

The development of polyseme learning under uncertainty

Alexander LaTourrette (latourre@usc.edu)

Department of Psychology, University of Southern California,
3620 S. McClintock Ave, Los Angeles CA 90089 USA

Victor Gomes (vgomes@harvard.edu)

Department of Psychology, Harvard University,
33 Kirkland St, Cambridge, MA 02138 USA

Katinka Tangen (katinkat@sas.upenn.edu)

Department of Psychology, University of Pennsylvania,
425 S University Ave, Philadelphia, PA 19139 USA

John Trueswell (trueswel@psych.upenn.edu)

Department of Psychology, University of Pennsylvania,
425 S University Ave, Philadelphia, PA 19139 USA

Abstract

Acquiring multiple meanings for a word is often proposed to be difficult for word learners. However, the difficulty may depend on the meanings: prior work has demonstrated that word-learning is easier for both adults and children when words' multiple meanings are related (polysemous, like "cap") than unrelated (homophonous, like "bat"). However, it remains an open question how learners infer polysemous meanings if learners encounter these words in more referentially ambiguous contexts. In two studies, we examine children's and adults' learning of polysemes under uncertainty, using both artificial stimuli from prior work (Study 1) and attested non-English polysemes (Study 2). Results suggest that while adults can use similarities between referents to infer polysemous meanings across multiple exposures, children generally struggle to do so. This indicates that polyseme learning improves with age and suggests current computational models of cross-situational word-learning may capture children's word learning strategies better than those of adults.

Keywords: Word learning, Polysemy, Cross-situational learning, Language acquisition, Psycholinguistics

Introduction

Word learning is often conceptualized as the process of mapping a word to a meaning (Baldwin & Markman, 1989; Trueswell et al., 2013; Yu & Smith, 2007). For example, after hearing "chair" in a series of situations featuring a specific type of single-person, sittable furniture, the learner correctly associates the word form "chair" with the *chair* category. However, children's actual daily experience of learning words is likely to feature substantially more ambiguity – both in word's likely referents and in their possible meanings.

Recent work reveals substantial referential ambiguity in children's environments: when hearing a word, there will typically be more than one viable referent present. Indeed, work examining infants' visual experience using head-mounted eye-trackers has demonstrated that infants have an average of around 8 distinct types of objects in view at any given moment during a caregiver interaction (Clerkin et al., 2017). Even in theoretically optimal situations where parents are naming a restricted set of toys given to children to play with, children hearing a toy's name were slightly more likely

to be looking at the *wrong* toy than the right one (Yu et al., 2021). This visual ambiguity is also not regularly, or completely, clarified by the perceptual or social cues in a given interaction: even adults, when shown muted videos of child-caregiver interactions and asked to guess the word uttered at a particular moment, often failed to guess the intended meaning (Cartmill et al., 2013; Gillette et al., 1999; Medina et al., 2011). Thus, much of children's exposure to words is likely to feature some kind of referential ambiguity.

To add to this challenge, the words children hear often have multiple meanings as well. This semantic ambiguity can take two forms. Studies have suggested that around 7% of words in the English language are *homophonous* (Rodd, 2002), with a single word having multiple, unrelated meanings (e.g., a child hearing "bat" during both their baseball practices and their zoo trips). This represents a clear learning challenge – and indeed, both children and adults do find it harder to learn homophones (Mazzocco, 1997; Yurovsky & Yu, 2008; though see Dautriche et al., 2018, for mitigating factors).

However, in cases of *polysemy*, the multiple meanings are semantically related: for instance, the word "book" can refer to both the physical object ("I dropped the book") and the story ("The book is so sad"). Estimates of the frequency of polysemes vary widely, from 40 to 80%, depending on the criteria for distinct word senses (Durkin & Manning, 1989; Fellbaum, 1998; Rodd et al., 2002). Still, it is clear that polysemes are a frequent occurrence in children's input. However, it is less clear how children learn them—and if the semantic relations between senses facilitate their acquisition.

