (referent selection & test trials; 5 min). They next completed the sticky visual attention task (3.5 min). For both measures, children were seated on their caregiver's lap approximately 2 feet away from a 55-in. LCD screen. Caregivers wore blacked-out glasses. Visual and auditory stimuli were presented using E-prime (Psychology Software Tools, Inc, Sharpsburg, PA) (language task) and Matlab (sticky visual attention task). Children's eye movements were recorded using a digital camera mounted below the television. Afterward, the child completed the PPVT–IV, whereas the caregiver filled out a demographic questionnaire.

Results

Model Structures

All analyses were carried out using linear mixed-effects models in which we regressed children's accuracy or latency in fixating the target object for each trial on condition (contrast coded as −0.5 for the high salience condition and 0.5 for the low salience condition). Following Barr, Levy, Scheepers, and Tily's (2013) recommendation, we included the maximum random-effects structure; each model included a by-subject random intercept and by-subject random slope for condition. For analyses of individual differences, the between-subject effect of interest (e.g., latency in the visual disengagement task) and its interaction with condition were added to the model. Additional analyses were run with the data from each condition separately; these analyses are not reported here, but confirm that the observed effects are not driven by one of the conditions. All analyses were carried out in RStudio (version 1.0.136) using the lme4 package (version 1.1–12; Bates, Mächler, Bolker & Walker, 2015).

Validation of Salience Manipulation

To validate our manipulation of familiar object salience, we first examined children's fixations on referent selection trials during the baseline window (before the onset of the target novel word). If our manipulation of salience was successful, children should fixate the target novel object less when it was paired with a highly salient familiar object than when it was paired with a less salient familiar object (see Figure 2). This is the pattern we observed. Before the onset of the target word, children were less likely to fixate the novel object on trials in the high salience condition ($M = 34.4\%$, $SD = 9.2\%$) compared to trials in the low salience condition ($M = 46.7\%$, $SD = 12.5\%$; see Figure 3). The within-subject effect of condition was statistically significant: $b = .12$, $F(1, 36.1) = 21.1$, $p < .001$. Children spent significantly more time fixating the familiar object with high salience than the novel object, $b = -.16$, $F(1, 34.9) = 92.8$, $p < .001$, but fixated the familiar object with low salience and the novel object equally, $b = -.03$, $F(1, 34.7) = 2.7$, $p = .11$. These results validate our experimental manipulation of salience.

The baseline window (−1,633 to 0 ms) included a period of time when the objects were displayed in silence (−1,633 to −953 ms) and in the presence of a spoken carrier phrase (−953 to 0 ms). Visual inspection of the time course of children's fixations suggests that differences in children's looking behavior between the two conditions (high salience vs. low salience) were attenuated during the carrier phrase portion of the baseline window (Figure 2). Indeed, the within-subject effect of condition was significantly moderated by time period (contrast coded as −0.5 for the silent period and 0.5 for the carrier phrase period), $b = -.13$, $F(1, 35.0) = 5.4$, $p < .05$. During the silent period of the baseline window, children were significantly less likely to fixate the novel object on trials in the high salience condition ($M = 40.0\%$, $SD = 16.1\%$) compared to trials in the low salience condition ($M = 58.6\%$, $SD = 17.9\%$), $b = .20$, $F(1, 35.7) = 19.4$, $p < .001$. During the carrier phrase period of the baseline window, however, the difference in fixations between trials in the high salience condition ($M = 32.8\%$, $SD = 12.5\%$) and the low salience condition ($M = 38.7\%$, $SD = 16.6\%$) was only marginally significant, $b = .07$, $F(1, 35.4) = 3.4$, $p = .07$.

These findings suggest that our manipulation of salience was perhaps attenuated by the onset of the carrier phrase. This observation must be interpreted, however, with two important caveats. First, there is a plausible alternative hypothesis: the effect of familiar object salience simply attenuates over time and this is independent of (but confounded with) the onset of the carrier phrase. Second, the decision to further split analyses within the baseline window was not a confirmatory test of an a priori hypothesis. Future research can determine whether the effect of salience attenuates with the onset of the carrier phrase or alternatively attenuates over time, by extending the silent portion of the baseline window. Although prior research has also found that children look significantly more often at a familiar object rather than a novel object during the baseline portion of referent selection, to our knowledge, no research has systematically compared children's fixations during the silent period and carrier phrase period of the baseline window (Byers-Heinlein & Werker, 2009, 2013; Mather & Plunkett, 2009; Schafer, Plunkett, & Harris, 1999; White & Morgan, 2008). We include this post hoc analysis to encourage future researchers to mindful of this distinction.

Referent Selection

Our first hypothesis was that the salience of the familiar object present during referent selection would influence children's accuracy in fixating the target novel object *after* it was labeled. Children were less accurate in fixating the target novel object after it was labeled in the high salience condition (M = 63.8%, SD = 10.6%) than the low salience condition (M = 72.9%, SD = 9.0%; see Figure 4). The within-subject effect of condition was statistically significant: b = .09, F(1, 34.8) = 12.2, p < .01. In both the high salience, b = .14, F(1, 34.8) = 62.1, p < .001, and low salience, b = .23, F(1, 34.4) = 158.8, p < .001, conditions, children were significantly above chance in fixating the target novel object. These results indicate that children were able to successfully identify the novel object as the referent of the novel word in both conditions, but they were less successful at referent selection in the high salience condition compared to the low salience condition.

Interpreting this difference in children's accuracy during the critical window of referent selection trials, however, is complicated by the difference in their accuracy during the baseline window. It is possible that the effect of condition during the critical window is driven entirely by differences in children's fixations at the onset of the critical window (see Figure 2). At the very least, the accuracy scores overestimate the effect of condition during the critical window. Baseline-adjusting children's accuracy during the critical window would potentially correct for these initial differences. However, in contrast to prior research that has used baseline-adjusted accuracy (e.g., McMillan & Saffran, 2016), our baseline differences in accuracy were intentional and therefore much larger. A baseline adjustment of this magnitude would be inappropriate for a bounded measure like accuracy (e.g., for a condition with 30% baseline accuracy, children have the potential to increase their accuracy by 70% during the critical window; for a condition with 50% baseline accuracy, however, children only have the potential to increase their accuracy by 50%). RT analyses provide an alternative method to deal with our baseline problem. Because RT analyses only include trials where children are fixating the distractor familiar object at target word onset, they equate the two salience conditions with respect to gaze location at the onset of the target word.

Therefore, as a further test of our first hypothesis, we examined whether the salience of the familiar object on referent selection trials influenced latency to shift from the familiar object to the novel object after it was labeled. Children's RTs were slower in the high salience condition (M = 700 ms, SD = 138.4 ms) than the low salience condition (M = 631 ms, SD = 135 ms; see Figure 5). The within-subject effect of condition was statistically significant: b = −87.9, F(1, 24.9) = 4.9, p < .05. We obtain the same effect of condition when we use log-transformed RTs, b = −.11, F(1, 24.9) = 4.4, p < .05. These findings further illustrate the effect of familiar object salience on children's ability to identify the referents of novel words. Crucially, the RT analysis avoids the interpretive difficulty in the mean accuracy analysis described earlier.

Word Learning

Our second hypothesis concerned the influence of familiar object salience during referent selection on word learning. Specifically, we predicted that children would be less accurate on test trials for novel word-referent mappings that were taught during referent selection trials in the high salience condition compared to the low salience condition. Visual inspection of the time course of fixations during test trials suggests that, in both conditions, children increased their fixations to the novel object after it was labeled (see Figure 6). Children were equally accurate in remembering the names of novel objects in the high salience condition (M = 51.9%, SD = 20.1%) and the low salience condition (M = 57.4%, SD = 21.4%; see Figure 7). The within-subject effect of condition was not significant: b = .07, $F(1, 34.2) = 2.5$, $p = .12$. Although there was no difference between conditions, planned comparisons were carried out to determine whether children's accuracy was significantly greater than chance in each condition. Children's accuracy in identifying the target novel object was significantly greater than chance in the low salience condition, b = .09, $F(1, 34.0) = 7.0$, $p < .05$, but not significantly different from chance in the high salience condition, b = .02, $F(1, 34.2) = 0.3$, $p = .59$.

Visual inspection of Figure 6 suggests that children's fixations are increasing, rather than leveling off or decreasing at the end of the critical window. Many prior studies of novel word learning have used longer time windows, although the exact durations of the windows vary (Bion et al., 2013; Booth & Waxman, 2010; Houston-Price, Plunkett, & Harris, 2005; Mather & Plunkett, 2010). We found similar results when we reran our analyses with the critical window extended by 1,000 ms (300–2,800 ms after the onset of the target word). The only difference was that the within-subject effect of condition was marginally significant, $b = -.07$, $F(1, 34.7) = 2.9$, $p = .096$. Taken together these results partially confirm our hypothesis that the manipulation of salience during referent selection affects children's ability to learn and retain word-referent mappings. Children were able to learn and retain the names of novel objects that were labeled in the presence of familiar objects with low salience, but not in the presence of familiar objects with high salience. With only a marginally significant difference between conditions, however, the evidence to suggest that children's word learning was more accurate in the low salience compared to the high salience condition is less robust.

