Caregivers as Experimenters: Reducing Unfamiliarity Helps Shy Children Learn Words

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Conflict of interest statement

We have no known conflict of interest to disclose.

Data availability statement

The data and code used to generate the results in this paper can be found on the Open Science Framework repository: https://osf.io/37nb6/

Abstract

Previous work has found that shy children show chance-level disambiguation and retention of novel word meanings in a typical lab-based word learning task. This effect could be explained in terms of shy children's aversion to unfamiliarity disrupting the requisite attentional processes, because the task is marked by a high degree of unfamiliarity. To test this argument, we examined whether increasing the familiarity of the task facilitates shy children's ability to form and retain word meanings. Two-year-old children ($N = 23$) took part in a word learning task in which their caregiver acted as the experimenter. On referent selection trials, children were presented with sets of three objects, one novel and two familiar, and were asked for either a familiar object using its known label, or a novel object using a novel word. Children were then tested on their retention of the previously formed novel word-object mappings. In this context of increased familiarity, shyness was unrelated to performance on referent selection trials. However, shyness was positively related to children's retention of the word-object mappings, meaning that shyer children outperformed less-shy children on this measure of word learning. These findings show that context-based familiarity interacts with intrinsic individual differences to affect word learning performance.

Keywords: shyness, word learning, fast mapping, temperament

Parents as Experimenters: Reducing Unfamiliarity Helps Shy Children Learn Words

Despite substantial variation in child-rearing environment (e.g., Bergelson et al., 2023), the progression of early language development appears remarkably stable across children (e.g., Sampson, 2005). One of the first stages of this development, the ability to learn word meanings, emerges during the first years of life, and children demonstrate impressive flexibility in the processes by which they determine and learn these word meanings. Children learn words from the adults around them (Snow, 1972), other children (Senghas & Coppola, 2001), and even from television (Rice & Woodsmall, 1988), storybooks (Horst et al., 2011) and tablet computers (Korat et al., 2010). However, given the potential for a highly variable input, these children appear to become skilled at engaging with this input in a way that facilitates the efficient acquisition of language. Scholars have rightly been very interested in how children acquire language, out of philosophical interest (e.g. Quine, 1960), in order to inform theories of development (e.g. Spencer et al., 2009), or to develop interventions for children with atypical language development (e.g. Gray, 2005). Given the difficulties of rigorously studying the learning of a single word in situ, scholars have typically opted to examine children's learning of previously unknown word-object mappings in the more easily controlled environment of the lab.

Often inspired by Quine's (1960) exploration of the difficulty posed by deciphering the correct referents of words, researchers have examined how children disambiguate the myriad words that they hear. Disambiguation must be speedy because children are frequently required to respond rapidly to requests, often in situations where their interactional partner does not provide an unambiguous cue to the correct referent. Children therefore appear to become skilled in using in-the-moment heuristics to attempt to respond contingently. For example, a parent may point to a fruit bowl containing apples, oranges and a banana and remark on what a bright color the banana is. If the child already knows the words "apple" and "orange," then from the age of around 18 months, they will assume that the yellow object must be the referent of the word "banana" (Halberda, 2003; Mervis & Bertrand, 1994). This behavior, by which a child will rapidly map a word onto a referent is known as *fast mapping*. Studies of fast mapping typically consist of *referent selection* trials in which a novel object is presented alongside one or more familiar competitors. The experimenter then asks for an object using a novel word (e.g., *Can you show me the blicket?*) in order to examine whether children do indeed select the novel object as its referent (Axelsson et al., 2012; Golinkoff et al., 1992; Horst & Samuelson, 2008; Mervis & Bertrand, 1994; Spiegel & Halberda, 2011).

Initially, fast mapping appeared to provide a useful explanation for children's remarkably speedy acquisition of language during the second year of life and beyond (e.g. Golinkoff et al., 1992). However, more recent work demonstrates that succeeding on a referent selection trial does not mean that the word-object mapping has been learned. For example, Horst and Samuelson (2008) demonstrated that 24-month-old children who had correctly mapped novel labels to novel objects during referent selection showed no evidence for retention of these mappings after a five-minute delay, and instead selected objects during retention tests in way that did not differ from random selection. More recent empirical work has replicated the finding that accurate referent selection is possible when performance on tests of retention does not differ from chance (e.g. Axelsson et al., 2012; Twomey et al., 2014), and these findings are supported by computational modeling of word learning which show that selection of the novel object as the referent of the novel label is possible without reliable learning by the model (McMurray et al., 2012). The discrepancy between initial mapping and longer-term retention have prompted a more detailed exploration of the possible mechanisms underlying referent selection, which has improved our understanding of why successful referent selection does not necessarily support retention of the initial mappings.

Mather and Plunkett (2009) examined children's looking when presented with a familiar and a novel object to better understand the relationship between attentional dynamics and success on referent selection trials. The authors presented 22-month-old children with pairs of objects, one of which was novel and one of which was familiar. Upon hearing a novel label, the children showed no evidence of preferential looking towards the novel object. Instead, looking towards the familiar competitors appeared to be key in supporting the selection of the novel object as the referent of a novel label (see also Halberda, 2006). This work indicates that referent selection, considered as separate from retention, is the result of rejecting familiar competitors as potential referents (Halberda, 2006; Markman & Wachtel, 1988; Twomey et al., 2016) rather than an a priori implicit drive to map the novel label directly onto the novel object (as suggested by Mervis & Bertrand, 1994). Thus, successful referent selection may require little or no sustained attention to the novel object.

However, a wider reading of the literature suggests that subsequent heightened attention to the novel object is required for the word-object mapping to be retained (and thus learned). Horst and Samuelson (2008) found that ostensively naming the object (by pointing at it and labeling it) following referent selection led to retention of the word-object mapping. Similarly, Axelsson and colleagues (2012) found that following referent selection, dampening attention to competitors by partially covering them, and highlighting the novel object by illuminating it, also supports retention, while Hilton and colleagues (2019) found that looking time to the target object during labeling was positively related to retention of the word-object mapping. These findings are in line with theories suggesting that although they are linked, the processes underlying referent selection are different to those required for long term word learning (Bion et al., 2013; McMurray et al., 2012). While referent selection is the result of probabilistic mechanisms based on ambiguous input (e.g. Xu & Tenenbaum, 2007) retention is governed by associative learning, so that the stronger the association between label and object, the more likely it is to be retained (Yu & Smith, 2007).

