

English Negative Constructions and Communicative Functions in Early Child Language

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Abstract

How does abstract linguistic negation develop in early child language? Previous research has suggested that abstract negation develops in stages and from more concrete communicative functions such as rejection, prohibition, or non-existence. The evidence for the emergence of these functions in stages is mixed, however, leaving the possibility that negation is an abstract concept from the beginning that can serve multiple specific functions depending on early communicative environment. Leveraging automatic annotations of large-scale child speech corpora in English, we examine the production trajectories of seven negative constructions that tend to convey communicative functions previously discussed in the literature. The results demonstrate the emergence and gradual increase of these constructions in child speech within the age range of 18-36 months. Production mostly remains stable, regular, and close to parents' levels after this age range. These findings are consistent with two hypotheses: first, that negation starts as an abstract concept that can serve multiple functions from the beginning; and second, that negation develops in stages from specific communicative functions but this development is early and quick, leaving our corpus methods incapable of detecting them from the available corpus data.

Keywords: negation; syntactic construction; communicative function; development; child language.

Word count: X

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Introduction

Negation is an abstract concept that serves different communicative functions in everyday communication. A coffee shop can divide its menu into “coffee” and “not coffee” sections, with “not coffee” bringing together diverse items with no common label like tea and hot chocolate. It could be used in a sign like “no mask, no entry” to regulate people’s behaviors. An employee could say “I don’t like Mondays” to communicate their desires or dislikes. But how does abstract multi-functional negation emerge and develop in the human mind? Are early stages of negation in child language specific to one or a few functions? Or does negation emerge as an abstract and multifunctional concept from the beginning?

Previous literature has proposed that abstract negation develops from less abstract communicative functions in ordered stages (Pea, 1978). For instance, Darwin (1872) hypothesized that the earliest manifestation of negation in infants is when they refuse or reject food from parents by withdrawing their heads laterally. Similarly, Pea (1978) also proposed “rejection” as the first function of negation in child language. By contrast, Bloom (1970) argued that the use of negation to express “non-existence” emerges before “rejection.” For example, when an object that children expect to be present is not, children may say: “there is no window.” Follow-up study by Choi (1988) argued that “prohibition” emerges as early as rejections and non-existence. In cases of prohibition, children use negation to stop others or themselves from performing actions (e.g. “don’t go”). A function similar to prohibition is “inability” (e.g. “I cannot zip it”), in that both involve conceptualizing actions and negating them. Choi (1988) suggested that expressions of inability emerge after the functions in the first phase, namely non-existence, rejection, and prohibition.

Despite considerable research on early functions of negation, their developmental trajectories in children’s productions remained unclear. Different studies pro claimed different order of acquisition (Pea, 1978).

the possibility that negation develops as an abstract concept that can serve multiple communicative functions early in the development based on the context of use in parent-child interactions. Therefore, across (a larger number of) children, distinct functions of negation could develop within the same age range and share common production trajectories.

However, previous experiments have mainly relied on manual annotations of corpus data to determine the communicative function of a given negative utterance, which in turn has limited their work to only a handful of children per study. Here we aim to go beyond existing work via utilizing a large collection of child speech corpora in English (MacWhinney, 2000) along with computational tools to automatically identify negative utterances that tend to convey the communicative functions discussed in prior research (Table 1). In particular, our study investigates three questions: (1) how does the developmental trajectory of the negative constructions for each function look like? (2) for utterances expressing the same function, does the developmental trajectory differ depending on particular lexical items that negation modifies (e.g. *like* or *want* for rejection)? (3) taking all functions into account, do they share similar developmental characteristics, or would there be function-specific differences?

Given the automatic fashion of our approach, we focus on larger/longer negative constructions at the single-sentence level. This is in opposition to short negative forms at the discourse-level such as cases consisting of one morpheme (e.g. “no!”) or repetition of negative morphemes (e.g. “no no no”), which arguably could express multiple functions when not taking the discourse context into account and accordingly leave more room for ambiguous interpretation.