Individual Differences in Sticky Visual Attention

Our third hypothesis concerned the relation between sticky visual attention and referent selection. We predicted that after hearing the target novel word, children with stickier visual attention would be slower and less accurate in shifting from the distractor familiar object to the target novel object. Moreover, we predicted that this relation would be stronger in the high salience condition than the low salience condition. For all analyses, we estimated two separate models for each measure of children's sticky visual attention (latency and timeout proportion).

Referent Selection Accuracy—Individual differences in children's latencies in the visual disengagement task did not predict their accuracy in referent selection. The between-subject effect of disengagement latency was not statistically significant ($p = .25$). The effect of disengagement latency was marginally moderated by condition, $b = -.11$, $F(1, 30.6) = 3.2$, $p = .08$ (see Figure 8). Children's disengagement latencies did not predict their accuracy during referent selection trials in the high salience condition ($p = .66$), but significantly predicted their accuracy in the low salience condition, $b = -.1$, $F(1, 30.3) = 4.3$ $p < .05$. Consistent with our predictions, children with slower latencies in the visual disengagement task (i.e., stickier attention) were significantly less accurate in fixating the target novel object during referent selection trials. Contrary to our predictions, however, this effect was only present when the familiar object had low salience.

The relation between children's proportion of timeout trials in the visual disengagement task and their accuracy in referent selection was trending toward significance. The between-subject effect of timeout trial proportion was marginally significant, $b = -.13$, $F(1, 29.2) = 3.6$, $p = .07$ (see Figure 9). This between-subject effect was not moderated by condition ($p = .64$). Consistent with our predictions, children with a greater proportion of timeout trials in the visual disengagement task (i.e., stickier attention) were less accurate in fixating the target object during referent selection. Contrary to our predictions, however, this effect was the same both when the familiar object had high salience and low salience.

Referent Selection Latency—Contrary to our predictions, children's disengagement latencies and proportion of timeout trials in the visual disengagement task did *not* predict their latency in referent selection. Moreover, neither effect was moderated by condition (p's $> .46$). We obtained the same null results when log-transforming children's latency in referent selection.

Individual Differences in Referent Selection

Finally, we hypothesized that individual differences in children's success in referent selection would predict their success in word learning. Specifically, children with higher accuracy on referent selection trials would have higher accuracy on test trials. Contrary to our predictions, however, individual differences in children's speed and accuracy during referent selection did *not* predict their accuracy in word learning (p's $> .22$).

Individual Differences in Receptive Vocabulary

Individual differences in the size of children's receptive vocabulary did not predict their accuracy or speed in referent selection, their accuracy in word learning, or their accuracy on familiar trials (p's $> .21$).

Discussion

In order to learn new words, children must correctly identify their referents. In experimental settings, children are able to use the presence of familiar objects with known names to successfully identify the referents of novel words (e.g., Markman & Wachtel, 1988). With successful referent selection, children learn and retain novel objects' names (Bion et al., 2013). In more natural settings, however, the presence of familiar objects may be a double-edged sword—at times hindering, rather than helping, children's word learning. The current experiment was designed to take a step toward examining children's ability learn new words in everyday environments by testing how differences in the salience of familiar objects influence novel word learning.

We tracked children's gaze behavior to measure their ability to identify the referents of novel words (referent selection) and learn and remember the novel word-referent mappings (word learning). During referent selection, a novel object was labeled in the presence of a familiar object with high salience or low salience. Children were above chance in fixating the target novel object after it was labeled in both salience conditions. However, children spent significantly less time fixating the target novel object both *before* and *after* it was labeled, and were slower to shift their gaze, in the high salience compared to the low salience condition. After referent selection, we tested word learning by labeling a novel object in the presence of another novel object. Children's accuracy was above chance when both objects were drawn from the low salience referent selection condition, but not the high salience referent selection condition. Although children's accuracy in word learning was numerically higher in the low salience condition compared to the high salience condition, this difference was not statistically reliable.

Taken together, these findings provide strong evidence that familiar objects with high salience interfere with children's ability to identify the referents of novel words and weaker evidence that the familiar object's salience interferes with word learning. Because we manipulated familiar object salience in multiple ways, it is impossible to determine whether the effect of salience was driven by changes in visual features, categorical features, or both. Another possibility is that the familiar objects' categories (independent of their salience) may affect children's novel word learning. Children more readily learn the names of novel objects from semantic categories for which they have high knowledge compared to low knowledge (Borovsky, Ellis, Evans, & Elman, 2016). The novel objects in the current experiment were not clearly identifiable as members of any specific semantic category (see Figure 1), as confirmed by name-ability scores for each object in the NOUN database (Horst & Hout, 2016). Moreover, the assignment of novel objects to each condition was counterbalanced across children. Differences in the semantic category density of the familiar objects, however, may influence novel word learning (Eiteljörge & Mani, 2017). Our familiar objects with high salience (animals, vehicles, foods) closely align with the high knowledge categories for children in Borovsky et al. (2016). Regardless of the underlying factor(s), the current findings support the hypothesis that not all familiar objects facilitate novel word learning.

Familiar object salience influenced children's attention both *before* and *after* the novel object was labeled during referent selection. Because individual differences in children's fixations during referent selection failed to predict their success in word learning, it is impossible to determine whether the effect of familiar object salience on novel word learning was driven by changes in children's fixations during one or both of these time windows. We believe that the changes in children's attention across the entire referent selection trial likely affected novel word learning. Failing to attend to a novel object after it is labeled makes it more difficult to form and retain the word-referent mapping (Bion et al., 2013). However, failing to attend to an object before it is labeled will also make this mapping more difficult. When children do not attend to a novel object until it is labeled, they must simultaneously encode both the novel object and novel word (Althaus & Plunkett, 2015; Kucker & Samuelson, 2012). By decreasing children's attention to the novel object before it was labeled, our manipulation of familiar object salience may have increased the encoding demands, impairing children's word learning.

Prior research using children's reaching behavior suggests that directing children's attention to the novel object during referent selection does not improve children's explicit choices in referent selection, but does improve word learning (Axelsson & Horst, 2014; Axelsson et al., 2012; Horst et al., 2010). In the current experiment, we did not measure children's manual selections during referent selection. While children sometimes pointed during the procedure, these responses were not elicited and were therefore sporadic. Future studies combining visual attention and manual selections, using real objects, would be informative about the relation between children's attention and their explicit choices during referent selection.

Our individual difference measures were largely unpredictive of children's performance in referent selection and word learning. Thus, the variance in children's performance is largely unaccounted for. There are several reasons why some of our individual difference measures were uninformative. We discuss these reasons separately for each individual difference measure next. Although it is difficult to interpret null results, it is our hope that this discussion will help inform future researchers to make more motivated choices in individual difference measures.

We found weak evidence that children with stickier visual attention were less accurate in fixating the target novel object during referent selection. This pattern is consistent with prior research, which has found that children with stickier visual attention are less accurate in fixating a target object during familiar word comprehension (Venker, 2017a, 2017b). Contrary to our predictions, however, children with stickier attention were not more affected by our manipulation of salience. This may be because our measure of sticky visual attention —the visual disengagement task—measures children's ability to shift between equally salient visual stimuli. Other measures of sticky visual attention using stimuli with mismatched salience may more accurately capture individual differences in how much familiar object salience affects word learning. Additionally, our measure of sticky visual attention did not provide sufficient statistical power for the analyses involving children's latency in referent selection. Not all children completed the measure of sticky visual attention and not all children had enough data to measure their latency in referent selection; the cross section of these subsamples included only 23 children.

Individual differences in children's accuracy in referent selection did not predict their accuracy in word learning. That is, children who were more successful in fixating the target novel object during referent selection were not more successful in fixating that novel object in subsequent tests of word learning. We do not believe that this lack of a significant relation was due to a lack of power. In prior research, the association between referent selection and word learning is fairly strong (f^2 = .27; Bion et al., 2013); a power analysis indicates that a minimum of 32 participants is necessary to have 80% power to detect this effect at an alpha of .05. While the lack of a relation in the current experiment is surprising, it serves as an important reminder that children's visual attention is necessary but not sufficient for word learning (e.g., Smith & Yu, 2013). Greater attention to a novel object does not guarantee greater success in encoding or retention, particularly when many children are failing to learn. Moreover, the lack of a relation between referent selection and word learning in the current research may be due to increased task demands. With lower cognitive demands and greater overall success in word learning, individual differences in children's accuracy in word learning are meaningful (e.g., a child with 80% accuracy is more successful in word learning than a child with 60% accuracy). With greater cognitive demands and lower overall success in word learning, however, it is less clear whether individual differences in children's accuracy are meaningful (e.g., is a child with 20% accuracy *less* successful in word learning compared to a child with 40% accuracy, when chance is 50%?). The increased salience of the familiar objects and greater number of novel word-object pairings in the current experiment undoubtedly led to higher cognitive demands compared to prior research (Bion et al., 2013). Indeed, visual inspection of Figure 7 reveals that a substantial portion of the variability in children's word learning consists of differences in accuracies systematically below chance (0%–50% accuracy).