Recently, therefore, attention has turned to factors internal to the child that may explain individual differences in their word learning. For example, children who are better able to focus their attention on the novel object during labeling are likely to show more successful learning of the label meaning. A promising factor that could help explain differences in children's attention during word learning is their approach to novelty. Individual differences in response to novelty have long been understood as a key component of children's temperament (Chess et al., 1963). These individual differences are early-emerging, biologically-based, and therefore stable (Rothbart, 1981), shaping children's behavior throughout development. Aversion to novelty initially manifests as behavioral inhibition (BI), characterized by negative affect and heightened motor responses in response to novelty that is measurable from 4 months of age (Kagan & Snidman, 1991). Later in development, novelty aversion can further manifest as the related but distinct construct of shyness, an additional aversion to social novelty (Putnam et al, 2006).

Throughout childhood, shy children demonstrate discomfort when faced with novel social situations (Buss, 1986). A typical lab-based word learning task however involves substantial novelty: the room is usually new, the task is unfamiliar, and the experimenter is typically an unfamiliar adult. Lab-based tasks may therefore be more uncomfortable for shy children than less-shy children. Shy children could be less likely to focus their attention on the word learning task sufficiently to form and retain word object mappings in the face of such a high degree of novelty, because instead they feel discomfort related to the novel elements of the environment (i.e. the room and/or the experimenter).

Hilton and Westermann (2017) directly examined whether shyness affected children's word learning performance on a typical lab-based task. They first presented children with referent selection trials consisting of one novel and two familiar objects. When asked to select an object using a novel word (e.g. “where’s the koba?”), shy children were less likely to select the novel object. On subsequent retention trials consisting of three just-seen novel objects, less-shy children retained the word-object mappings encountered during referent selection at levels greater than expected by chance while shy children did not. Subsequent work has confirmed this negative relation between shyness and performance on referent selection and retention tasks during early childhood (Axelsson et al., 2022; Melnick & Kucker, 2023). One potential explanation for these findings is that shy children’s aversion to novelty, compounded by a reluctance to rely on a label cue that could feasibly refer to one of the known competitors, disrupted attention to the novel object during referent selection. This disruption of children’s attentional processing results in unsystematic performance and failure to retain any mappings that were formed. This explanation has been supported by subsequent eye-tracking work that found shy children looked less to target objects during labeling, regardless of whether the target object was novel or familiar (Hilton et al., 2019), and that shy children showed heightened attention to the face of an unfamiliar adult who was labeling novel objects (Hilton et al., 2023), further reducing attention the target object being labeled.

Taken together, this previous work has shown that shyness can in part account for differences in the in-the-moment processes by which children disambiguate word meaning. Interestingly, however, some have argued that nevertheless, shy children’s receptive language skills are overall not affected by shyness (Smith Watts et al., 2014). It is therefore possible that the longer term associative processes supporting word learning outside of the lab may be protected from the effects of shyness, possibly because word-object associations are formed across different contexts, some of which may be better suited for shy children to learn from.

Understanding which contexts facilitate shy children's learning of novel word-object mappings could shed further light on how they learn words.

Given the effect of novelty on shy children's performance in word learning tasks, increasing the familiarity of the learning context may facilitate their attention towards the objects in the task, freeing up their attentional system to disambiguate the novel label and select the correct referent. This increase in available attention may also lead to heightened looking at the novel object, which could in turn support shy children's retention of the novel word-object mapping. The present study therefore examined shy and less-shy children's word learning under conditions of increased familiarity. Children took part in a fast mapping task (as in Hilton & Westermann, 2017), with the key difference that each child's caregiver, rather than an experimenter, presented each array of objects and asked for the target. On referent selection trials, the parent presented their child with two familiar objects and one novel object, and asked either for a familiar object using its known label or for the novel object using a novel word. After a five-minute delay, children were then tested on their retention of the novel word-object mappings presented during referent selection. If increasing the familiarity of the situation reduces the impact of shyness on the attentional processes that support word learning, shyer children should select the novel object as the referent of the novel label, and retain the mapping after the delay. However, if familiarity has no effect on performance, shy children should, as in Hilton and Westermann (2017), fail to select novel targets during referent selection, and fail to retain any mappings that were formed.

Method

Participants

Twenty-three typically developing two-year-old children participated (*M* = 29 m, 9 days, *SD* = 118 days; range = 24 m, 18 days to 35 m, 15 days; 12 girls and 11 boys). On the group level, a sample size of 5 is adequate to detect an effect size of 1.34 on novel referent selection tasks with 80% power at $p < .05$ (Bergmann et al., 2018; Lewis et al., 2020). Statistical power was maximized by analyzing predictors as continuous variables (Lazic, 2018) and by gathering and analyzing data from multiple trials per participant and condition (Baker et al., 2021).

All children were monolingual and predominantly from middle-class families living in North West England, UK. Families were recruited by contacting parents who had previously indicated interest in participating in child development research. Parents' travel expenses were reimbursed and children were offered a storybook for participating. The present study was conducted according to guidelines laid down in the Declaration of Helsinki, with written informed consent obtained from a parent or guardian for each child prior to data collection. All procedures in this study were approved by the Research Ethics Committee of the Faculty of Science and Technology at Lancaster University. Data from four additional children were excluded from analyses due to their parent not following the correct procedure ($n = 2$), refusal to participate ($n = 1$), and failure to pass training ($n = 1$).

A subset of questions from the Early Childhood Behavior Questionnaire (ECBQ; Putnam et al., 2006) was used to assess children's shyness as an enduring, biologically-based individual difference. The complete ECBQ asks parents to rate how often their child has demonstrated particular behaviors over the previous two weeks on a scale ranging from 1 (*never*) to 7 (*all the time*) which measure 18 fine-grained sub dimensions of temperament. The 12 items measuring the sub domain of shyness were extracted and randomly shuffled with 12 items measuring an unrelated sub dimension (perceptual sensitivity) to avoid demand characteristics confounding responses. Responses to the perceptual sensitivity items were not coded or analyzed.

The shyness items assess how children react in situations that elicit shy behavior, for example "When approaching unfamiliar children playing, how often did your child watch rather than join?" and "In situations where s/he is meeting new people, how often did your child become quiet?". Each child was scored from 1-7 by averaging their parents' responses to the 12 questions relating to shyness (after correcting for reverse coded questions). A score of 1 is considered the least shy, and a score of 7 is considered the most shy.