Previous Studies

In this section, we review previous research that proposed functional origins and stages for the development of negation in child language. One of the earliest such accounts was

80 proposed by Charles Darwin. Darwin (1872) (Chapter 6) hypothesized that negation
81 originates from early expressions of human emotions and desires. He considered nodding and
82 shaking as the earliest expressions of affirmation/approval and negation/disapproval
83 respectively. He argued that: “With infants, the first act of denial consists in refusing food;
84 and I repeatedly noticed with my own infants, that they did so by withdrawing their heads
85 laterally from the breast, or from anything offered them in a spoon. In accepting food and
86 taking it into their mouths, they incline their heads forwards . . . [moreover] . . . when the
87 voice is exerted with closed teeth or lips, it produces the sound of the letter *n* or *m*. Hence
88 we may account for the use of the particle *ne* to signify negation, and possibly also of the
89 Greek *μn* in the same sense.” In later research, this function of negation was referred to as
90 “rejection” or “refusal.” Darwin did not explain how communicative functions of negation
91 other than “rejection” develop in childhood.

92 Much later, McNeill and McNeill (1968) proposed a five-stage account in which a child
93 creates more and more fine-grained concepts of negation by adding “features” to their
94 conceptual space. They studied the development of three Japanese negative morphemes (*Nai*,
95 *Iya*, *Iiya*) in the speech of a 27-month-old Japanese speaking girl called Izanami. According
96 to McNeill and McNeill (1968), *nai* expresses falsity of statements (e.g. “*no* [that’s not an
97 apple]), *Iya* expresses desires (e.g. “*no* [I don’t want an apple]”), and *Iiya* expresses contrast
98 (e.g. *no* [I didn’t have an apple. I had a pear])). In the first stage, Izanami used a simple
99 negation like *nai* to express non-existence of events and objects - similar to “not here”.
100 Although the study also reports the use of *shira-nai* (I don’t know). In the second stage,
101 Izanami used negation to mark incorrectness of statements - similar to “false”. Such uses of
102 negation were labeled as “denials”. In stage three, negation was also used to express
103 disapproval or rejection - similar to “I don’t want that”. In the fourth stage, Izanami used
104 negation to express contrasts - similar to “not this but something else”. Finally in the last
105 stage, Izanami had an abstract concept of negation. According to McNeill and McNeill
106 (1968), these stages took about five months.

Bloom (1970) considered three communicative functions for early negation: non-existence, rejection, and denial. She studied three children (Eric, Kathryn, and Gia), two from 19 months and another from 21 months of age. She argued that in all three children, negation followed three phases. In the first phase, negation was mostly used to express non-existence. In the second phase, negation was used to convey rejection as well. And finally in phase three, examples of denial negation were also attested. Table provides a few examples for each category. Outside the context of use, many examples do not immediately stand out as instances of non-existence, rejection, or denial. This is partly because many early examples are minimal combinations of negation and other words and rely heavily on the context of use for their interpretations. It is therefore hard to assess the intention behind the use of negation in such cases.

Table 1

Examples of non-existence, rejection, and denial negation in the speech of Eric, Kathryn, and Gia from Bloom (1970)

Non-existence	Rejection	Denial
no more choochoo train	no train	no Daddy hungry
no more noise	no want this	no more birdie
no children	no bear book	no ready
no it won't fit	no go outside	no tire
Kathryn no like celery	no dirty soap	no dirty

Pea (1978) studied six children between the ages of 8-24 months. Children were visited monthly in their homes and recorded for about 90 minutes. Examples of negation included headshakes, Pea (1978) argued that children first started by using negation that expresses internal states (i.e. rejection), then used negation to express external states (e.i. disappearance), and finally used negation to connect language to external states

(i.e. truth-functional or propositional negation, often similar to denials).