Encouragingly, past research on polysemy has identified some cases in which learners will spontaneously extend a polysemous word mapped to one meaning (e.g., a physical book) to the polyseme's other meaning (e.g., the story) (Srinivasan & Snedeker, 2011). This kind of spontaneous extension has been shown for object/abstract content mappings (e.g., "book"), substance/object relationships (e.g., "glass" refers to both the material and a particular kind of

object shaped from that material), container-contents (e.g., “pot”) and for instrument/action pairs (e.g., “hammer”) (Rabagliati et al., 2010; Srinivasan et al., 2017, 2019; Srinivasan & Snedeker, 2011). Each of these semantic relations provides the basis for what are often called “regular” polysemes (Rabagliati et al., 2011). These regular polysemes feature numerous examples within a given language (e.g., “book”, “DVD”, “flash drive”, and “scroll” all show the object/abstract content pattern) and also show some degree of consistency across languages. Specifically, meanings which are rated by English-speaking adults as more strongly associated with each other, or more conceptually similar, also tended to be colexified more frequently across a sample of 250 languages (Xu et al., 2020). Thus, highly regular polysemes may pose little difficulty for learners.

However, many polysemes in any given language will not follow a highly regular, cross-linguistically consistent pattern. Instead, these “irregular” polysemes may refer to a set of meanings sharing only a loose family-resemblance structure, each of which might be highly similar to one other sense but not to *all* other senses. This is a common result of semantic chaining, in which each new sense is coined based on a single previous sense. For instance, Ramiro et al. (2018) noted that while “face” initially referred only to a body part, it later gained the sense of an object’s front side, and then later, based on that meaning, the sense of confronting something (i.e., from the front). As these polysemes are poorly captured by rule-based extensions (to “back” one’s fear does not mean to run from it), they seem likely to provide a stiffer challenge for children. Furthermore, while regular polysemes’ senses are often encountered together (e.g., “book,” “glass”), irregular polysemes’ meanings are more likely to emerge across different exposures and contexts.

This raises new questions for computational models of cross-situational word learning, as most models assume that a word’s meanings are acquired independently. Notably, this is true for both local, hypothesis-testing models (Stevens et al., 2017) and global associative models (Fazly et al., 2010; Yurovsky & Frank, 2015). According to local, hypothesis-testing models, learners retain only a single hypothesis about a word’s meaning from any given exposure, but can track multiple meanings for the word across exposures, enabling these models to learn homophones (Stevens et al., 2017; Yue et al., 2023). However, polysemes and homophones are treated identically: related and unrelated senses are learned equally quickly. Similarly, global, associative models retain multiple word-referent links from any given exposure and across exposures, but meanings are all strengthened or weakened independently, making polyseme and homophone acquisition functionally identical.

This assumption that a word’s multiple meanings will be acquired independently, regardless of their semantic relatedness, has recently been called into question by work showing that polysemes (even irregular polysemes) are easier to learn than homophones. Specifically, Floyd and Goldberg (2021) found that both children and adults were more successful in learning multiple meanings for a word when

those meanings shared some similarities than when the meanings were unassociated. In their study, participants were presented with four novel words, each of which was paired with three distinct referents. In the polysemous condition, a word’s three referents had a family-resemblance similarity structure: one referent (the “prototype”) either had a similar shape as another referent (a shape match) or was made of a similar material as another referent (a material match). In the homophonous condition, a word’s three referents were designed to share no key shape or material features. In both conditions, each novel word was presented four times in an ostensive labeling context with a single referent on the screen: for polysemes, the word occurred twice with the prototype and once each for the shape and material match. When tested either immediately after learning or a week later, both children and adults generally recalled more meanings for “polysemous” words, featuring the internally similar referents, than they did for “homophonous” words, featuring unrelated referents. This result suggests that even irregular relationships between word meanings can influence word learning, making polysemes easier to learn.

Current Work

Open questions remain, however, in considering how such a polyseme advantage might play out in children’s everyday word learning. One important consideration is the ecological validity of the polysemes used. The stimuli used in Floyd and Goldberg (2021) were not naturally occurring: instead, they were constructed to ensure they always had very visibly similar physical properties (varying either in shape or material). In contrast, the polysemous word meanings that children come across in daily life will often be less perceptually similar and will naturally vary along many dimensions beyond shape and material similarity. Indeed, there is some reason to think that shape and material similarities might be unusually supportive of word extension. Both children and adults are robustly attuned to shape similarity in word extension even when the word has only a single meaning (e.g., Landau et al., 1988, 1992). In addition, material-shape mappings could arguably constitute a form of regular polysemy linking materials and objects made from that material (Srinivasan et al., 2019), rather than irregular polysemy which varies across many more dimensions. Thus, we compare children and adults’ learning of these artificial polysemes to that of attested, more variable polysemes.