Stimuli

Figure 1

Subset of stimuli used in the experiment

Note. Not to scale. Panel A) shows examples of familiar objects used during referent selection, and Panel B) shows the four novel objects.

All stimuli were used in both conditions. Twelve objects, selected because they are easily named by two-year-old children, acted as familiar objects and consisted of animals (duck, elephant, fish, pig), vehicles (car, motorbike, helicopter) and household objects/toys (spoon, fork, cup, ball and doll). The four novel objects, selected because they are unfamiliar to two-year-old children, were a pyramid-shaped Rubik's puzzle, a cocktail strainer, a plastic massager, and a napkin holder (see Figure 1). Four distinct non-words (*cheem*, *koba*, *sprock*, *tannin*) were used to name the novel objects, and were taken from previous research using similar methodology (Behrend et al., 2001; Halberda, 2006; Horst & Samuelson, 2008; Samuelson & Horst, 2007). Novel names were randomly assigned to objects across participants. All objects were similar in size (approximate mean size 5 cm x 6 cm x 9 cm). The objects were presented on an unpainted wooden tray, divided into three equal compartments.

Procedure and Design

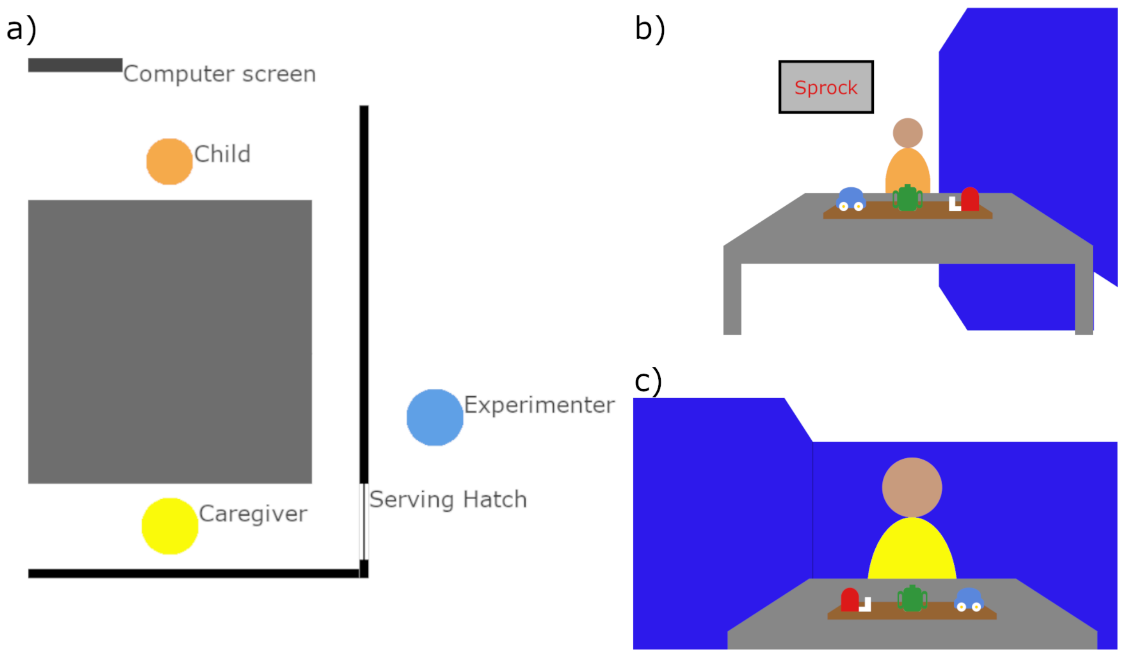
Prior to their visit to the lab, each child's parent was emailed a 10-minute training video. The video was a walk-through of the experiment with commentary explaining the procedure in more detail. Importantly, the video did not explain that novel words or objects would be used in the task. Instead, the video contained only familiar objects and labels. This was to ensure that parents did not practice the task beforehand with their child in order to train them in selecting a novel object as the referent of a novel label. When parents arrived at the lab, they were then informed that some of the labels and objects may be novel, but that they should not react differently to these objects or labels. Parents then completed the shyness questionnaire, and the experimenter explained the procedure once more. Both during the training video and the in-lab explanation, it was emphasized that the caregivers should administer the task neutrally, meaning that on referent selection and retention trials, they should not look at any object or attempt to influence the response of their child. When their child was settled and comfortable, the parent and child moved to the testing room and the experiment began.

Word learning task.

Warm up trials. During the task children sat on a high chair across a white table from their parent. The experimenter sat occluded by a screen, ready to organize the stimuli and pass them to the parent through a serving hatch out of view of the child (see Figure 2). The experimenter monitored the procedure to ensure that it was being correctly executed by the caregivers, and this compliance was confirmed by video recordings of the experimental session. All trials consisted of three objects being presented to the child on the tray. Warm-up trials consisted of three familiar objects and were designed to introduce the child and parent to the forced-choice task, and to ensure that children understood their parent's instructions. On each trial, the requested object label was displayed on a computer screen behind the child. The experimenter then passed the tray of objects through the opening to the parent. The parent then placed the tray on the table, out of reach of the child, and asked for the target three times (e.g., "Wow a duck! Can you see the duck? Where's the duck?"). The caregiver then slid the tray forward into reaching distance for the child, and gave the child the opportunity to retrieve the requested object. If correct, the child was praised, and if incorrect the child was corrected. The order in which the objects were requested was randomly determined prior to training. Warm-up trials continued until children had correctly selected each referent once.

Figure 2.

Schematic of testing setup



Note. Not to scale. a) Birds-eye view of test booth. b) Caregiver's view of the testing procedure. The serving hatch, through which the tray was passed between caregiver and experimenter, can be seen below the table. c) Child's view of the testing procedure.

Referent selection trials. Referent selection trials began immediately after warm up trials, and proceeded in the same manner with two exceptions. First, neither praise nor corrections were given following the child's choice. Second, two of the objects were familiar and one was novel. Each novel object was randomly assigned a novel word, and familiar objects presented during referent selection had been used as warm up stimuli.

Each novel object was randomly grouped with two familiar objects, forming four sets of objects. Across 12 referent selection trials, each set was presented on three trials. The presentation order of the sets was pseudorandomized, ensuring that each set was not presented more than twice consecutively. On the first two trials for each set, the caregiver requested the novel object (using the novel label), and on the final trial, the caregiver requested a randomly selected familiar object. This design ensured that children had extended exposure to the word and object mapping and kept the task as naturalistic as possible for parent and child. The trial order was pseudorandomized, The position of the objects on the tray was also pseudorandomized, ensuring that for each set of objects, the target was placed once each in the left, middle, and right section of the tray across referent selection trials. The combination of familiar and novel objects that comprised each set was randomly selected prior to the experiment.