Villiers and Villiers (1979) studied the communicative functions of negation in the speech of Adam (27-31 months), Eve (18-22 months), and Nicholas (23-29 months). They annotated children's examples of negation for six communicative functions: non-existence, disappearance, non-occurrence, cessation, rejection, and denial. Disappearance referred to cases where an object became hidden and "cessation" referred to the use of negation when a movement or action stopped (e.g. "no walk" when a toy stopped walking). They found rejections and denials to be the most frequent (and most reliable to annotate) functions of negation in parents' and children's speech. Both functions were present from the earliest samples of speech and the authors concluded that there are individual differences in the functions of negation in child language that mirrors similar variation in child directed speech. They emphasized the close relation between the development of form and function in early child language.

Choi (1988) looked at the speech of 11 children (2 English, 4 Korean and 5 French speaking) between the ages of 1;7-3;4 months. She reported 9 communicative functions for children's negation shown in Table 2. She matched each communicative function with forms and constructions that commonly convey it and proposed that these forms and functions develop in three phases. First, children used "*no*" alone to express the four functions of nonexistence, prohibition, rejection, and failure. In the second phase, *no* was used to express denial, inability, and epistemic negation. Novel forms such as "*not*+NP" (e.g. "*not a bee*"), *can't* (e.g. "*I can't put back*"), and *I don't know* were also used to express these functions. New forms also distinguished the functions in the previous phase such as rejection (e.g. "*I don't want to*"). In the third phase, normative negation and inferential negation emerged in children's speech with modal auxiliaries like *can't*. Negative forms for prohibition also emerged with the structure "*don't*+Verb."

Table 2

Examples of communicative functions and their forms in Choi (1988)

Function	Definition	Forms	Example
Non-existence	expressing absence of entities	<i>no+V</i>	“ <i>no more</i> ” (after emptying a bag)
Failure	expressing absence of an event	<i>it wont</i>	“ <i>not work</i> ” (puzzle piece not fitting)
Prohibition	negating actions of others	<i>don't + V</i>	
Rejection	negating the child's own actions	<i>I don't want (to)</i>	
Denial	negating a others' propositions	<i>AUX + not</i>	“ <i>no that's a pony</i> ” (in response to “Is this a car?”)
Inability	expressing physical ability		“ <i>can't!</i> ” (taking two lego pieces apart)
Epistemic	lack of knowledge	<i>I don't know</i>	“ <i>I don't know</i> ” (in response to “what color is this?”)
Normative	expressing expected norms	(you) <i>can't</i>	“ <i>Him can't go on a boat</i> ”
Inferential	child's inference about the listener	<i>AUX + not</i>	“ <i>I not broken this</i> ” (seeing a broken crayon)

148 Cameron-Faulkner, Lieven, and Theakston (2007) focused on dense recordings of a
 149 single English speaking child between the ages of 2;3 and 3;3. They classified his utterances

into seven communicative functions, mostly adopted from Choi (1988) and dropping the categories of “normative” and “inferential” negation. They found examples of all these functions in Brian’s early speech. Starting at 2;3, single-word discourse-level *no* was used to convey most functions but gradually other forms using *not*, *don’t*, *can’t*, or *won’t* emerged and replaced *no* in usage. For example with inability and prohibition, Brian mostly used *no* and *not* at 2;3 but switched to *can’t* to express inability and *don’t* to express prohibition almost exclusively at 3;3. Cameron-Faulkner, Lieven, and Theakston (2007) argued that at 2;3 Brian has a broad conceptualization of negation and likely represents it as a “unitary category in conceptual space.”

In a recent study, Nordmeyer and Frank (2018) looked at the speech of five children between the ages of in the Providence corpus (Demuth, Culbertson, & Alter, 2006) and classified children’s negative utterances into seven functional categories: “disappearance,” “prohibition,” “self-prohibition,” “rejection,” “failure,” “denial,” and “unfulfilled expectations.” Self-prohibition referred to cases where children addressed a prohibition to themselves (e.g. saying “no” to themselves when reaching for a forbidden object) and “unfulfilled expectations” referred to cases that expressed surprise when an object was not in an expected place, similar to some cases of non-existence in previous research. They concluded that the developmental trajectory of different communicative functions of negation may not be as consistent across individuals as some previous research had suggested.