In addition, even if children are adept at solving the semantic ambiguity challenge for polysemes, the challenge of *referential* ambiguity is likely to remain. That is, while Floyd and Goldberg (2021) relied on ostensive labeling contexts, with the novel word unambiguously labeling the target referent on each trial, these kinds of unambiguous exposures will often make up a minority of children’s exposures to new words (e.g., Medina et al., 2011). A critical question, then, is whether learners can also leverage semantic relationships between polyseme meanings to spontaneously map polysemes to new, semantically related referents even under referential ambiguity. This would represent a

substantial learning advantage, enabling far more rapid learning of polysemes than homophones. It would also call into question the semantic independence assumption made by most computational models of cross-situational word learning.

In the present work, we addressed both questions. In Study 1, we used a referentially ambiguous cross-situational word learning paradigm to test whether children and adults still successfully learn the artificial shape- and material-based polysemes used in Floyd and Goldberg (2021). Specifically, we tested whether learners prefer to map a word to multiple meanings that are polysemously related rather than meanings that are unrelated. In Study 2, we tested the generalizability of this effect by using a similar paradigm but replacing the artificial material/shape polysemes with natural polyseme meanings attested in non-English languages. We used non-English examples to avoid our subjects (native-speakers of English) using their knowledge of English polysemes. If learners rely on similarity between meanings to guide their online word learning, then we should observe successful polyseme learning in both studies.

Study 1

We first tested whether children and adults would spontaneously form polysemous meanings despite learning words under referential ambiguity. For example, having mapped a word to a “prototype” member of one of Floyd and Goldberg’s (2021) artificial polyseme sets, would learners then preferentially extend that word to the shape and material matches as well? To test this question, we taught participants two words across a series of referentially ambiguous trials. On each trial, participants chose between one of two possible referents for that word. We then examined whether participants’ choice on one trial predicted their referent selection on the next exposure. While learners’ choice on the first exposure is uninformative, if learners are sensitive to semantic relations between referents in online word learning, then for subsequent trials, learners should prefer to select referents semantically related to their prior selection. This series of alternating senses for a word might reflect the experience of a child encountering an irregular polyseme like “cap” uttered first in the presence of a bottlecap (alongside other referents) and then in the presence of a hat (alongside other referents) before hearing it in the presence of a bottlecap again, and so on. This longer series of exposures also enabled us to determine whether learners would a) *spontaneously* infer the polyseme, leading to an immediate preference for polysemous, related meanings, b) *gradually* infer the polyseme, leading to an incremental increase in polysemous meanings across exposures, or c) *fail* to form consistent polysemous meanings under ambiguity.

Methods

Participants For the adult study, 41 monolingual adult speakers of English were recruited from a university subject pool in the United States. The study took 15 minutes and was

completed online. All participants gave informed consent and were given course credit for their participation.

For the child study, 32 monolingual English-speaking children (17 female, 15 male) were recruited from ads on social media. The study took 15 minutes and was completed online. All parents gave informed consent and were compensated with \$10 Amazon gift cards. There were no exclusions. Children’s ages ranged from 3.26 to 6.88 years ($M = 4.74$, $SD = 1.03$). Preliminary analyses indicated no significant effect of age on performance in the cross-situational word learning task, $\beta = -0.12$, $SE = .11$, $p = .29$, so all children were analyzed together.

Materials We used the exact images that were used in Floyd and Goldberg’s (2021) original study. As noted above, each of the polyseme sets contained 3 referents: the prototype, a “shape match” object matching the prototype in shape but not material, and a “material match” object matching the prototype in material but not shape. See Fig. 1.

Audio stimuli consisted of simple labeling sentences (e.g., “One of these is a dax! Point to the dax!”). All stimuli were recorded by a female native English speaker, using child-directed speech. The novel words that were used were “zum,” “dax,” “mipen,” and “fendle.”

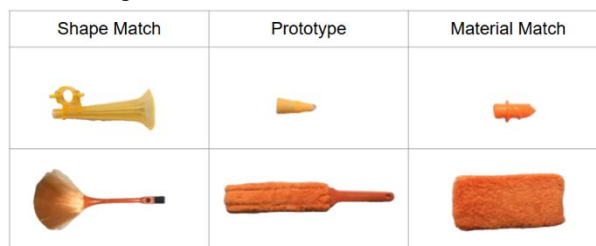


Figure 1. Study 1 Stimuli. Two sets of stimuli showing the irregular polysemy structure of the items in Study 1.