Finally, individual differences in children's receptive vocabulary did not predict their success in referent selection, word learning, or even familiar word comprehension. Although there have been robust results linking vocabulary size to familiar word comprehension (e.g., Fernald, Perfors, & Marchman, 2006), there have been inconsistent and mixed results linking vocabulary size to referent selection and word learning. While there is substantial methodological variability between studies, we notice one general pattern: experiments that have found a significant association between vocabulary size and referent selection or word learning used measures of children's expressive vocabulary (Bion et al., 2013; Law & Edwards, 2015). Many of the experiments that have failed to find a relation—the present experiment included—used measures of children's receptive vocabulary (Hollich et al., 2000; Mather & Plunkett, 2009, 2010, 2012; cf. Horst & Samuelson, 2008; Kucker & Samuelson, 2012). Indeed, Law and Edwards (2015) collected measures of both expressive and receptive vocabulary, but only reported analyses involving expressive vocabulary. Although not indicative, this pattern suggests that children's expressive vocabulary, rather than their receptive vocabulary, is a better predictor of their success in referent selection and word learning. This may be because children are more likely to reject a familiar object as the referent of a novel word when they can both comprehend and produce its name rather than only comprehend its name (Grassmann, Schulze, & Tomasello, 2015).

Object salience has been shown to influence infants' and children's success in a diverse array of developmental tasks, including tasks measuring perseveration (Clearfield, Dineva, Smith, Diedrich, & Thelen, 2009; Doebel & Zelazo, 2015; Fisher, 2011), dual representations in scale models and math manipulatives (DeLoache, 1991, 2000; McNeil, Uttal, Jarvin, & Sternberg, 2009; Petersen & McNeil, 2013), and novel word learning (Hollich et al., 2000). By exploring different factors that influence children's success in developmental tasks, we arrive at a more nuanced understanding of children's development, which is dynamic and context dependent. In doing so, we gain a stronger appreciation for how the skills and behaviors we measure in the laboratory translate into the real world.

Despite our interests in naturalistic settings, our experimental setting lacked ecological validity in many ways: Children sat on their parent's lap in a sound-attenuated booth and viewed pairs of pictures accompanied by labeling frames. In more natural settings, children are moving through complex environments while hearing sentences labeling many different objects. These familiar objects are real and can be manipulated by the child (e.g., toys) or may themselves move around and make noise (e.g., pets). These features, which were absent from the current experiment, will likely further enhance the salience of familiar objects in children's dynamic environments and their effect on novel word learning.

Another significant way in which our experimental setting differed from more natural word learning environments was the number of objects that were present. In the current experiment, novel objects were labeled in the presence of only one familiar object. In everyday environments, however, children are surrounded by many familiar objects. It is unclear how familiar object salience will affect word learning when multiple familiar objects are present. Increasing the number of familiar objects may decrease the effect of a single familiar object with high salience. Alternatively, a single familiar object with high salience may "pop out" and capture children's attention regardless of the number of other familiar objects that are present. This is an important issue for future research to address by systematically varying the number and salience of familiar objects. Prior research using a reaching task found that each additional familiar object incrementally increases the amount of time children require to select a novel object as the referent of a novel word (Horst et al., 2010). This finding is consistent with the proposal that children consider and reject each familiar object (Halberda, 2006); and suggests that even in the presence of other familiar objects, a single familiar object with high salience would affect children's referent selection and word learning.

Children's earliest words predominantly refer to the most salient things in their environment: people, animals, food, toys, and vehicles (Nelson, 1973; Tardif et al., 2008). Children are learning the names of things that they can act on, as well as things that can act themselves; children are not learning the names of things that are simply there (Nelson, 1973). In closing, we note that our manipulation of salience parallels this distinction. Our highly salient familiar objects included animals, foods, and vehicles, whereas our less salient familiar objects mostly consisted of household furniture. Many theories of word learning propose that infants learn their earliest words by brute force and are able to leverage this knowledge (both vocabulary and syntax) to more readily learn new words (e.g., Bloom, 2000). Some theorists propose that a marked increase in the rate of word learning, or a "vocabulary spurt" is caused by the emergence of word-learning abilities like referent selection (Behrend, 1990; Golinkoff, Mervis, & Hirsh-Pasek, 1994; Markman, 1990; Mervis & Bertrand, 1994; Nazzi & Bertoncini, 2003; cf Bloom, 2000; McMurray, 2007). Our findings suggest that many of children's earliest words, by virtue of their salience, may not be as helpful for future word learning as was previously assumed. Instead, familiar objects have a more nuanced effect, potentially hindering as well as helping children's novel word learning.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This research was supported by an NICHD NRSA Grant funding Ron Pomper (F31 HD091969), Training Grants funding Ron Pomper from the NICHD (T32 HD049899, PI Maryellen MacDonald) and NIDCD (T32 DC05359, PI Susan Ellis Weismer), an NICHD Grant funding Jenny R. Saffran (R37 HD037466), a James S. McDonnell Foundation Grant to Jenny R. Saffran, and NICHD Core Grants funding the Waisman Center (P30 HD03352 & U54 HD090256).

References

Althaus N, Plunkett K. 2015; Timing matters: The impact of label synchrony on infant categorisation. Cognition. 139:1–9. DOI: 10.1016/j.cognition.2015.02.004 [PubMed: 25781891]

Axelsson EL, Churchley K, Horst JS. 2012; The right thing at the right time: Why ostensive naming facilitates word learning. Frontiers in Psychology. 3:1–8. DOI: 10.3389/fpsyg.2012.00088 [PubMed: 22279440]

Axelsson EL, Horst JS. 2014; Contextual repetition facilitates word learning via fast mapping. Acta Psychologica. 152:95–99. DOI: 10.1016/j.actpsy.2014.08.002 [PubMed: 25195163]

Bååath R. 2010; ChildFreq: An online tool to explore word frequencies in child language. LUCS Minor. 16:1–6.

Baldwin DA. 1993; Infants' ability to consult the speaker for clues to word reference. Journal of Child Language. 20:395–418. DOI: 10.1017/S0305000900008345 [PubMed: 8376476]

Barr DJ, Levy R, Scheepers C, Tily HJ. 2013; Random effects structure for confirmatory hypothesis testing: Keep it maximal. Journal of Memory and Language. 68:255–278.

Bates D, Mächler M, Bolker B, Walker S. 2015; Fitting Linear Mixed-Effects Models using lme4. Journal of Statistical Software. 67:1–48. DOI: 10.18637/jss.v067.i01

Behrend DA. 1990; Constraints and development: A reply to Nelson (1988). Cognitive Development. 5:313–330. DOI: 10.1016/0885-2014(90)90020-T

Bion RAH, Borovsky A, Fernald A. 2013; Fast mapping, slow learning: Disambiguation of novel word-object mappings in relation to vocabulary learning at 18, 24, and 30 months. Cognition. 126:39–53. DOI: 10.1016/j.cognition.2012.08.008 [PubMed: 23063233]

Bloom, P. How children learn the meanings of words. Cambridge, MA: MIT Press; 2000.

Booth AE, Waxman SR. 2010; A horse of a different color: Specifying with precision infants' mappings of novel nouns and adjectives. Child Development. 80:15–22. DOI: 10.1111/j.1467-8624.2008.01242.x.A

Borovsky A, Ellis EM, Evans JL, Elman JL. 2016; Lexical leverage: Category knowledge boosts real-time novel word recognition in 2-year-olds. Developmental Science. 19:918–932. DOI: 10.1111/desc.12343 [PubMed: 26452444]

Byers-Heinlein K, Werker JF. 2009; Monolingual, bilingual, trilingual: Infants' language experience influences the development of a word-learning heuristic. Developmental Science. 12:815–823. DOI: 10.1111/j.1467-7687.2009.00902.x [PubMed: 19702772]

Byers-Heinlein K, Werker JF. 2013; Lexicon structure and the disambiguation of novel words: Evidence from bilingual infants. Cognition. 128:407–416. DOI: 10.1016/j.cognition.2013.05.010 [PubMed: 23774635]

Clearfield MW, Dineva E, Smith LB, Diedrich FJ, Thelen E. 2009; Cue salience and infant perseverative reaching: Tests of the dynamic field theory. Developmental Science. 12:26–40. DOI: 10.1111/j.1467-7687.2008.00769.x [PubMed: 19120410]

DeLoache J. 1991; Symbolic functioning in very young children: Understanding of pictures and models. Child Development. 62:736–752. DOI: 10.2307/1131174 [PubMed: 1718666]

DeLoache JS. 2000; Dual representation and young children's use of scale models. Child Development. 71:329–338. DOI: 10.1111/1467-8624.00148 [PubMed: 10834468]

Diesendruck G, Markson L. 2001; Children's avoidance of lexical overlap: A pragmatic account. Developmental Psychology. 37:630–641. DOI: 10.1037//0012-1649.37.5.630 [PubMed: 11552759]

Doebel S, Zelazo PD. 2015; A meta-analysis of the Dimensional Change Card Sort: Implications for developmental theories and the measurement of executive function in children. Developmental Review. 38:241–268. DOI: 10.1016/j.dr.2015.09.001 [PubMed: 26955206]

Dunn, LM, Dunn, DM. Peabody Picture Vocabulary Test, Fourth Edition (PPVT-IV). Bloomington, MN: NCS Pearson Inc; 2007.

