A Child’s Acquisition of Polysemy: of, with, and by in Child English

Norielle Adricula and Megan Pielke

1. Introduction

The lexical category of prepositions presents a difficult “mapping problem” (Clark, 1993) for children. Prepositions are highly relational, that is, they denote relationships between entities as opposed to entities themselves, and they are highly polysemous. Their meanings can include a range of spatial, concrete, and abstract meanings (Rice, 2003). Additionally, they encode a wide range of semantic roles and grammatical functions (e.g. Lakoff, 1987; Sandra & Rice, 1995; Tyler & Evans, 2003). Given the nature of this lexical class, children may have difficulty in identifying and acquiring their various meanings and uses.

This mapping problem may be particularly acute for less spatial, highly grammaticized prepositions, such as with. Though highly spatial prepositions such as in and on have grammatical usages (Rice, 2003; Schneider et al. 2015; etc.), they frequently encode core spatial concepts such as containment, tight-fit, and support to which children exhibit sensitivity at an early age (Bowerman & Choi 2003; Hespos & Spelke 2004; Casasola & Cohen, 2002). In comparison, while with may denote “spatial proximity” (Kidd & Cameron-Faulkner, 2008), with is most frequently used to denote non-spatial relationships between entities, i.e. semantic relations such as instrument or accompaniment (Kidd & Cameron-Faulkner, 2008), which are not concrete and perceptible in the way spatial relationships might be. Other prepositions have similar properties: of marks partitive relations, by marks agents in passive clauses, to marks the recipient, etc.

How do children acquire the meanings of these kinds of prepositions that typically denote non-spatial relationships between entities and events?

One way children might resolve this mapping problem is by utilizing various cues that may be available in caregiver input. In the domain of verb meaning acquisition, caregiver input frequency and usage patterns have been shown to be significant predictors of children’s verb uses. For example, input is a significant predictor of children’s verb uses (Theakston et al., 2004), verb meaning often requires information about the syntactic environments in which they occur (e.g. Gleitman, 1990, Snedeker & Gleitman, 2004, etc.), and syntactic context can be used as a cue to verb meaning by toddlers (Fisher, 1996; Fisher & Snedeker, 2002; Naigles, 1990). Different senses of polysemous verbs have been shown to strongly correlate with different argument structure probabilities (Hare et al. 2003, 2004).

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A few prior studies have shown similar results for the preposition with. Kidd (2003) and Snedeker & Trueswell (2003) have shown that the construal of with in Verb-Noun Phrase-Preposition Phrase (V-NP-PP) sentence frames is affected by verb semantics. Kidd & Cameron-Faulkner (2008) show that semantic roles indicated by with can be distinguished on at least two dimensions, including the syntactic contexts in which they prototypically occur and their co-occurring verb semantics. If properties such as input frequency, syntactic contexts, semantic contexts, etc. in caregivers’ input exhibit stable contextual patterns, such properties may help children resolve the difficulty of the mapping problem for non-spatial, highly grammaticized prepositions.

In this study, we ask if input frequencies and the surrounding linguistic context can provide clues to children to learn the meanings of these highly polysemous items. To explore this question, we examine a corpus of one child’s production and his surrounding input of three relatively non-spatial and highly grammaticized prepositions: of, with, and by. These prepositions have relatively different frequencies in adult language (Rice, 2003) and frequently encode semantic roles: of marks partitive relations, with marks instruments, and by in passive clauses marks agents, etc. We examine preposition sense frequencies, their surrounding syntactic and semantic contexts, and compare how similar or different these elements are between the production and input. Because this is a corpus study, we can examine and characterize any potential patterns of usage in both production and input. However, we can only indirectly infer how Abe is acquiring and representing these different prepositions, and thus we make no argument to the causal mechanisms of this process.

2. Methods
2.1. Data

The child and caregiver data used in this study comes from the Kuczaj corpus (Kuczaj, 1976) in the North American English collection in CHILDES (MacWhinney, 2000). This is a longitudinal corpus containing transcriptions of spontaneous speech from the child Abe and his interactions with his parents and other interlocutors from age 2;4 to 5;0. Abe was regularly sampled in the home over a period of several years. From 2;4 to 4;1, he was sampled twice a week, thirty minutes each. From 4;1 to 5;0, he was sampled once a week, thirty minutes each. All participants engaged with Abe at the time of the sample were recorded and transcribed.