Overall, a survey of previous research provides us with two important insights. First, defining and detecting the communicative functions of a morpheme like negation is not a trivial task. There is a considerable degree of variation on what basic categories should be included and what utterances count as an instance of each category. Second, there seems to be considerable variation in the developmental trajectory of children with respect to negation. Therefore, studies with small numbers of children can reasonably reach different conclusions that are true of the sample but do not generalize to the population of, for example

English-speaking, children.

Current Study

Previous studies have focused on early forms of negation with *no* or *not* and manually annotated their communicative functions in context. Here we take a different approach. We focus on larger syntactic constructions that tend to convey particular communicative function. Our emphasis is on the combinatorial capacity of negation. What other functional morphemes or syntactic categories does negation combine with in children’s early productions?

We also investigate *no* as a response particle at the discourse level and try to capture constructions that it negates in conversation. This measure can potentially capture communicative functions that the response particle *no* captures before the full syntactic forms and constructions are produced by children.

Denial usually involves a subject-predicate structure, with the predicate providing a nominal label or an attribute for an entity. We call such cases of “denial” as labeling.

Data and preprocessing

For child language data, we turned to the CHILDES database (MacWhinney, 2000)¹ and selected English speaking children with typical development within the age range of 12 - 72 months. Parents’ and children’s utterances were extracted via the childe-db (Sanchez et al., 2019) interface using the programming language R. In order to obtain (morpho)syntactic representations for parents’ and children’s utterances, we used the dependency grammar framework (Tesnière, 1959). Part-of-speech (POS) tags for each token within an utterance were automatically derived using Stanza (Qi, Zhang, Zhang, Bolton, & Manning, 2020), an open-source natural language processing library; dependency relations for all utterances were

¹ Code and data are in quarantine at https://github.com/zoeyliu18/Negative_Constructions.

acquired also in an automatic fashion using DiaParser (Attardi, Sartiano, & Yu, n.d.), a dependency parsing system that has been demonstrated to achieve excellent performance for at least written texts in English.

We focus on seven negative constructions shown in Table 1 that tend to convey the communicative functions of rejection, non-existence, prohibition, inability, labeling, epistemic state, and possession. We test children’s knowledge of these constructions at two levels: sentence level and discourse level. Negation is marked in two fundamentally different ways in English and many other languages. First, at sentence level, morphemes such as *no*, *not*, or the reduced form *n’t* combine with other lexical items to form a negative sentence. For example in sentence level rejection, *n’t* can combine with *want* to form “*I don’t want to go.*” Second, negative response particles such as *no* can be used anaphorically to negate a previous utterance in discourse. For example in discourse level rejection, when a parent asks “*Do you want to go?*” a child can respond with *No!*. Here, the negative discourse particle stands for the proposition “I don’t want to go.” Children’s earliest negative productions are dominated by discourse level negation, presumably because it is shorter and easier to produce when children are limited in their productive capacity. Nevertheless, successful communication with discourse level negation can indicate the children understand the propositions conveyed it.

At the sentence level, we characterized the syntactic features of the negative utterances associated with each communicative function, then classified utterances based on these features in a rule-based fashion with the help of POS information and syntactic dependencies. To decouple the development of the syntactic construction from the development of negation in that construction, we also examined the production of positive counterparts to each negative construction. The positive counterpart of our negative constructions share the same syntactic features (e.g. same head verb) but they have no negative morphemes. These positive constructions do not express the same communicative

function as their negative counterparts. Our main purpose for including the positive counterparts is to factor in the development of the syntactic construction without negation.