Retention trials. Following referent selection there was a five-minute break, during which the child and caregiver read storybooks. This break was to ensure that any retention in the following trials was the product of long-term memory (following Horst & Samuelson, 2008). After the five-minute break, the child participated in four retention trials. Now, caregivers presented children with sets of three just-seen novel objects. Across the four retention trials, each novel object was the target once. The two novel objects presented alongside the target were randomly determined. On presentation of each set, the caregiver asked their child to select the target three times (i.e. "Wow a koba! Can you see the koba?

Where's the koba?"). The caregiver then slid the tray forward and the child indicated the chosen object. Trial order was randomized across participants.

Data Analysis

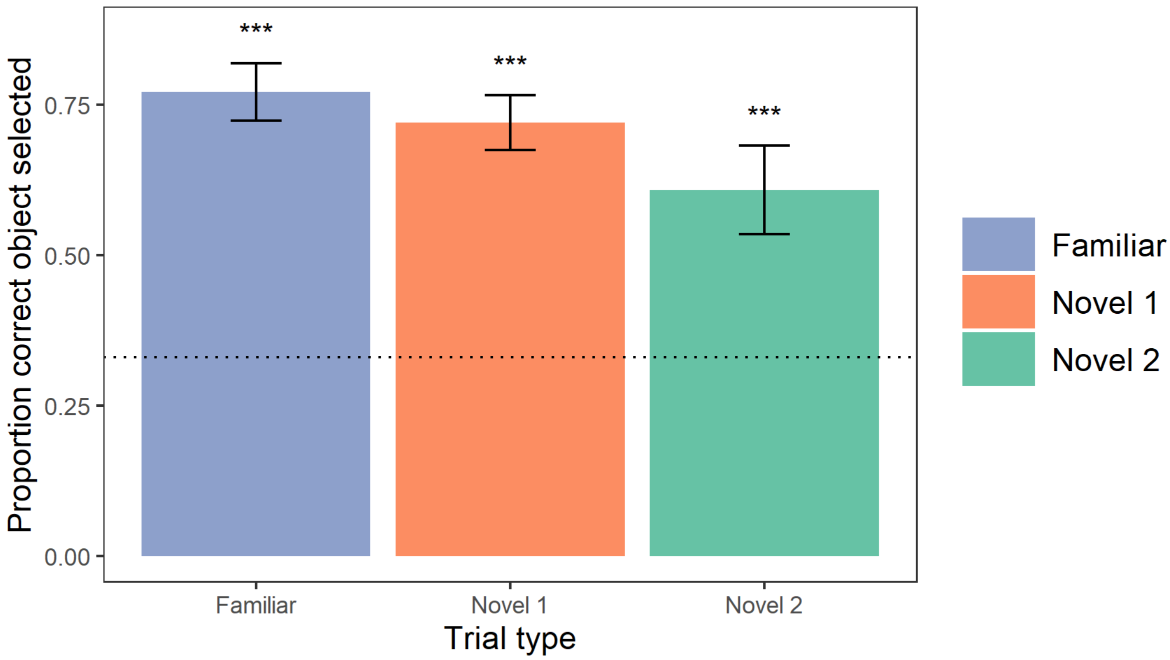
Children's object selections were coded online by the experimenter and subsequently verified offline using the video recording of the session. Children's performance was coded on each trial as either correct, if the child selected the target object, or incorrect, if the child selected another object. To examine performance against chance, a proportion of correct selections measure was calculated for each child and trial-type by dividing the number of correct responses by the total number of responses. To examine the relation between shyness and children's performance on the task, logistic regressions were run in R (R Core Team, 2022) using the in-built glm function, with target object choice on each trial (correct or incorrect) as dependent variable and shyness score (mean-centered) as predictor, and p values obtained via likelihood ratio tests.

Results

Referent Selection

Figure 3

Mean proportion of correct object selections split by trial type



Note. The dotted line represents chance (0.33). *** $p < .001$.

Out of a total of 276 referent trials, children failed to respond on only 13 trials (5 familiar, 4 first novel, and 4 second novel trials), indicating that all children were engaged with the referent selection phase. As can be seen in Figure 3, children selected the correct referent on all trial types at above-chance levels (familiar trials: t (22) = 9.19, $p < .001$; first novel trials: t (22) = 8.58, $p < .001$, second novel trials: t (22) = 3.80, $p < .001$). In line with previous work (e.g., Axelsson et al., 2012; Kucker et al., 2020; Twomey et al., 2014), a logistic regression revealed a significant effect of trial type on children's referent selection (χ2 (2) = 6.26, p = .044). Unexpectedly, however, this effect was driven by children's reduced performance on second novel trials relative to familiar trials (OR = 0.45, 95% CI = [0.23, 0.87], χ2 (1) = 5.77, p = .016). No difference was detected between familiar trials and first novel trials (OR = 0.80, 95% CI = [0.40, 1.58], χ2 (1) = 0.43, p = .51) or between first novel trials and second novel trials (OR = 0.57, 95% CI = [0.30, 1.07], χ^2 (1) = 3.10, p = .08).These findings indicate that introducing the second novel label trials can lead to deterioration, rather than consolidation, of children's novel word-object mapping, a finding that warrants further investigation. Visual inspection indicates that performance on familiar and first novel trials are broadly similar to previous studies that have been run by an experimenter (e.g., Horst & Samuelson, 2008), suggesting that the caregiver acting as experimenter did not modulate children's general behavior during the referent selection task. Critically, unlike previous studies (Hilton & Westermann, 2017; Axelsson et al., 2022), our analyses did not reveal a significant relation between children's shyness scores and their performance across referent selection trial types (see Table 1; also Figure 4).