2.2. Procedure

The CLAN tool (MacWhinney, 2000) was used to extract all instances of of, with, and by and their contexts from Abe, his father, and his mother. Excluding non-spontaneous utterances, repetitions, unknown usages from analyses (n = 221), there were a total of 2,457 utterances to analyze. For each utterance, several elements were coded: preposition sense, syntactic context, and semantic context. Preposition sense categories were derived preliminarily from Rice’s (2003) category superset used for her study on children’s acquisition of nine prepositions.
[in, on, at, to, for, from, with, by, and of]. This set coded for usages such as semantic roles and grammatical functions. This preliminary set was adjusted by removing and adding categories to better describe the data. Additional categories were guided by the corpora-driven annotation guidelines from the Preposition Supersense Project (Schneider et al., 2015, 2016) that utilizes various features to annotate prepositions in corpora of English. Please see Table 1 for a sample of the coding categories and examples.

Table 1. Sample coding categories for of, with, and by

<table>
<thead>
<tr>
<th>CODING CATEGORIES: Adapted from Rice (2003) &amp; Schneider et al. (2015)</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantifier (Rice, 2003)</td>
<td>Typically a quantifier or number indicating an amount of some countable noun</td>
</tr>
<tr>
<td></td>
<td>*CHI: &lt;we have&gt; [I] we have <strong>ONE OF</strong> those books &lt;at home&gt; [I] at our home?</td>
</tr>
<tr>
<td>Partitive (Rice, 2003)</td>
<td>Part-whole relationship; an amount of X is still X; doesn't change properties; indicated by words like &quot;part&quot; or &quot;portion&quot; or partitive locational nouns, i.e. the top of X</td>
</tr>
<tr>
<td></td>
<td>*CHI: &lt;the whole&gt; [/] the wide bottom of the peanut butter has a big crack in it.</td>
</tr>
<tr>
<td></td>
<td>*CHI: Mom (.) what those kind <strong>OF</strong> rocks?</td>
</tr>
<tr>
<td>Comitative (Rice, 2003 &amp; Schneider et al., 2015)</td>
<td>A person or object that is together with another person or object, co-participants in an activity, such as verbs of movement, dynamic verbs; indicated by phrases such as &quot;along with,&quot; &quot;together with,&quot; &quot;accompanied by&quot;</td>
</tr>
<tr>
<td>Instrumental (Rice, 2003 &amp; Schneider et al., 2015)</td>
<td>An object or body part that enables or facilitates an action, but does not require a result caused by the instrument. Includes uses such as &quot;play with x&quot;</td>
</tr>
<tr>
<td></td>
<td>*CHI: you know that feather and ink? *CHI: we could make a word <strong>WITH</strong> that.</td>
</tr>
<tr>
<td>Attributive (Rice, 2003 &amp; Schneider et al., 2015)</td>
<td>Preposition whose complement is an attribute or feature of the entity or person</td>
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<tr>
<td></td>
<td>*CHI: I wanna make a book <strong>WITH</strong> monsters.</td>
</tr>
<tr>
<td>Passive Agent (Rice, 2003)</td>
<td>Animate doer of action in passive sentence (not an inanimate object, which would be either cause or instrument)</td>
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<tr>
<td></td>
<td>*MOT: he got bitten by a snake.</td>
</tr>
<tr>
<td>By x-self</td>
<td>A semi-productive formulaic multi-word expression &quot;by x-self&quot; where &quot;x&quot; is a reflexive pronoun. Presently analyzed as a particular kind of multi-word expression, though it may have other sense meanings such as manner.</td>
</tr>
<tr>
<td></td>
<td>*CHI: because you were still playing volleyball? *FAT: uhhuh. *CHI: oh <strong>BY YOURSELF</strong>? *FAT: no ‡ I was playing with some other people.</td>
</tr>
</tbody>
</table>

Due to space limitations, the full category scheme with definitions, examples, etc. can be found at https://osf.io/9tbev/?view_only=8f17c54c503f48c092f379b6ae7013f1
Coding the syntactic context involved two steps: 1) coding the grammatical category of the word or phrase being modified by the prepositional phrase (NP, VP, ADVP, etc.) and 2) coding the grammatical category of the preposition complement (PRON, NP, ADJ, etc.). This allowed us to quantify syntactic data, analyze any potential patterns, and address any potential syntactic ambiguity in the use of these prepositions.