At the discourse level, we need to analyze the negative constructions that the discourse particle *No* stands for. To achieve this, we selected utterances that started with negative discourse particles like “no no I like it.” These instances were tagged with the dependency relation “discourse” by our dependency parser. For each negative utterance identified this way, we extracted the previous utterance (the antecedent) in the discourse context. For child speech, we included interactions (negative utterances + their antecedents) where antecedents were produced by either the parents or the children themselves. For parent speech, we only included interactions where the antecedent was produced by children. We then applied the same analyses we had performed to sentence level constructions to these antecedent utterances. The assumption here is that the negative discourse particles are implicitly negating the content of their discourse antecedents.

Measures

We took age as a proxy for children’s development and divided the 12-72 months range into monthly bins. We used the following two metrics for each age bin and communicative function. First, we defined the ratio $R_{c,i}$ for construction c and age bin i as the number of utterances in construction c and age bin i divided by the total number of utterances produced at age bin i . For example at age 30 months, children produced a total of 81,302 utterances, out of which 391 were classified as rejections. Therefore the ratio of rejection at 30 months is $391/81,302 = 0.005$.

$$R_{c,i} = \frac{\#U_{c,i}}{\#U_i}$$

Second, we borrowed the measure of “moving (cumulative) ratio” from the analysis of time series data (Wei, 2006). We defined the cumulative ratio $MR_{c,i}$ for a construction c at age bin i , as the sum of the number of utterances produced with construction c from the first

age bin to age bin i , divided by the sum of all utterances produced between the first age bin and age bin i . For example up to age 30 months, children in our corpus produced 721,748 total utterances, out of which 2,166 were instances of rejection. Therefore, the cumulative ratio of rejection at age 30 months is $2,166/721,748 = 0.003$. The cumulative ratio has the advantage that at each age bin, it takes into account the productions in previous age bins. Assuming that children accumulate linguistic knowledge throughout their development, this measure provides a more realistic and stable measure of children’s productive capacity at each age.

$$CR_{c,i} = \frac{\#U_{c,1-t}}{\#U_{1-t}}$$

The two ratios mentioned above were calculated for negative constructions and their positive counterparts at sentence and discourse levels for children as well as parents. In this study we use parents’ speech as a benchmark for children’s development. Therefore, our figures show children’s productions side by side the production of parents at the corresponding age of children. In what follows, we describe in detail the results for each communicative function and its associated negative construction.

Negative Constructions

Rejection. For instances of “rejection” and positive counterparts, we selected utterances in which the lemma of the head verb of the phrase is either *like* or *want*. For negative instances, the head verb is modified by one of the three negative morphemes *no*, *not* or *n’t*, whereas cases including the same head verb but without negation were classified as positive. Table 3 shows examples of negative utterances including those in which the speakers describe their own desires with or without an auxiliary verb (e.g. 1 and 2), as well as cases that express rhetorical inquiries of desires from one interlocutor to another (e.g. 3), and instances where the speaker is describing the desires of somebody else (e.g. 4). We classified a total of 20,641 negative utterances (child: 9,398; parent: 11,243), and a total of

275 180,881 negative utterances (child: 63,427; parent: 117,454).

Table 3

Examples of sentence level rejection (negative) and positive counterparts in children’s speech

Rejection (Negative)	Positive Counterpart
<i>I no like sea</i>	<i>she likes cheese</i>
<i>don’t wanna go</i>	<i>I want it</i>
<i>don’t you wanna try it</i>	<i>I wanna have that</i>
<i>Sarah doesn’t like that either</i>	<i>she likes this one</i>