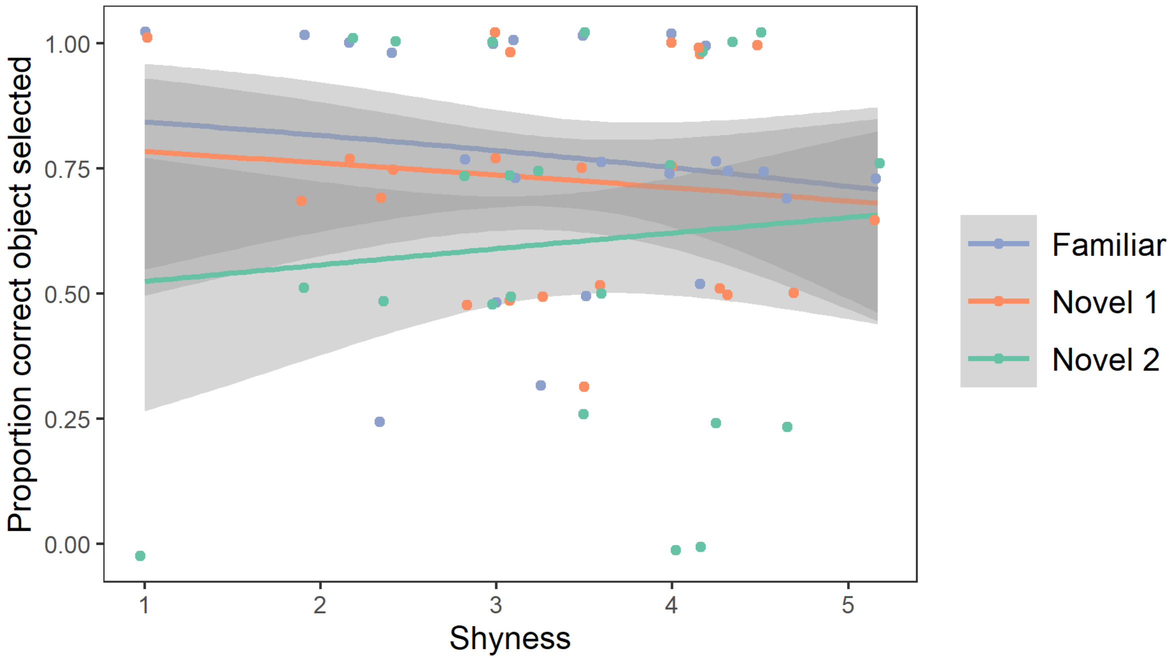
Table 1

Results of logistic regression testing the effect of shyness on each trial type.

Trial Type	OR	95% OR	$\chi^2(1)$	*p*
familiar	0.83	[0.47, 1.44]	0.46	.495
first novel	0.88	[0.54, 1.45]	0.26	.613
second novel	1.14	[0.74, 1.77]	0.35	.551

Figure 4

Children's performance on referent selection trials plotted against their shyness scores



Note. Performance is calculated as proportion of trials on which the child correctly selected the target object (baseline = 0.33). Lines are linear regressions and shaded areas are standard errors of the mean, for illustration.

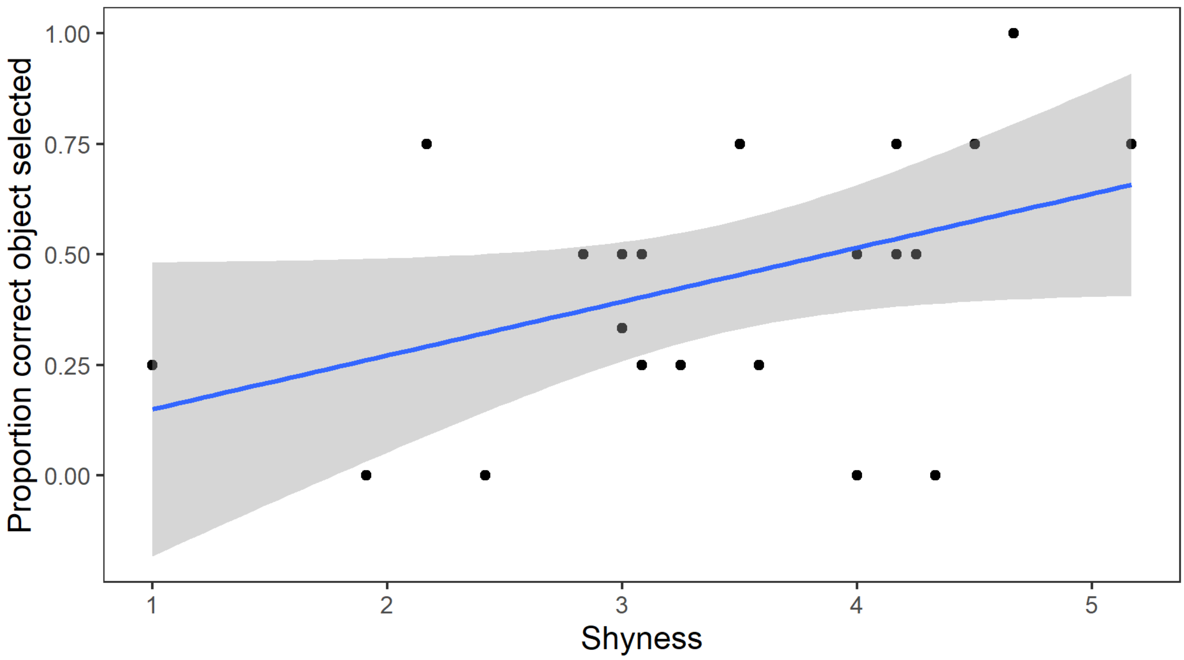
Retention

We first examined whether children had on average retained the word-object mappings that they had correctly formed during referent selection. We therefore calculated the proportion of correct target selection on retention trials for which children had correctly selected the target on both referent selection trials. One child refused to respond on all retention trials, meaning that their data could not be analyzed. Results revealed that children did not retain the novel-word object mappings above levels expected by chance alone (*t* (15) = 1.65, *p* = .120), in line with previous findings that young children's encoding of word-object mappings presented during referent selection is fragile resulting in unreliable retention at the group level (Horst & Samuelson, 2008). Results of the logistic regression indicated no significant relation between shyness and retention of the novel word-object mappings (OR = 2.11, 95% CI = [0.87, 5.14], χ^2 (1) = 3.03, *p* = .082).

However, it is possible that children formed the novel-word object mapping despite not consistently correctly selecting the target during referent selection. Therefore in a further exploratory analysis, we analyzed children's retention of all word-object mappings, regardless of performance during referent selection. This alternative analysis also indicated that children did not learn the novel word-object associations above levels expected by chance (*t* (21) = 1.85, *p* = .078). However, these results revealed a significant positive relation between shyness and retention performance (OR = 1.63, 95% CI = [0.99, 2.67], χ^2 (1) = 4.04, *p* = 0.045), suggesting that shyer children's word learning was boosted relative to their less-shy peers on a task administered by their caregiver (Figure 5). This result indicates that shyer children were more likely to form word-object mappings in the absence of correct referent selection, suggesting that manual referent selection might not be the most accurate online measure of children's encoding of label-object mappings.