Design Child and adult participants all learned 2 novel polysemous words, presented fully interleaved, with 7 referentially ambiguous exposures for each word. Crucially, each word was assigned to appear with members of the same two polysemy “sets” from Floyd and Goldberg (2021). Thus, regardless of which referent participants selected on their first referentially ambiguous exposure (when neither referent should be favored), their second exposure—and all subsequent exposures—presented a chance to map the word to either a polysemously related meaning or to an unrelated meaning (i.e., the meaning polysemously linked to the previous, unselected referent from the prior exposure).

Procedure On each trial, learners saw two images and heard an ambiguous labeling phrase (e.g., “One of these is a [dax]. Point to the dax!”). Adults clicked an image to indicate their answer. Children were prompted to point, and their caregiver pressed a key indicating their response.

The experiment was split into two phases: an initial cross-situational word learning phase and a Sense Extension Test. In the first 6 cross-situational word learning trials for each word, we alternated two of the polyseme’s meaning (e.g., the word “dax” might alternate being paired a polyseme set’s prototype and its shape match). See Fig. 2. To offer learners

the best chance at making polysemous inferences, the “prototype” member of each polyseme set was always one of these two meanings. We counterbalanced across participants whether the other alternating meaning was a shape match or a material match. Within participants, we counterbalanced which words were matched to shape- or material-similarity meanings. Using only two of Floyd and Goldberg’s three meanings in each polyseme set simplified the learning challenge somewhat for our learners (as well as providing a clearer analogue to Study 2, below). Note that the delay between exposures for each word was also likely to be shorter than in Floyd and Goldberg (2021), and participants learned only two words instead of four.

After completing these six initial cross-situational word learning trials featuring two members of each “polyseme set,” learners were then given a “Sense Extension Test” in which they were prompted to map the word to the third, held-out member of the polyseme sets. This provided a strict test of whether learners, having been repeatedly exposed to two polyseme meanings, would spontaneously extend the meaning to a third, related meaning. For both the initial cross-situational learning phase and the Sense Extension Test, we also assessed whether learners showed any differences in making shape- or similarity-based extensions.

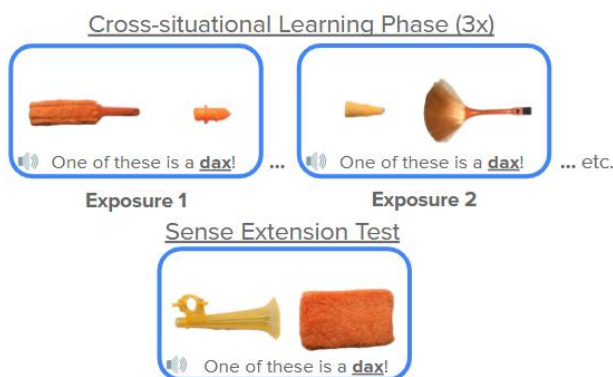


Figure 2. Study 1 Design. Children and adults learned 2 novel words across 7 exposures. The initial Cross-situational Learning Phase featured two polysemous meanings presented on alternating trials for 6 exposures. Finally, the Sense Extension Test featured the third polysemous meaning from each set.

Results

Polyseme Learning under Uncertainty. First, we examined whether children and adults systematically selected polysemous matches across the first six exposures (which featured two of the three referents from each polyseme set). To test this, we constructed a mixed effects binomial regression, predicting whether a learner’s choice on a given exposure came from the same polyseme set as their choice on the preceding exposure. All tests were conducted in R with the lme4 and lmerTest packages (Bates et al., 2014; Kuznetsova et al., 2017). If learners exploit shape/material similarities when learning multiple meanings for a word, then they should prefer to select referents from the same polysemy

set across exposures. We also included a fixed effect of age group (sum-coded: adults [.5] vs. children [-.5]) and random effects of participant and the previously chosen item category. A significant intercept in this model indicated that overall, learners successfully inferred polysemous meanings despite referential uncertainty, $\beta = .80$, $SE = .18$, $p < .0001$. However, we observed a significant effect of age group, $\beta = 1.05$, $SE = .32$, $p = .0011$. We therefore split the data by age group for further analysis, using the same modeling structure.