Eiteljörge, S; Mani, N. The interplay of word and category knowledge in early childhood; Poster Presented at the 42nd Annual Boston University Conference on Language Development; Boston, MA. 2017 Nov.

Farroni T, Johnson MH, Menon E, Zulian L, Faraguna D, Csibra G. 2005; Newborns' preference for face-relevant stimuli: Effects of contrast polarity. Proceedings of the National Academy of Sciences of the United States of America. 102:17245–17250. DOI: 10.1073/pnas.0502205102 [PubMed: 16284255]

Fernald A, Perfors A, Marchman V. 2006; Picking up speed in understanding: Speech processing efficiency and vocabulary growth across the 2nd year. Developmental Psychology. 42:98–116. DOI: 10.1037/0012-1649.42.1.98 [PubMed: 16420121]

Fernald, A, Zangl, R, Portillo, AL, Marchman, V. Looking while listening: Using eye movements to monitor spoken language comprehension by infants and young children. In: Sekerina, I, Fernandez, E, Clahsen, H, editors. Developmental Psycholinguistics: On-line methods in children's language processing. Philidelphia, PA: John Benjamins; 2008. 97–135.

Fisher AV. 2011; Automatic shifts of attention in the Dimensional Change Card Sort task: Subtle changes in task materials lead to flexible switching. Journal of Experimental Child Psychology. 108:211–219. DOI: 10.1016/j.jecp.2010.07.001 [PubMed: 20674930]

Frank MC, Braginsky M, Yurovsky D, Marchman VA. 2017; Wordbank: An open repository for developmental vocabulary data. Journal of Child Language. 44:677–694. DOI: 10.1017/S0305000916000209 [PubMed: 27189114]

Golinkoff RM, Mervis CB, Hirsh-Pasek K. 1994; Early object labels: The case for lexical principles. Journal of Child Development. 21:125–155. DOI: 10.1017/S0305000900008692

Grassmann S, Schulze C, Tomasello M. 2015; Children's level of word knowledge predicts their exclusion of familiar objects as referents of novel words. Frontiers in Psychology. 6:1–8. DOI: 10.3389/fpsyg.2015.01200 [PubMed: 25688217]

Halberda J. 2006; Is this a dax which I see before me? Use of the logical argument disjunctive syllogism supports word-learning in children and adults. Cognitive Psychology. 53:310–344. DOI: 10.1016/j.cogpsych.2006.04.003 [PubMed: 16875685]

Hollich GJ, Hirsh-Pasek K, Golinkoff RM, Brand RJ, Brown E, Chung HL, Rocroi C. 2000; Breaking the language barrier: An emergentist coalition model for the origins of word learning. Monographs of the Society for Research in Child Development. 65(Serial No. 3):i–vi. 1–123. DOI: 10.1111/1540-5834.00090

Horst JS, Hout MC. 2016; The novel object and unusual name (NOUN) database: A collection of novel images for use in experimental research. Behavior Research Methods. 48:1393–1409. DOI: 10.3758/s13428-015-0647-3 [PubMed: 26424438]

Horst JS, Samuelson LK. 2008; Fast mapping but poor retention by 24-month-old infants. Infancy. 13:128–157. DOI: 10.1080/15250000701795598

Horst JS, Samuelson LK, Kucker SC, McMurray B. 2011; What's new? Children prefer novelty in referent selection. Cognition. 118:234–244. DOI: 10.1097/MPG.0b013e3181a15ae8.Screening [PubMed: 21092945]

Horst JS, Scott EJ, Pollard JA. 2010; The role of competition in word learning via referent selection. Developmental Science. 13:706–713. DOI: 10.1111/j.1467-7687.2009.00926.x [PubMed: 20712736]

Houston-Price C, Plunkett K, Harris P. 2005; "Word-learning wizardry" at 1;6. Journal of Child Language. 32:175–189. DOI: 10.1017/S0305000904006610 [PubMed: 15779882]

Johnson MH, Dziurawiec S, Ellis H, Morton J. 1991; Newborns' preferential tracking of face-like stimuli and its subsequent decline. Cognition. 40:1–19. DOI: 10.1016/0010-0277(91)90045-6 [PubMed: 1786670]

Kucker SC, Samuelson LK. 2012; The first slow step: Differential effects of object and word-form familiarization on retention of fast-mapped words. Infancy. 17:295–323. DOI: 10.1111/j.1532-7078.2011.00081.x [PubMed: 22661907]

Landry R, Bryson SE. 2004; Impaired disengagement of attention in young children with autism. Journal of Child Psychology and Psychiatry, and Allied Disciplines. 45:1115–1122. DOI: 10.1111/j.1469-7610.2004.00304.x

Law F II, Edwards JR. 2015; Efects of vocabulary size on online lexical processing by preschoolers. Language Learning and Development. 11:331–355. DOI: 10.1080/15475441.2014.961066 [PubMed: 26508903]

Markman EM. 1990; Constraints children place on word meanings. Cognitive Science. 14:57–77. DOI: 10.1207/s15516709cog1401_4

Markman EM, Wachtel GF. 1988; Children's use of mutual exclusivity to constrain the meanings of words. Cognitive Psychology. 20:121–157. DOI: 10.1016/0010-0285(88)90017-5 [PubMed: 3365937]

Mather E, Plunkett K. 2009; Learning words over time: The role of stimulus repetition in mutual exclusivity. Infancy. 14:60–76. DOI: 10.1080/15250000802569702

Mather E, Plunkett K. 2010; Novel labels support 10-month-olds' attention to novel objects. Journal of Experimental Child Psychology. 105:232–242. DOI: 10.1016/j.jecp.2009.11.004 [PubMed: 20031152]

Mather E, Plunkett K. 2012; The role of novelty in early word learning. Cognitive Science. 36:1157–1177. DOI: 10.1111/j.1551-6709.2012.01239.x [PubMed: 22436081]

McMillan BTM, Saffran JR. 2016; Learning in complex environments: The effects of background speech on early word learning. Child Development. 87:1841–1855. DOI: 10.1111/cdev.12559 [PubMed: 27441911]

McMurray B. 2007; Defusing the childhood vocabulary explosion. Science. 317:631.doi: 10.1126/science.1144073 [PubMed: 17673655]

McNeil NM, Uttal DH, Jarvin L, Sternberg RJ. 2009; Should you show me the money? Concrete objects both hurt and help performance on mathematics problems. Learning and Instruction. 19:171–184. DOI: 10.1016/j.learninstruc.2008.03.005

Mervis CB, Bertrand J. 1994; Acquisition of the novel name-nameless category (N3C) principle. Child Development. 65:1646–1662. DOI: 10.2307/1131285 [PubMed: 7859547]

Nazzi T, Bertoncini J. 2003; Before and after the vocabulary spurt: Two modes of word acquisition? Developmental Science. 6:136–142. DOI: 10.1111/1467-7687.00263

Nelson K. 1973; Structure and strategy in learning to talk. Monographs of the Society for Research in Child Development. 38(Serial No. 1/2):1–135. DOI: 10.2307/1165788

Nothdurft HC. 2000; Salience from feature contrast: Additivity across dimensions. Vision Research. 40:1183–1201. DOI: 10.1016/S0042-6989(00)00031-6 [PubMed: 10788635]

Petersen LA, McNeil NM. 2013; Effects of perceptually rich manipulatives on preschoolers' counting performance: Established knowledge counts. Child Development. 84:1020–1033. DOI: 10.1111/cdev.12028 [PubMed: 23240867]

Schafer G, Plunkett K, Harris PL. 1999; What's in a name? Lexical knowledge drives infants' visual preferences in the absence of referential input. Developmental Science. 2:187–194. DOI: 10.1111/1467-7687.00067

Smith LB, Yu C. 2013; Visual attention is not enough: Individual differences in statistical word-referent learning in infants. Language Learning and Development. 9:1–27. DOI: 10.1080/15475441.2012.707104

Simion F, Valenza E, Cassia VM, Turati C, Umiltá C. 2002; Newborns' preference for up-down asymmetrical configurations. Developmental Science. 5:427–434. DOI: 10.1111/1467-7687.00237

Smith LB, Suanda SH, Yu C. 2014; The unrealized promise of infant statistical word-referent learning. Trends in Cognitive Sciences. 18:251–258. DOI: 10.1016/j.tics.2014.02.007 [PubMed: 24637154]

Smith L, Yu C. 2008; Infants rapidly learn word-referent mappings via cross-situational statistics. Cognition. 106:1558–1568. DOI: 10.1016/j.cognition.2007.06.010 [PubMed: 17692305]

Tardif T, Fletcher P, Liang W, Zhang Z, Kaciroti N, Marchman VA. 2008; Baby's first 10 words. Developmental Psychology. 44:929–938. DOI: 10.1037/0012-1649.44.4.929 [PubMed: 18605825]

Venker CE. 2017a; Spoken word recognition in children with autism spectrum disorder: The role of visual disengagement. Autism. 21:1–9. DOI: 10.1177/1362361316653230

Venker, CE. Visual disengagement relates to familiar word recognition in children with and without autism. Talk presented at the biennial meeting of the Society for Research in Child Development; Austin, TX: 2017b Apr.