Figure 5

Children's performance on retention trials plotted against their shyness scores



Note. Performance has been calculated as proportion of trials on which the child correctly selected the target object. The line is linear regression and shaded area standard error of the mean, for illustration.

Discussion

This study indicates that the negative effects of shyness on children's word learning demonstrated in previous studies could be mitigated by increasing the familiarity of the task context. While previous work has shown that shy children did not reliably select a novel object as the referent of a novel label when asked by an experimenter (Hilton & Westermann, 2017), the current study found that this effect was absent when the objects were presented and the label spoken by the child's caregiver. Critically, increasing the familiarity of the task context appeared to boost shyer children's learning of the novel word-object mapping, as shown by the positive relation between shyness and children's performance on retention trials, meaning that the increased familiarity boosted the learning performance of shy children relative to less-shy children. We argue that shy children's retention is improved when the task context is more familiar because their aversion to novelty no longer disrupts the attention allocation that supports disambiguation of the novel label.

Given that shy children exhibit discomfort in the presence of unfamiliar adults (Putnam et al., 2006), they likely struggled in previous studies to attend to the relevant features of the task in the presence of an unfamiliar experimenter. Hilton and Westermann (2017) argued that shy children's aversion to novelty disrupts the attentional processes that support their selection of the novel object as the referent of the novel label: the perceived 'threat' of the novelty of the task and/or experimenter could therefore serve to interrupt shy children's attempts to systematically scan and reject competitors as referents. Later work confirmed that shy children show heightened attention to the face of an unknown experimenter during labeling, with a parallel decrease in attention to the target object, weakening encoding of the label-object association (Hilton et al., 2019). The current study finds that removing social novelty by asking a familiar adult to conduct the task frees up the attentional system of shy children to attend to the task, potentially facilitating a more robust encoding of the label-object associations.

Hilton & Westermann (2017) also offered an interpretation of their results based on shy children's later heightened wariness of negative social evaluation (Coplan et al., 2007) and risk-aversion (Levin & Hart, 2003), suggesting that shyness is marked by a reluctance in "hazarding a guess" (Coplan & Evans, 2009, p. 212). Although children typically map novel labels to novel referents on novel referent selection trials, it is possible that the novel label could instead refer to one of the familiar objects, for example as a superordinate category label. It is therefore plausible that one characteristic of shyness is a reluctance to rely on an ambiguous cue in determining appropriate responses. This behavior could inform both children's reduced interaction in novel (and therefore less predictable) settings, and serve as a basis for shyer children's later emerging fear of negative evaluation. Given that increasing the familiarity of the task context extinguished shyer children's typical reluctance to select the novel referent on novel trials, it appears that reducing their shyness-related discomfort extinguishes their aversion to responding to ambiguous cues. This finding therefore suggests that shyness-related differences in behavior are situation-specific, rather than indicative of general enduring differences in cognitive processing.

Exemplifying the complex and dynamic nature of the relationship between shyness, context and word learning, less-shy children were less likely to retain the label-object associations in this context of heightened familiarity. This result could suggest that these children were able to allocate their attention appropriately in order to select the novel object as the referent of the novel label, but their attention was subsequently not sufficiently focused on the novel object to robustly encode the word-object mapping. Alternatively, less-shy children may fail to re-engage with the task after the break. In any case, it is unlikely that less-shy children are unable to learn words from their caregiver. It is, however, possible that increasing the familiarity of the environment may cause less-shy children to lose interest, resulting in weaker encoding of the label-object associations presented during referent selection.

While previous research has examined the effect of shyness on language production in older children (Crozier & Badawood, 2009; Crozier & Perkins, 2002; Reynolds & Evans, 2009; Smith Watts et al., 2014), taken together with Hilton & Westermann (2017), the current study is the first to suggest that shyness could drive this effect early in language acquisition by modulating the disambiguation and retention of words. This study therefore builds on recent investigations of the effect of attention during referent selection on the retention of words (Axelsson et al., 2012; Bion et al., 2013; Smith & Yu, 2013) by providing evidence of an intrinsic factor that may affect attention during word learning: shyness.

Importantly, the finding that shy children retained word-object mappings when the objects were presented by their caregiver suggests that the negative impact of shyness on language development (e.g. Smith Watts et al., 2014) does not imply that shy children's language development is somehow disordered or delayed (Coplan & Armer, 2005). Instead, the optimal environment in which children can acquire language varies according to shyness. The finding that shy children learn better in environments that are familiar may explain why shyness is not associated with long-term academic problems (Cameron, 2009), because shy children are able to learn once they have familiarized themselves with the environment.

The current work raises important methodological issues. First, caregivers complied with the instructions necessary to ensure a controlled task when given thorough training, demonstrating the feasibility of controlling the familiarity of the testing environment and laying the groundwork for future, caregiver-controlled experimental tasks. Second, attrition rates from this study (14 % dropout rate) were equal to or better than most studies based on similar paradigms run by trained researchers (e.g., 21% dropout rate; Hilton & Westermann, 2017). Children therefore engage well with a task when interacting with their caregivers, suggesting that asking the caregiver to act as the experimenter is a feasible means to increase the familiarity of lab-based tasks.

It is important to note that that current study did not directly manipulate familiarity of the experimenter, meaning that conclusions drawn about effects of experimenter familiarity are formed relative to results of previous studies (i.e., Hilton & Westermann, 2017). Although the sample characteristics and task were substantially comparable, future work should experimentally manipulate experimenter familiarity to confirm the proposed effects that we outline. Furthermore, although the most critical aspects of the task were controlled and monitored (e.g., ensuring that the caregiver named each object the correct number of times), it was not possible to exert control over all features of the experiment. For example, there was some variation between caregivers in the precise timing of the trials, which may in part have been driven by caregivers adapting their labelling style to the capabilities of their child. Future work could explore options to exert more stringent control over these potential confounding variables, for example by recording and presenting caregivers voice through computer-controlled loudspeakers (as in van Rooijen et al., 2019). It would also be beneficial to examine in future studies how the child co-operates on different types of experimental task (e.g., turn-taking paradigms) administered by their caregiver in relation to their shyness. Since Carey's (1978) seminal work we have come a long way in understanding the complex link between children's initial disambiguation of word meaning and their learning of these words. We have moved from arguments that children's use of a priori constraints or lexical principles leads to word learning (Golinkoff et al., 1994; Markman & Wachtel, 1988), to the understanding that children's word learning is both emergent and dynamic (Bion et al., 2013; McMurray et al., 2012; Regier, 2003; Samuelson & Smith, 2000; Smith & Samuelson, 2006). Children's in-the-moment processing of word meaning (as demonstrated on novel referent selection trials) supports rapid and contingent responding, critical for meaningful interaction with those around them. However, real-world word learning appears to be driven predominantly by longer-term associative processes, in which the child encounters the word and its referent multiple times across contexts (see Kucker et al., 2015 for a review). The current work highlights the dynamic nature of the processes that support word learning by demonstrating the importance of understanding the interaction between intrinsic and extrinsic factors and their effect on the behaviors that impact on language acquisition.