As expected, adults ($M = .73$, $SE = .044$) performed well above chance, $\beta = 1.68$, $SE = .44$, $p = .00012$. See Figure 3. To test whether this success varied as a function of similarity type (shape vs. material), we added a fixed effect of similarity type to the model (sum-coded: shape [.5] vs. material [-.5]) along with a random slope of similarity by participant. This revealed no significant effect of similarity type, $b = .58$, $SE = .91$, $p = .53$, though notably, performance was above chance only for shape similarity ($M = .77$, $SE = .049$, $\beta = 2.15$, $SE = .54$, $p < .0001$). For material-based similarity, performance was not significantly above chance, $M = .69$, $SE = .059$, $\beta = 1.41$, $SE = 1.26$, $p = .26$. This was largely due to heterogeneity across the different polyseme sets included as random effects: surprisingly, only 1 of the 4 sets showed numerically above-chance (> 50%) preferences for referents similar in their material (compared to 3 of the 4 sets showing above-chance preferences for shape-based similarity). Note that the divergent patterns in overall and item-based analyses are in part because given the nature of the design, it is impossible to balance participants across polyseme sets, making some sets more popular choices than others. In sum, while adults successfully used similarity to infer polysemous word meanings, use of material similarity was less consistent across items than for shape similarity.

Finally, we also tested whether performance improved across trials, adding a fixed, centered effect of trial to the model and a trial-by-participant random slope. The effect of trial approached significance, $\beta = .45$, $SE = .23$, $p = .052$, with polysemous mappings tending to increase across trials. The effect of similarity remained non-significant, $\beta = .50$, $SE = .91$, $p = .58$, as did the interaction between trial and similarity type, $\beta = -.11$, $SE = .25$, $p = .66$. Thus, adults showed a robust, and largely spontaneous, preference for forming both shape- and material-based polysemes.

Children’s performance revealed a different pattern. Overall, children showed a weaker preference for polysemous matches ($M = .56$, $SE = .029$) than adults, though this preference remained significantly above chance in an intercept-only model, $\beta = .24$, $SE = .12$, $p = .039$. An additional analysis including similarity type in the model yielded an effect that approached, but failed to reach, significance, $\beta = .78$, $SE = .43$, $p = .074$. Examining material and shape similarity separately, children showed above-chance performance only for shape ($M = .64$, $SE = .049$, $\beta = .66$, $SE = .26$, $p = .011$) and not for material ($M = .48$, $SE = .054$, $\beta = -.10$, $SE = .27$, $p = .70$).

Notably, an analysis adding trial number to the previous model yielded a main effect of similarity type, $\beta = .65$, $SE =$

.23, $p = .0048$, but no significant effect of trial, $\beta = -.001$, $SE = .11$, $p = .99$, or an interaction of trial with similarity type, $\beta = -.033$, $SE = .16$, $p = .84$. In sum, children showed quite a weak tendency to form polysemous mappings under ambiguity. This tendency did not increase over trials and emerged at significantly above-chance levels only for shape-based similarities. This is consistent with a general preference for extending words to similarly-shaped objects (Landau et al., 1988), rather than a broader polyseme learning strategy.

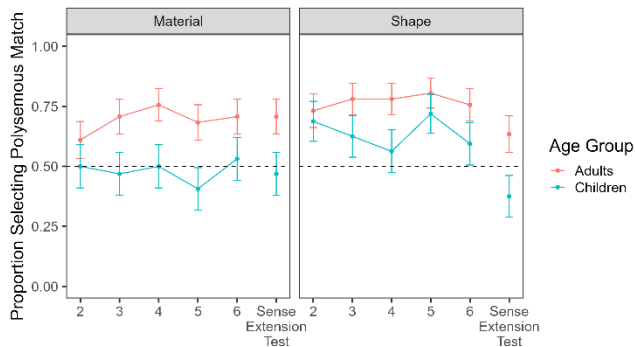


Figure 3. Study 1 Results. Adults (in red) and children (in blue) learned material- or shape-based polysemes (see facets) across 6 exposures. Adults outperformed children, who showed above-chance learning only for shape-based polysemes. On the Sense Extension Test, adults, but not children, extended the polyseme along the previously unused dimension (shape or material).