White KS, Morgan JL. 2008; Sub-segmental detail in early lexical representations. Journal of Memory and Language. 59:114–132. DOI: 10.1016/j.jml.2008.03.001

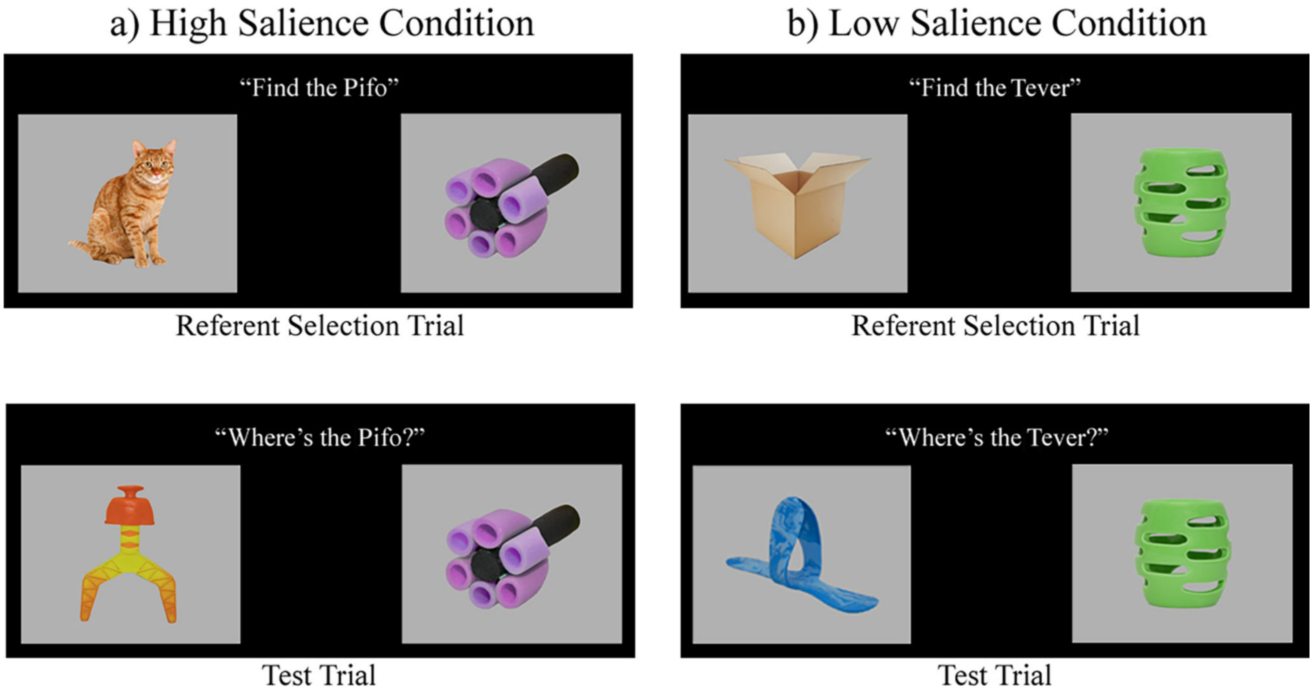

Figure 1.

Examples of referent selection trials and test trials in the high salience and low salience conditions.

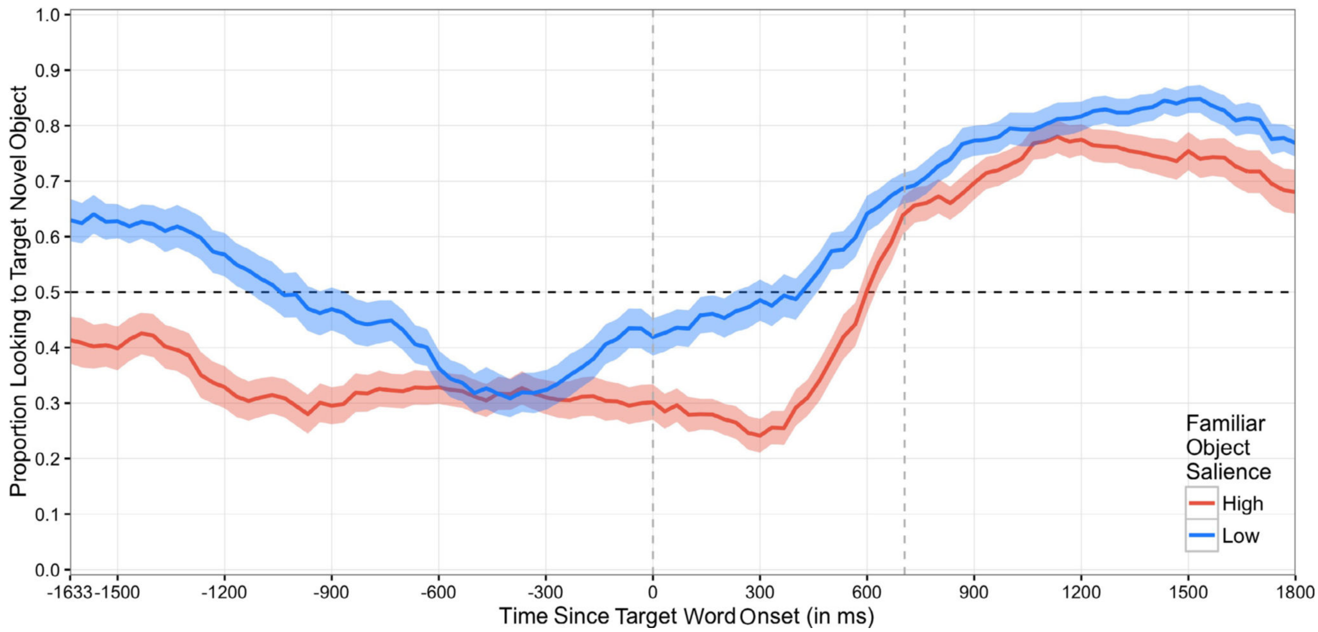

Figure 2.

Mean proportion of fixations to the target novel object on referent selection trials as a function of time (from the onset of the target novel word) and condition (the visual salience of the familiar distractor object). Lines represent the proportion of fixations to the target novel object in 33 ms increments averaged across children. Ribbons around the lines indicate ±1 *SE*. The dashed vertical lines represent the onset and offset of the target novel word.