Importantly, the current work demonstrates that the processes involved in referent selection vary across contexts. In line with recent demonstrations that intrinsic factors can come to bear on children's use of word-learning strategies (e.g. Perry & Samuelson, 2011), the current work supports accounts that the flexibility of attentional allocation can also explain the variability in results of previous studies of word learning: Retention is dependent on the interaction between aspects of the environment and – critically – the learner. We must take these interactions into account in attempting to form a more holistic and multidimensional explanation of children's apparent skill in learning words.

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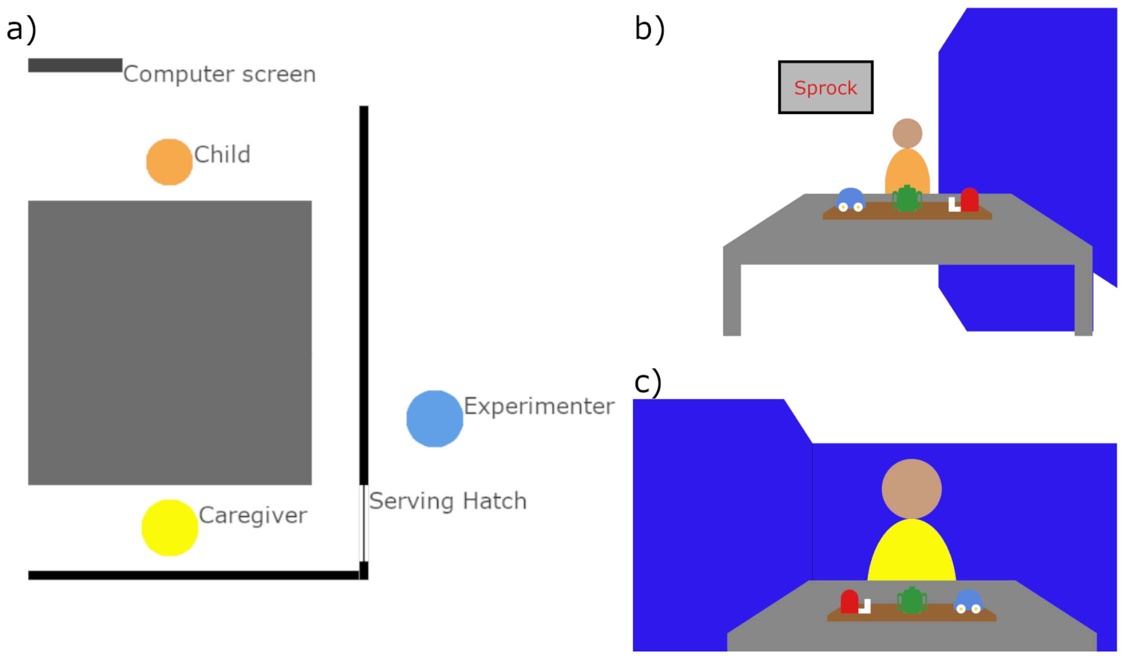
Figure 1

Subset of stimuli used in the experiment

Note. Not to scale. Panel A) shows examples of familiar objects used during referent selection, and Panel B) shows the four novel objects.

Figure 2.

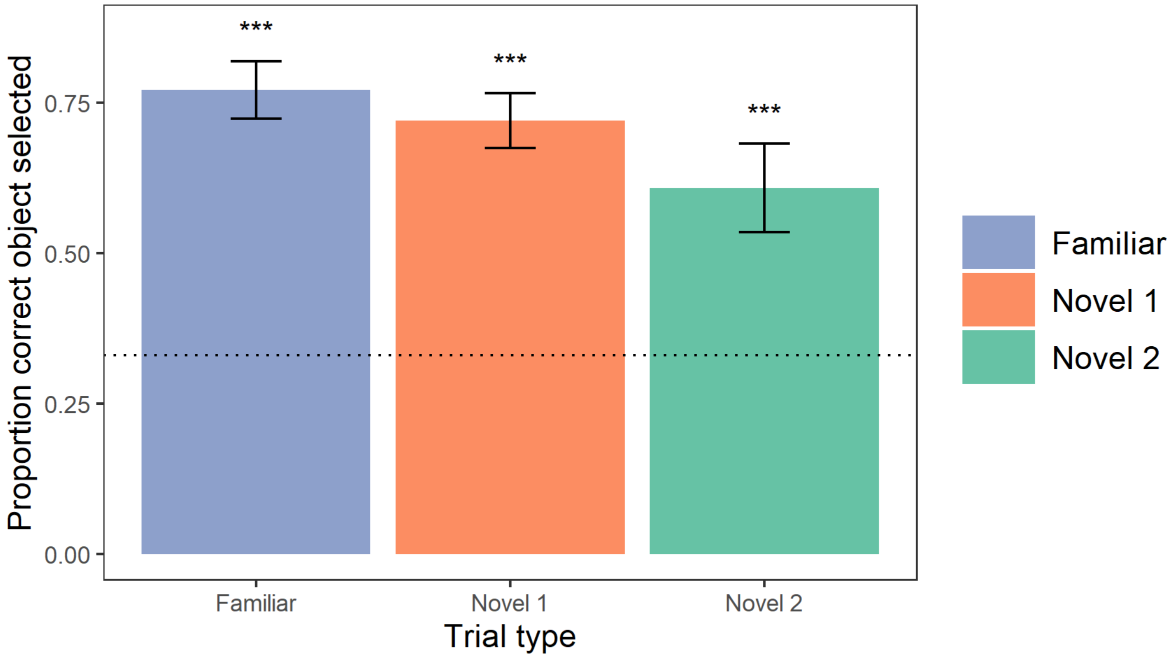
Schematic of testing setup



Note. Not to scale. a) Birds-eye view of test booth. b) Caregiver's view of the testing procedure. The serving hatch, through which the tray was passed between caregiver and experimenter, can be seen below the table. c) Child's view of the testing procedure.