Coding for semantic context involved identifying broad categories of verbs and nouns that co-occurred with the prepositional phrase. We limited our window of analysis to the elements within the analyzed syntactic context, i.e. the word or phrase being modified and the prepositional complement. Following Kidd & Cameron-Faulkner (2008), collocating verbs were categorized according to Levin’s (1993) verb classes. For example, verbs such as make, build, draw were categorized as “verbs of creation and image creation” (Levin, 1993, pp. 169-176). Three or more tokens of verbs of a particular Levin verb class constituted its own category. Co-occurring nouns were categorized into broad superordinate level categories, such as food, animals, people, etc. (Rosch, 1999), lexical categories like quantifier or number, or productive nominal chunks like “X piece” or “X part.” Three or more tokens of nouns falling under broad classifications (toys, food, etc.) constituted a category. Co-occurring verbs and nouns that did not fit into any category were labeled as miscellaneous VP or NP.

3. Results

Table 2 shows the total number of tokens per preposition for Abe, his father, and his mother. By was the least frequent preposition across the board, whereas with and of were much more frequent. Since Abe is a very expressive and precocious child, his higher token counts of these prepositions compared to his parents are not surprising.

<table>
<thead>
<tr>
<th></th>
<th>of</th>
<th>with</th>
<th>by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abe</td>
<td>633</td>
<td>633</td>
<td>86</td>
</tr>
<tr>
<td>Father</td>
<td>317</td>
<td>238</td>
<td>38</td>
</tr>
<tr>
<td>Mother</td>
<td>281</td>
<td>202</td>
<td>29</td>
</tr>
</tbody>
</table>

For each preposition, we will show the overall distribution of the different preposition senses for Abe and the input. The co-occurring syntactic and semantic contexts will be shown and discussed for the most frequent senses and we will examine any potential patterns of usage in the input and the production.

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2 These contexts will be framed in syntactic terms, (e.g. NP, PP, S, etc.) however, we are making no claims that children represent their utterances in these ways.
3.1. Preposition *of*

Figure 1 shows the overall relative frequencies of the senses for *of* in Abe’s production and the caregiver input (total tokens = 1,231). A Spearman rank-order correlation between relative frequencies of senses in Abe’s production and the input suggests that production and input are very similar ($r_p (2,12) = 0.91, p < .0001$). This suggests that sense frequencies for *of* in the input may be an influential factor in Abe’s acquisition and use of these different *of* senses.

![Graph showing relative frequencies of *of*-senses across production and input](image)

**Figure 1. Overall relative frequencies of *of*-senses across production and input**

Altogether, the quantifier, partitive, and sortal senses make up more than half (60%) of Abe’s *of*-utterances. Species *of* occurs in an additional 16% of these utterances. These results indicate that the most frequent senses of *of* are primarily relational and denote various subsets: quantities or part-whole relationships for nouns (quantifier, partitive, sortal) and kinds of nouns. A Spearman rank-order correlation between overall syntactic contexts in the production and input show that they are strongly correlated ($r_p (2,18) = 0.795, p < .0001$), suggesting that the syntactic contexts in which *of* appears in the input may also be highly influential in Abe’s uses of *of*. The NP-of-NP syntactic context is the primary syntactic context for this preposition for all participants (Abe = 45%, Parents = 56%). Figure 2 shows a breakdown of these syntactic results by frequent senses, demonstrating what we could call as the prototypical syntactic context of a particular preposition sense (see Kidd & Cameron-Faulkner, 2008).

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3 Finer-grained senses allowed for in-depth analyses of their co-occurring elements.
In addition to sense frequencies and syntactic contexts, nouns co-occurring with *of* may help in the acquisition of these different senses. Common semantic contexts for frequent *of* senses are shown in Figure 3.

Quantifier *of* was the most frequent sense for *of* in both production and input. This sense denoted numbers or subsets of people and objects: “I maked two of them for me” (02;07.26), “you mean some of the birds had a Thanksgiving” (04;10.15). Figure 2 shows that in both production and input, it occurs in several different syntactic contexts including QUANT-of-PRON, NP-of-PRON, and NP-
of-NP. In production and input, this sense primarily denoted quantities and subsets of salient and prominent entities in a child’s life: people, such as family members and friends, pronouns (them, these, those, this), food, and others.