Author Manuscript
Author Manuscript
Author Manuscript

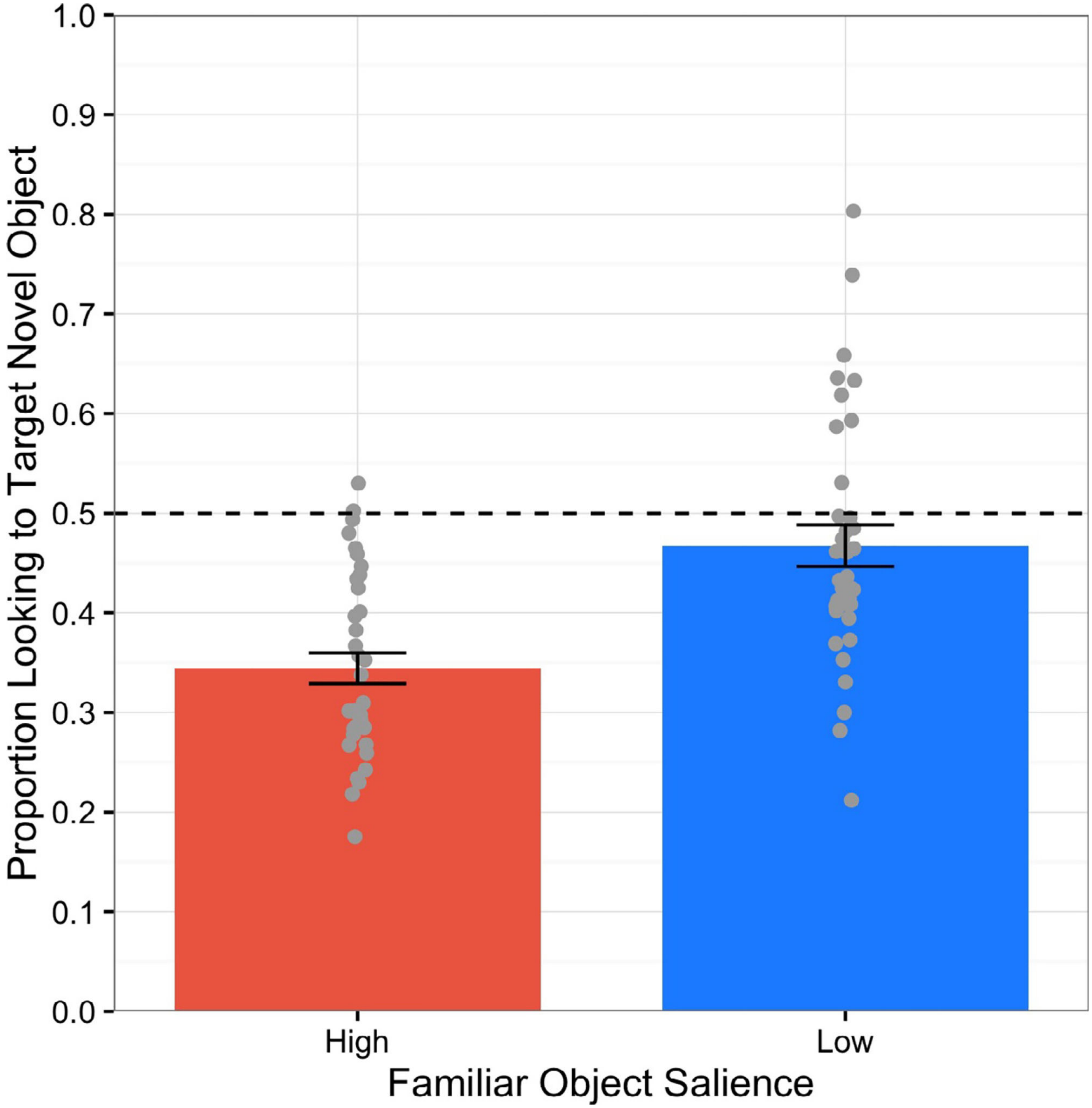

Figure 3.
Mean proportion of fixations to the target novel object on referent selection trials averaged across the baseline window (−1,633 to 0 ms from novel word onset) as a function of condition (the visual salience of the familiar distractor object). Data points represent the proportion for each child averaged across trials. Error bars represent ±1 *SE*. The dashed horizontal line at 50% marks equal looking to the target novel object and distractor familiar object.

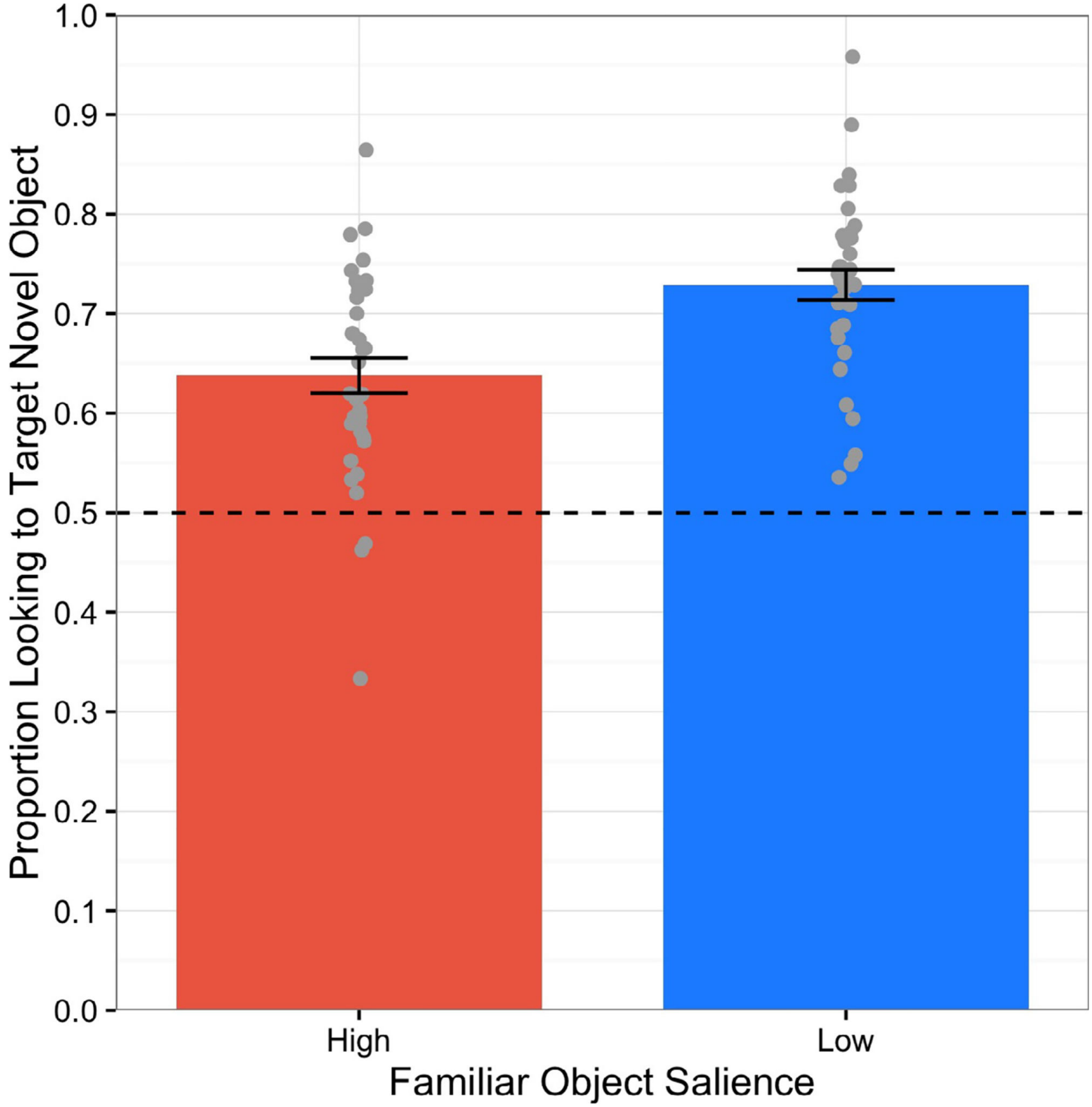

Figure 4.
Mean proportion of fixations to the target novel object on referent selection trials averaged across the critical window (300–1,800 ms) as a function of condition (the visual salience of the familiar distractor object). Data points represent the proportion for each child averaged across trials. Error bars represent ±1 *SE*. The dashed horizontal line represents chance (i.e., 50% or equal looking to both the target novel object and distractor familiar object).