Sense Extension Test. Finally, we considered performance on the final Sense Extension Test, featuring the third, held-out referents from the polyseme triads used in Floyd and Goldberg (2021). At issue was if, having been exposed to two alternating polysemous meanings, learners would then spontaneously extend the word along a different dimension. For instance, if participants had mapped a word to similarly-shaped referents, would they extend that word to a referent similar in material to one of those prior referents?

We constructed a binomial mixed effects model testing if participants selected a new referent from the same polyseme set as their final selection from the learning phase. The model included a fixed effect of age group (sum-coded) and random effects of participant and item (i.e., the prior referent’s polyseme set). This model showed a non-significant intercept, $\beta = .27$, $SE = .18$, $p = .12$, indicating that there was not an overall bias for the polysemous meaning. However, adults showed a significantly stronger bias than children, $\beta = .88$, $SE = .33$, $p = .0085$. While adults ($M = .67$, $SE = .051$) performed significantly above chance, $\beta = .71$, $SE = .24$, $p = .0025$, children ($M = .46$, $SE = .58$) performed at chance levels, $\beta = -.24$, $SE = .38$, $p = .52$. There was no effect of similarity type, $\beta = -.046$, $SE = .36$, $p = .20$, nor interaction with age group, $\beta = .24$, $SE = .72$, $p = .74$.

Thus, adults preferentially mapped words to new referents that were similar to prior referents along a new dimension. This bias for constructing polysemous meanings is consistent with adults’ stronger performance during the first six learning

trials as well, indicating that mature word learners make use of similarity between referents along multiple dimensions when learning a novel word. However, children appeared to choose randomly on the Sense Extension test, rather than relying on similarity to prior referents—consistent with their weak polysemy preferences on the previous learning trials. In this way, children’s learning patterns show a stronger resemblance to standard computational models of cross-situational word learning (e.g., Fazly et al., 2010; Stevens et al., 2017), with referent selections under uncertainty showing little effect of referent similarity.

Study 2

The results of Study 1 suggest the ability to infer irregular polyseme meanings from referentially ambiguous exposures emerges between early childhood and adulthood. However, the stimuli in Study 1 offer only an artificial approximation of some of the similarities children might exploit when learning polysemes. To provide a more ecologically valid test of learning polysemes under referential uncertainty, we conducted a second study featuring genuine polysemes from non-English languages. Specifically, we chose polysemes that were colexified in another language but not in English. For instance, in Spanish, *sierra* can refer to saws or mountain ranges (which often have a saw-like profile—an instance of shape similarity). We also required that these polysemes have visually identifiable referents and not feature robust regular polysemy. A norming study verified these polysemes were not used by English speakers. The key question, then, was similar to Study 1: when learners hear a novel word ambiguously mapped to alternating, polysemous meanings, will they spontaneously infer polysemous mappings?

Methods

Participants For the adult study, 42 monolingual adult speakers of English were recruited from a university subject pool in the United States. For the child study, 38 monolingual English-speaking children (18 female, 20 male) were recruited from ads on social media. The study took approximately 15 minutes and was completed online. All parents or adults gave informed consent. There were no exclusions. Children’s ages ranged from 3.16 to 6.95 years ($M = 5.21$, $SD = 1.02$). As in Study 1, preliminary analyses indicated no effect of age in the cross-situational word learning task, $\beta = .0027$, $SE = .079$, $p = .97$.

Materials We used images of concrete objects that could both be described with a polyseme in a non-English language but not in English. The polyseme pairings used were: horn/croissant, saw/mountain-range, nose/beak, petal/leaf, crane/faucet, feather/hair, pillar/mirror, and pocket/bag. For each item in a pair, at least 75% of monolingual English-speaking subjects in a norming study used the target English word (above) to describe the object and none used an English word polysemously to describe both objects.

Design The design was identical to Study 1 with two exceptions (see Fig. 4). To increase power, we included a second block to teach learners additional 2 words (for a total



Figure 4. Study 2 Design. Children and adults learned 4 novel words, in 2 blocks (distinguished by black and white boxes above) across 6 exposures. All exposures were ambiguous between two distinct polyseme meanings (e.g., saw/mountains vs. horn/croissant).

of 4, rather than 2). There was also no Sense Extension Test, as our natural polysemes had only two senses.