A similar sense of of, the partitive of (third most frequent sense), denoted part-whole relationships of nouns: “a part of a barn” (02:07) and locative partitives such as “at the top of” and “the inside of.” The frequencies of syntactic contexts for partitive of look similar across production and input, occurring primarily in NP-of-NP syntactic contexts compared to quantifier of. The kinds of co-occurring nouns for this sense are similar, though they vary in their relative frequencies (Figure 3). Like quantifier of, the use of this sense looks fairly similar between Abe’s use of this sense and the input.

The second most frequent of sense for Abe was species, where of denoted some instance of a category. In both production and input, the of-phrase attached to “species” words such as “type,” “kind,” “sort,” etc.: “Mom (.) what those kind of rock?” Like partitive of, this usage primarily appeared in NP-of-NP contexts. As indicated by Figure 3, species of frequently denoted types of toys, animals and plants, food, etc. in both production and input. Except for food, these nouns are relatively different from the nouns co-occurring with quantifier and partitive of.

Overall, the most frequent senses for of primarily denote quantities or subsets of entities that are salient in a child’s life, such as family members, food, animals, etc. The senses, syntactic contexts, and semantic contexts for of are similar between the production and input, providing support that various aspects of the input may play a role in Abe’s acquisition of this highly relational preposition.

3.2. Preposition with

Figure 4 shows the overall relative frequencies of the senses for with in Abe’s production and the parent input (n = 1,194). Similar to the results in Kidd & Cameron-Faulkner (2008) and Clark & Carpenter (1989), its most frequent usages tend to denote the instrument and comitative, or additional predication such as attributive. A Spearman rank-order correlation between the relative frequencies of sense in Abe’s production and the input suggests that frequencies of senses in the input may be an influential factor in Abe’s use of the different senses of with ($r_s (2,11) = 0.913, p < .0001$). This finding supports prior findings about the role of input in the acquisition and use of with (Kidd & Cameron-Faulkner, 2008; Clark & Carpenter, 1989; McKercher 2001).
A Spearman rank-order correlation for overall *with* syntactic contexts show that the syntactic contexts in which these senses occur in the production and input look relatively similar ($r_s(2,9) = 0.585, p < .05$). *With* most frequently appears as a modifier of a verb phrase and its complement is typically a noun or pronoun (Abe = 72%, parents = 83%). Occasionally, *with* modifies a noun phrase (Abe = 12.5%, parents = 7%). If we categorize these syntactic results by frequent senses, we see prototypical syntactic contexts in which frequent senses of *with* occur (Figure 5).

Co-occurring verbs and nouns modified by *with*-phrases are shown in Figure 6.
Instrumental *with* was the most frequent sense in both Abe’s production and the input. In both production and input, it occurred primarily in a VP-with-NP context, frequently with the verb *play*, light verbs such as *do, make, have,* and others. Types of instruments with which an action is done included toys, tools, and crafts: “okay, I wanna tell you somethin(g) before I cut with a little saw” (03;01.28), “wanna do my color with oil pastels” (02;11.25), or “have a race with our motorcycles” (03;05.03). Overall, the use of the instrumental *with* is very similar between Abe’s production and surrounding input. As we will show in the section for *by, by* and *with* overlap with each other in marking the instrument in Abe’s production.

Comitative *with* is the second most frequent sense for both Abe and his parents. This use frequently denoted activities that occur along with other people. Across production and input, the most frequent syntactic context this sense occurred in was VP-with-NP, like instrumental *with*. Comitative *with* frequently co-occurred with verbs of motion and manner of motion such as *go, come, walk, run,* verbs of social interaction especially *play,* etc. in both production and input. When Abe was not using *play* in an instrumental sense, he talked about playing *with* people. Given the patterns in the input and the situational contexts in which this use of *with* occurs, there may be multiple cues Abe might use to learn this sense of *with*.