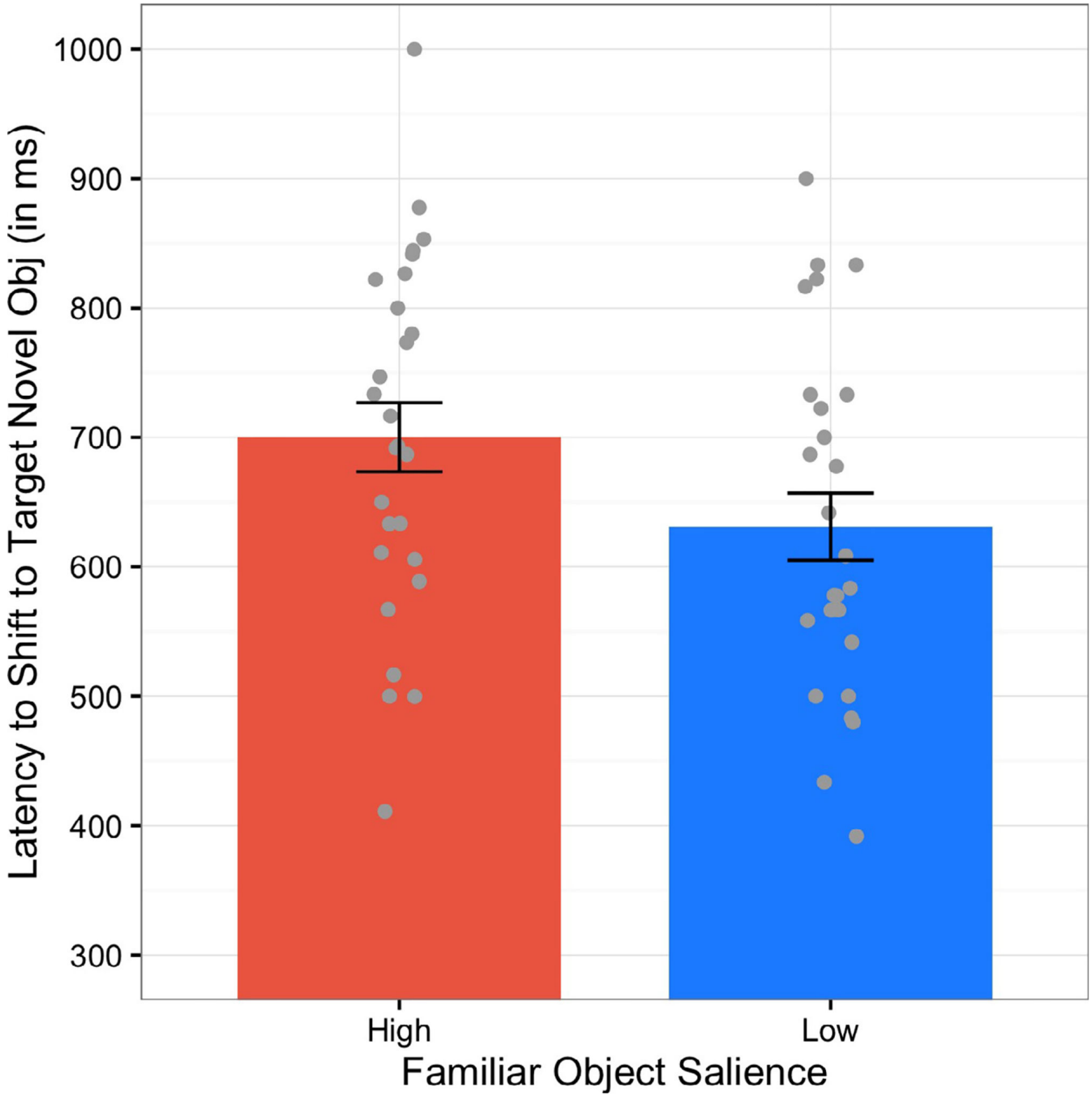

Figure 5.
Average latency (in ms) to shift from the distractor familiar object to the target novel object on referent selection trials during the critical window (300–1,800 ms) as a function of condition (the visual salience of the familiar distractor object). Data points represent the latency for each child averaged across trials. Error bars represent ±1 *SE*.

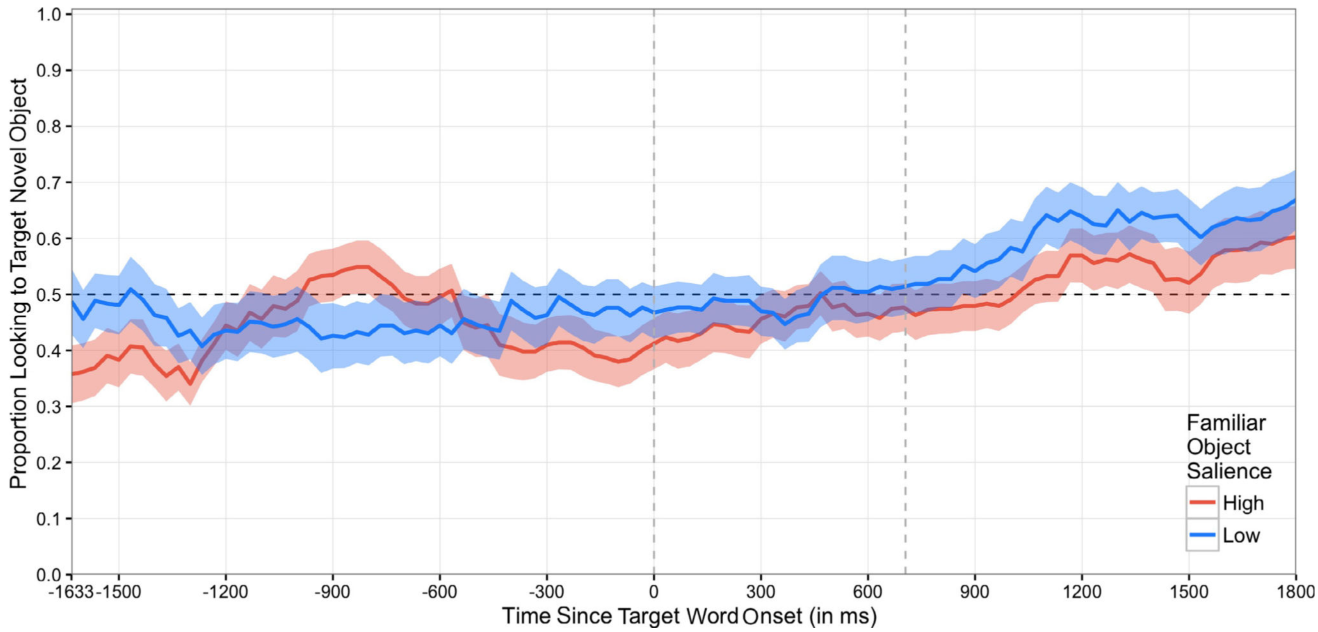

Figure 6.

Mean proportion of fixations to the target novel object on test trials as a function of time (since the onset of the target novel word) and condition (the salience of the distractor familiar object paired with the novel object during training). Lines represent the proportion of fixations to the target novel object in 33 ms increments averaged across children. Ribbons around the lines indicated ±1 *SE*. The dashed vertical lines represent the onset and offset of the target novel word.

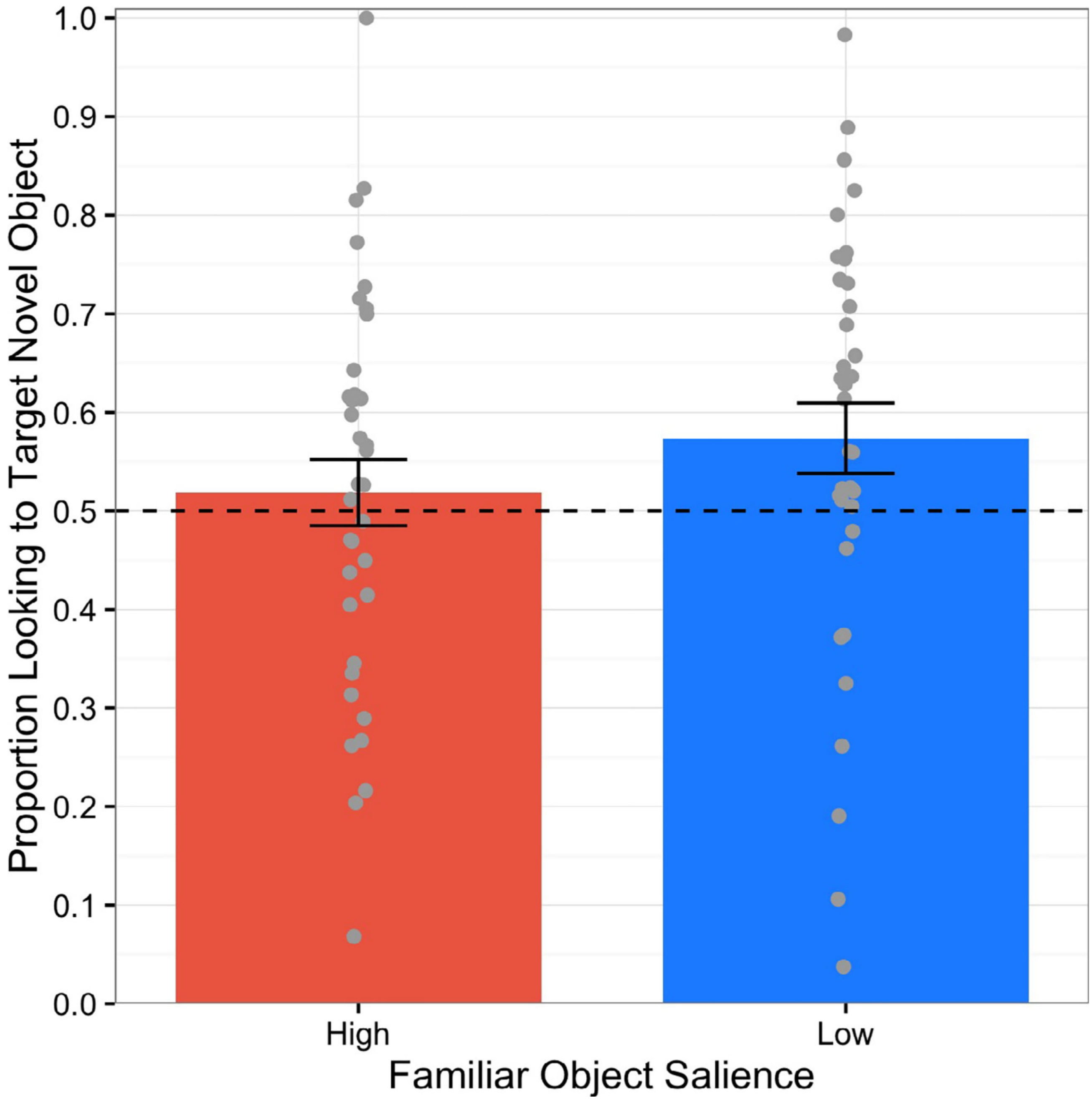

Figure 7.