Figure 3

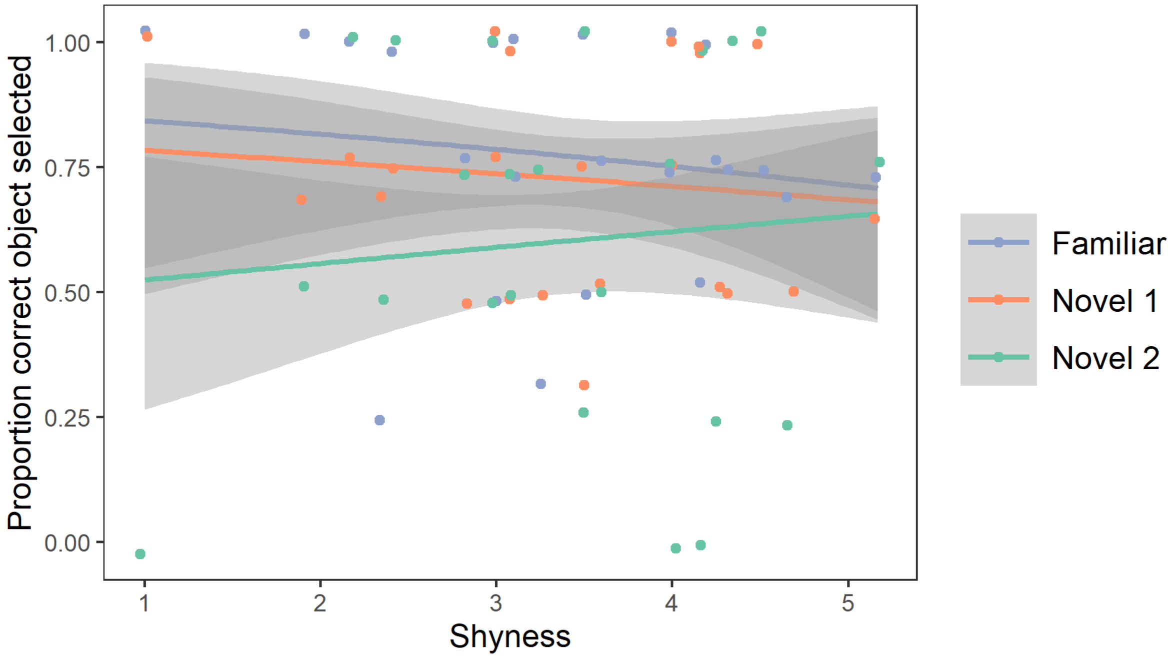
Mean proportion of correct object selections split by trial type



Note. The dotted line represents chance (0.33). *** $p < .001$.

Figure 4

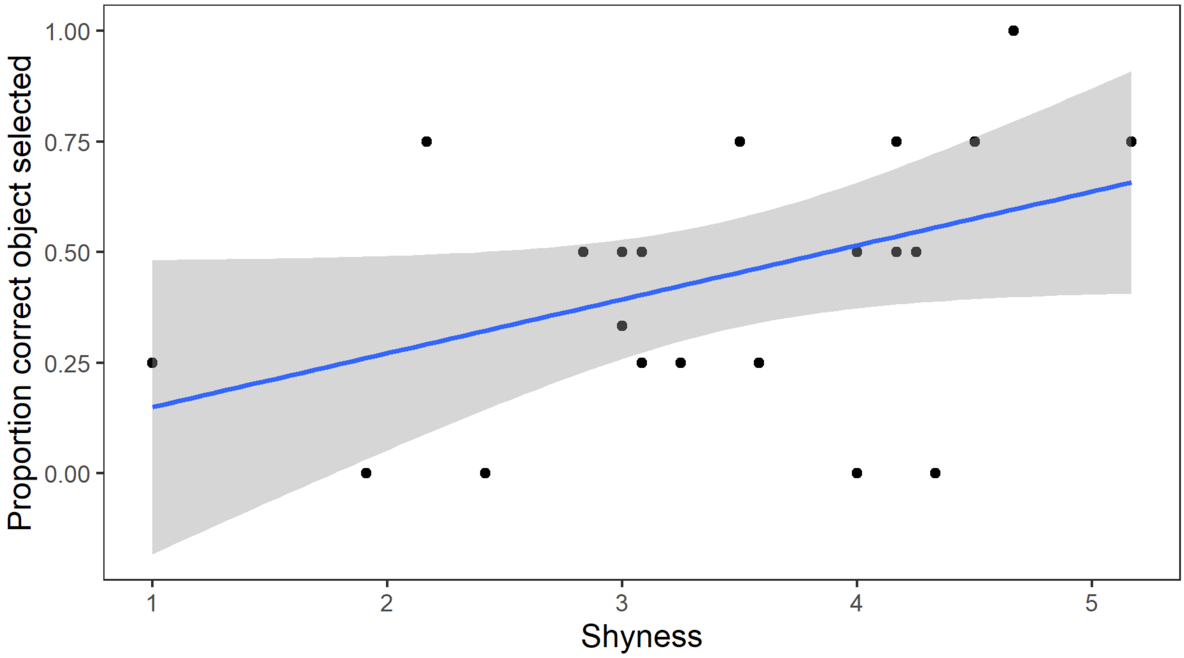
Children's performance on referent selection trials plotted against their shyness scores



Note. Performance is calculated as proportion of trials on which the child correctly selected the target object. Lines are linear regressions and shaded areas are standard errors of the mean, for illustration.

Figure 5

Children's performance on retention trials plotted against their shyness scores



Note. Performance has been calculated as proportion of trials on which the child correctly selected the target object. The line is linear regression and shaded area standard error of the mean, for illustration.

Table 1

Results of logistic regression testing the effect of shyness on each trial type.

Trial Type	OR	95% OR	$\chi^2(1)$	*p*
familiar	0.83	[0.47, 1.44]	0.46	.495
first novel	0.88	[0.54, 1.45]	0.26	.613
second novel	1.14	[0.74, 1.77]	0.35	.551