Attributive *with* stands in contrast with the instrumental and comitative *with* senses in several ways. Instead of denoting a semantic role, it denotes some additional predication to some noun phrase: “I wanna make a book with monsters” (2;4.24), “I like sandwich with cheese in it” (2;7.26), “What kind of game? A game with animals” (2;8.22). In both the production and input, this sense prototypically occurred in NP-with-NP syntactic contexts as opposed to VP-with-
NP contexts. Co-occurring nouns were similar between production and input, though Abe seemed to frequently use this sense when talking about food more than his caregivers. Like of, the overall patterns of with and observations from the more specific patterns suggest that input for the syntactic contexts and semantic contexts in which these senses occur may support Abe’s learning of these different senses.

3.3. Preposition by

Compared to of and with, by is relatively infrequent both in the production and the input. Figure 7 shows the overall relative frequencies of the senses for by in the data (n = 153).

![Figure 7: Overall relative frequencies of by-senses for Abe and parents](image)

The most frequent sense of by is the multiword expression by x-self, followed by passive agent, and instrumental. A Spearman rank order correlation between the relative sense frequencies for by in the input and Abe’s production was not significant ($r_p (2,6) = .301, p > .05$). Similarly, a Spearman rank order correlation between the different syntactic frames for by between Abe and his caregivers was not significant ($r_p (2,15) = .309, p > .05$). Compared to of and with, these results indicate that overall, there does not seem to be a significant relationship between Abe’s uses of by and his caregivers. Though this lack of significance is likely due to how few tokens of by there are in the sample overall, we can still identify some trends in the syntactic contexts and semantic contexts of the most frequent by senses. Figure 8 shows the prototypical syntactic contexts for these by senses.
Figure 8. Most frequent syntactic contexts for frequent by-senses

Examining the semantic contexts of these frequent senses might also be informative in learning these different senses. Figure 9 shows frequent co-occurring verbs for the most frequent by sense, by x-self.

Figure 9. Most frequent co-occurring verbs for by x-self

Similar to the results in Rice (2003), the multiword expression by x-self is the most frequent sense of by. The prototypical syntactic context for this sense is VP-by-PRON, where the by phrase modifies a verb phrase. Unsurprisingly, this sense

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4 Since there are much fewer usages for passive agent and instrumental by, co-occurring semantic contexts will be listed out instead of placed in a graph as is done for of and with.
is most distinguishable by the co-occurrence of a reflexive pronoun such as myself, himself, themselves, etc. Co-occurring verbs include verbs of motion, such as go, walk, etc., the verb play, and light verbs such as do or make. In the input, we find similar types of co-occurring verbs. For this sense of by, we see that patterns in production are similar to patterns in the input. However, we find a divergence in this general trend when we look at the other frequent senses for by.

Abe uses by second most frequently for agents in be- and get-passive sentences: “a monarch butterfly was killed by a bird” (3;7.28); “and the ten foot monster got eaten by bats.” (4;1). In the input, passive agent by was much rarer, but did include similarly formed utterances: “the alligator was kissed by the camel” (father, Abe = 2;4.24); “he got bitten by a snake” (mother, Abe = 3;5.23). Syntactic context was similar between production and input: VP-by-NP, where the VP was a transitive verb. For Abe, these transitive verbs were limited to eat (n = 3), bite (n =1), shoot (n =1), kill (n =2), and surround (n = 1). In the parent data, the transitive verbs included glue (n = 1), eat (n = 1), kiss (n = 1), and bite (n = 1). This very limited data sample shows there seem to be differences between the input and the production for this sense of by, however, due to the nature of sampling in corpora and the low frequency of this sense, we cannot conclude anything beyond that.

The differences in the use of by is most apparent in the instrumental sense, the third most frequent sense for Abe. These uses were characterized by the use of some object or body part, to achieve certain purposes. Like the passive agent by, prototypical syntactic contexts in the production and input for this sense was VP-by-NP. However, co-occurring verbs were not necessarily transitive verbs: go (n = 3), fix (n = 2), play (n =1), cover (n = 1), hang (n = 1), protect (n = 1). Most notably, these uses occasionally overlapped with instances where we might expect an instrumental with: “I could protect my tummy and here…by my cape” (3;4.04); “I think by tape we could fix it” (3;6.16). There is only one instance of instrumental by in the input if we take this example as a non-idiomatic chunk: “why don’t you just mix it up by hand?” (father, Abe = 2;10.27). Abe has a parallel example using a body part as an instrument: “Uhhuh I hanged by one leg” (2;9.23). Such instances are similar to the findings in Clark & Carpenter (1989), where some children used by to introduce instruments, causes, and agents. Although there is too little evidence to make conclusions, Abe’s uses of instrumental by seems somewhat nonconventional and unexpected given the input. One reason for why Abe might use by to also mark instruments is because they, like agents, enable actions in causal events. In English, the semantic difference between agents and instruments is that agents tend to be animate and volitional, while instruments are not. However, if a child has not yet learned that distinction between these two categories, it does not seem surprising that agents and instruments would be marked with by. That is, Abe’s extension of by from agents to instruments may reflect his representation of these categories as being conceptually similar and that entities that bring about results may be an emergent category (Clark & Carpenter, 1989).