Mean proportion of fixations to the target novel object on test trials averaged across the critical window (300–1,800 ms) as a function of condition (the visual salience of the familiar distractor object). Data points represent the proportion for each child averaged across trials. Error bars represent ±1 *SE*. The dashed horizontal line represents chance (i.e., 50% or equal looking to both the target novel object and distractor novel object).

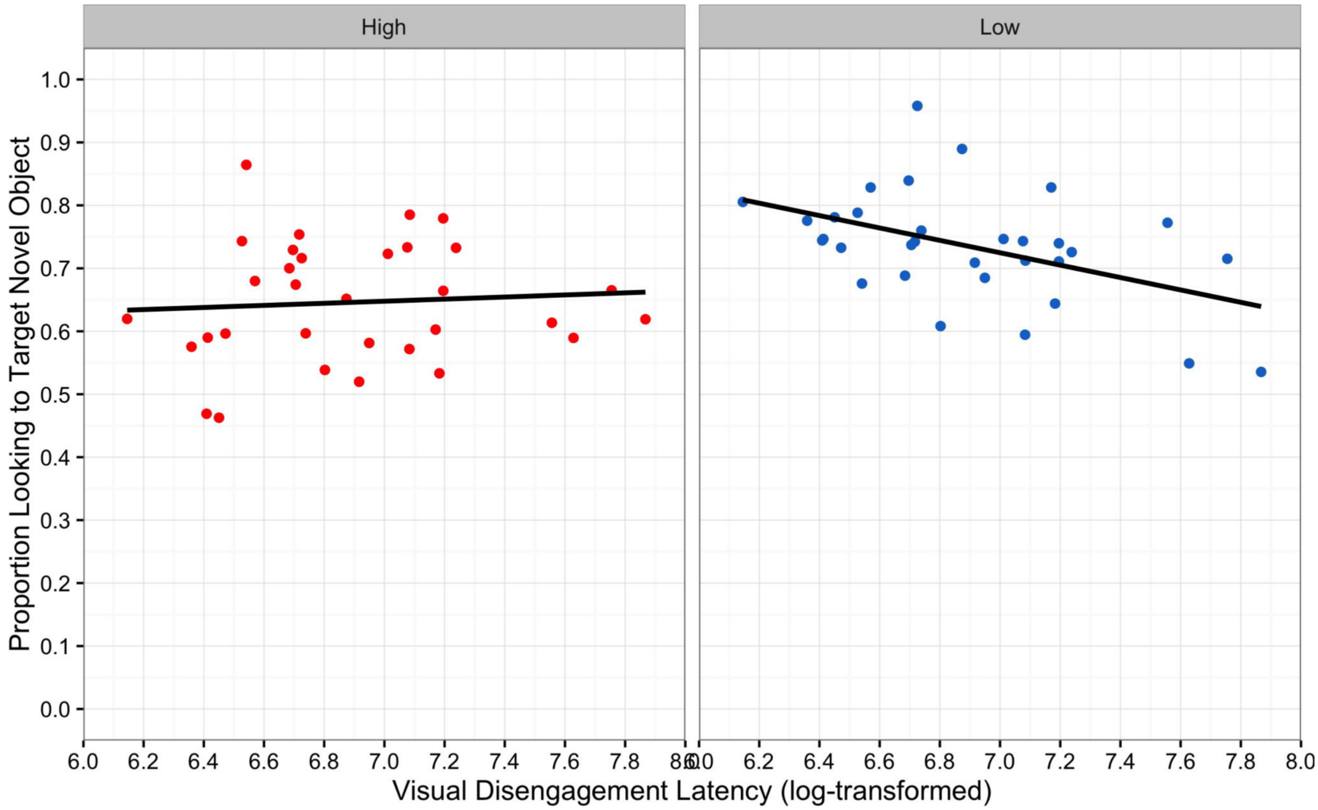

Figure 8.

Mean proportion of fixations to the target novel object on referent selection trials averaged across the critical window (300–1,800 ms) as a function of each child's average latency in the visual disengagement task and condition (the visual salience of the familiar distractor object). Data points represent the proportion for each child averaged across trials. The black lines represent the linear best fit.

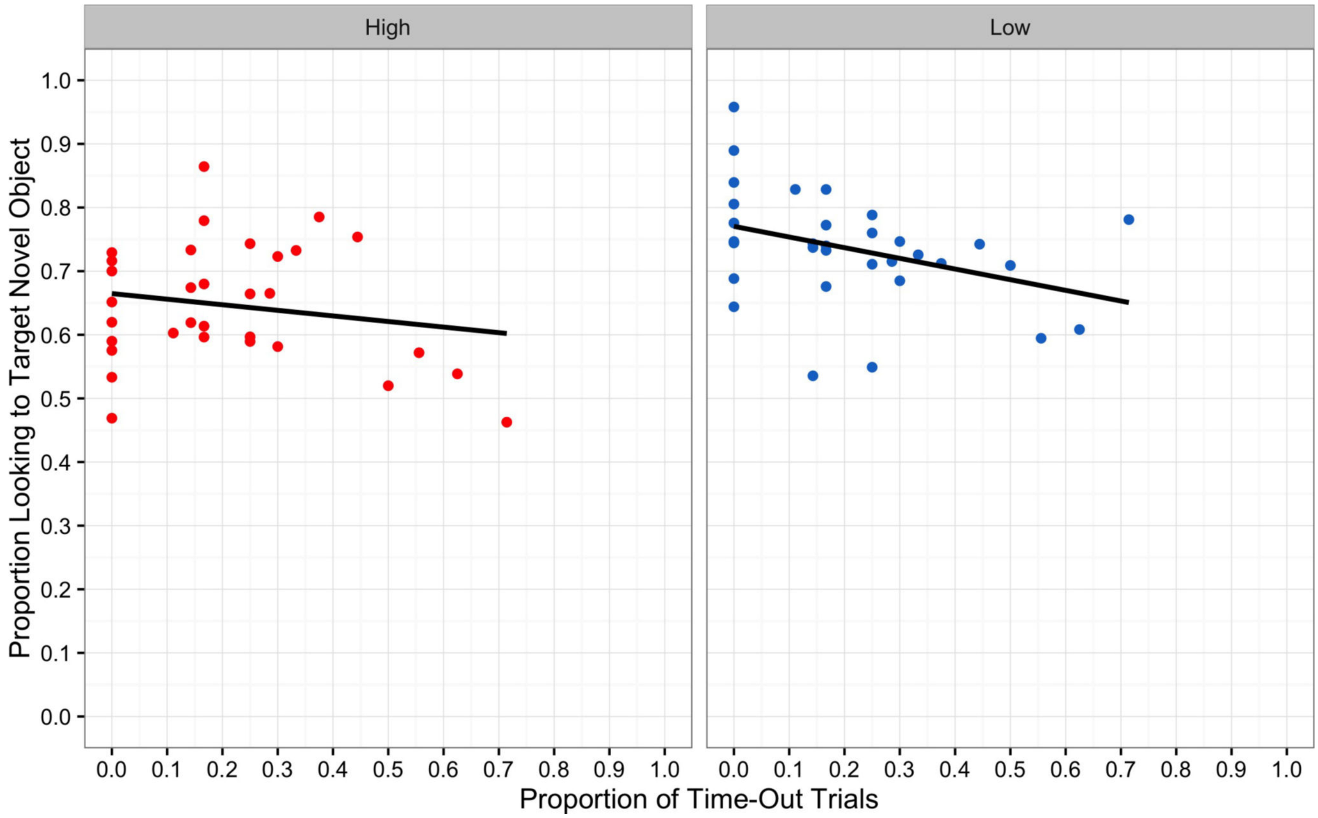

Figure 9.

Mean proportion of fixations to the target novel object on referent selection trials averaged across the critical window (300–1,800 ms) as a function of each child's proportion of timeout trials in the visual disengagement task and condition (the visual salience of the familiar distractor object). Data points represent the proportion for each child averaged across trials. The black lines represent the linear best fit.

Table 1

Familiar Word Norms

High salience				Low salience			
Item	**% Says**	**AoA**	**Freq.**	**Item**	**% Says**	**AoA**	**Freq.**
Juice	98	18	348	Bed	97	20	586
Fish	97	18	558	Door	96	20	411
Bird	97	18	454	Chair	94	21	382
Bus	96	21	176	Box	92	22	368
Cat	95	18	475	Brush	92	22	102
Cake	93	22	236	Sock	90	22	56
Average	96	19.17	374.5	Average	93.5	21.17	317.5

Note. % Says is the proportion of 30-month-olds reported to say each word according to English CDI data archived in the Word-bank database (Frank, Braginsky, Yurovsky, & Marchman, 2017). Thirty months is younger than our selected age range, but the upper limit of the CDI. *AoA* (age of acquisition) is the youngest age (in months) in which at least 50% of children were reported to say that word according to English CDI data archived in the Wordbank database. Freq. is the average number of occurrences per one million words in the CHILDES corpora for children between the ages of 39 and 45 months (Bååth, 2010).