Results

Polyseme Learning under Uncertainty. To test whether participants showed a preference for forming polysemous mappings, we constructed a binomial mixed effects model predicting whether a learner’s choice on one trial was congruent with their choice on the previous one (e.g., having mapped “zum” to a horn, mapping it to the croissant on the next trial). We included a fixed effect of age group (sum-coded: adults [.5] vs children [-.5]) and random effects of participant and polyseme item. This model yielded a significant intercept, $\beta = .40$, $SE = .18$, $p = .022$, suggesting above-chance preference for polysemous matching. However, this performance was driven by adults ($M = .67$, $SE = .036$), who significantly outperformed children ($M = .52$, $SE = .020$), $\beta = .72$, $SE = .21$, $p < .001$. Although taken separately, adult performance only approached, and did not reach, significance, $\beta = .82$, $SE = .43$, $p = .058$. Children performed at near-chance levels, $\beta = .037$, $SE = .12$, $p = .76$. Thus, as in Study 1, the ability to exploit polysemy under uncertainty appears to be limited for children but emerges successfully in mature word learners.

Finally, to test whether polyseme learning increased over trials, we added a fixed effect of trial (centered) and a trial-by-participant random slope to the model. For adults, this revealed a significant, positive effect of trial, $\beta = .14$, $SE = .067$, $p = .037$. Children showed no effect of trial, $\beta = .044$,

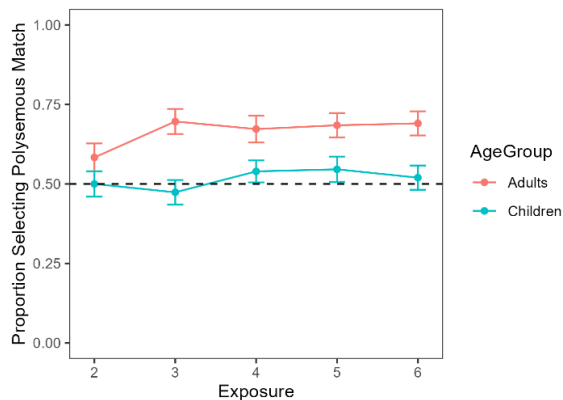


Figure 5. Study 2 Results. Adults increasingly selected polysemous referents across exposures; children showed no preference for polysemous mappings.

$SE = .053$, $p = .41$. Thus, over repeated exposures, adults tended to stabilize on a polysemous meaning—with much of this successful inference happening by the third exposure (see Figure 5). In contrast, children’s choices for a word’s new referents showed no consistent, similarity-based pattern.

General Discussion

In two studies, we show that when child and adult learners encounter a polysemous word under ambiguity, they differ in their preference for extending that word from one sense to a new, but related, referent. In Study 1, we demonstrate that despite the overall advantage for learning and retaining polysemes observed in Floyd and Goldberg (2021), only adults reliably identify those similarities when learning polysemes from referentially ambiguous exposures. While children showed a greater-than-chance likelihood of learning polysemous mappings overall, this effect was driven by their success in extending words between referents with similar shapes, but not with similar materials, and not in the Sense Extension Test. In Study 2, this pattern emerged even more strongly: children learning naturally occurring polysemes showed no preference for mapping words to related referents. This suggests that while some highly regular polysemes’ multiple meanings may be inferred spontaneously (e.g., for the concrete and abstract senses of “book”), other, more irregular polysemes may require their senses to initially be learned separately.

This may also offer some insight into the difficulty of children in exploiting polysemy in Study 1, despite Floyd and Goldberg’s (2021) previous study showing a polyseme learning advantage with the same stimuli. One possibility is that this polyseme advantage is primarily *memory-based*: that is, perhaps once children have been unambiguously taught multiple meanings, it is easier to recall those meanings when they are related than when they are not. As a result, even if children do not generally rely on similarities between meanings when acquiring new word-referent mappings, these similarities may facilitate later recall. This possibility requires future research, but it would prove substantially easier for computational models of word learning to accommodate, as there would be no need to change the word learning mechanism itself. Notably, children’s chance-like performance in Study 2 even resembles that predicted by computational models that assume independence between rival word-referent mappings. Such a strategy might prove more computationally efficient for children—by not requiring them to evaluate the similarity of new candidate against prior referents. It might also enable children to recover from their errors more quickly: in the event of forming an incorrect word-referent mapping, children will be able to more quickly reject it if they are open to dissimilar alternative meanings. Future research should investigate these potential advantages, as well as directly model performance in polyseme learning tasks, examine learning patterns for a broader range of both regular and irregular polysemes, and assess how word learning strategies change across development.

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