5 Since there are relatively few instances, an exhaustive list can be given here along with the token counts (n) instead of relative frequencies and broad categories.
Compared to *of* and *with*, the patterns of usage in the production and input do not seem to be very similar to each other. While this may be a result of *by*’s infrequency overall, it may also be due to how Abe uses *by* differently from his parents. Specifically, he uses *by* to mark passive agents and instruments in ways that we do not see in the input. Abe’s use of *by* may indicate that there is conceptual overlap in his categorization of agents and instruments.

4. Discussion & Conclusions

In this study, we argue that preposition senses are associated with their surrounding linguistic environments. And like prior research shown with verb senses (e.g. Theakston et al., 2004; Snedeker & Gleitman, 2004; Fisher & Snedeker, 2002; Fisher, 1996; Gleitman, 1990), preposition senses may be derivable from usage patterns in caregiver speech. To explore this idea, we examined one child’s acquisition and use of three non-spatial, highly grammaticized prepositions *of*, *with*, and *by* and explore factors in the input that may facilitate his acquisition of the meanings and uses of these prepositions. Broad analyses for *of* and *with* suggest that overall input frequencies of sense and syntactic contexts may play a crucial role in the acquisition of these senses. Analyses of frequent *of* and *with* senses show that these senses may occur in prototypical syntactic contexts and with certain kinds of verbs and nouns that might also provide cues to learning these different senses. However, the preposition *by*, though infrequent, hints that input frequencies are not the only factor in this process. Sampling size aside, Abe’s uses of *by* do not seem to conform to his parents’ patterns of usage, specifically his use of passive agent *by* and instrumental *by*. These somewhat divergent uses hint that Abe may have some representation of instruments as being conceptually similar to agents such that *by* can be used for both kinds of entities, even if it might appear very infrequently in the input. However, since this is production and input data from corpora, we can only indirectly infer how Abe is representing these different prepositions. More work needs to be done to examine what may be happening with *by* in more detail.

The influence of usage patterns in the input on a child’s acquisition of different preposition senses suggests that statistical learning may play a role in children’s acquisition of these different meanings (e.g. Kidd, 2012; Romberg & Saffran, 2010; etc.). Children may be using multiple statistical cues such as input frequencies of sense, syntactic context, semantic context, to infer the different meanings and uses of these prepositions. More corpus and experimental work need to be done in order to test whether statistical learning or other mechanisms play a role in the acquisition of preposition senses. Additionally, this study has only considered a few linguistic properties of the input and production. Other linguistic factors, such as discourse-pragmatic contexts, and non-linguistic factors, such as situational contexts, may also play a role in the acquisition of these polysemous items. To fully explain how children resolve this mapping problem, other information beyond what is presented here must also be examined.

Due to the nature of corpus data and these methods, there are various issues and limitations to the analyses presented here. For example, this data has come from one child-caregivers sample and therefore these results cannot be
generalized to all children. Additionally, since all input data and production data were analyzed at the same time intervals, one cannot judge whether input and production look similar because children are using elements in the input or because children and parents engage in the same conversations and discourse contexts (Theakston et al., 2004). A strategy around this would be to extract and analyze preposition use in the input and production from different conversations and at different time points, much like Naigles & Hoff-Ginsberg (1998) did for verbs. This would be difficult for this study given the relatively few tokens for each preposition per sample but may be more feasible with more child data.

In summary, our study has shown that various properties of the input may play important roles in children’s acquisition of highly polysemous words like prepositions. Further corpora and experimental research with these prepositions and others need to be done in order to test the conclusions drawn from this study.

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