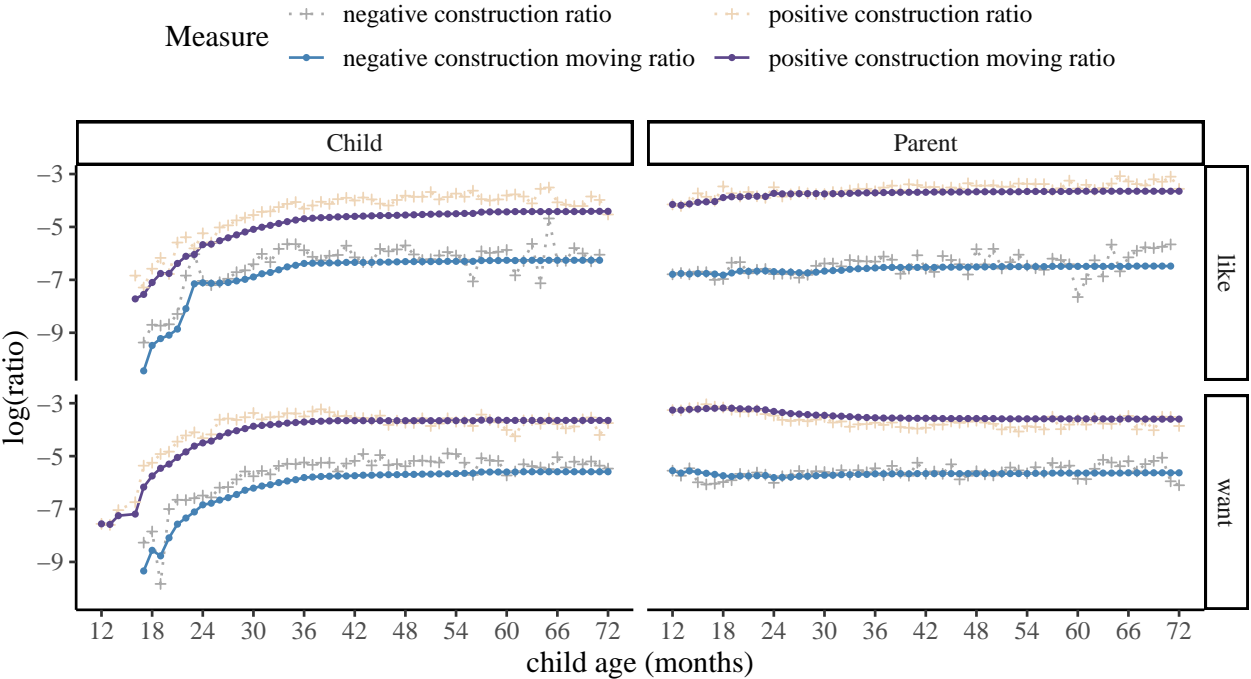


Figure 1. Rejection and its positive counterparts.

276 Starting with our analysis at the sentence level, Figure 1 shows the ratios and
277 cumulative ratios of parents’ and children’s instances of rejection and positive counterparts
278 on a logarithmic scale (y-axis) with age along the x-axis. Overall, we see a similar pattern of
279 production for rejection whether the head verb is *want* or *like*. Comparing the cumulative

ratios between parents and children, children's production of rejection gradually increases between the ages of 18 and 30 months. After about 30 months of age, children's production of these constructions stays at a relatively constant rate and close to parent levels. In all age bins, the production ratio for negative utterances is lower than that for their positive counterparts.

On the discourse level, we investigated discourse interactions (antecedent + negative utterance) in which the antecedent had one of the head verbs *like* or *want*, yet the head verb did not have to be modified by negative morphemes. Table 4 shows a few examples. We found a total of 1,957 such utterances (child: 994; parent: 963). As shown in Figure 2, children's production of negation as discourse response variables increases regularly from the age of 24 - 36 months². Overall negative morphemes are applied at the discourse level more frequently in child speech compared to parent speech.

Table 4

Example antecedents and discourse level rejections in parents' and children's productions

Antecedent	Utterance
Parent: <i>I want you to try it</i>	Child: <i>no no no</i>
Parent: <i>would you like to go</i>	Child: <i>no no</i>
Child: <i>I don't like that</i>	Parent: <i>no honey you have to try it</i>

² For each communicative function, at the discourse level we also examined cases of different subtypes (e.g. different head verbs) separately; though due to data sparsity issues, we collapsed these instances for our final analyses

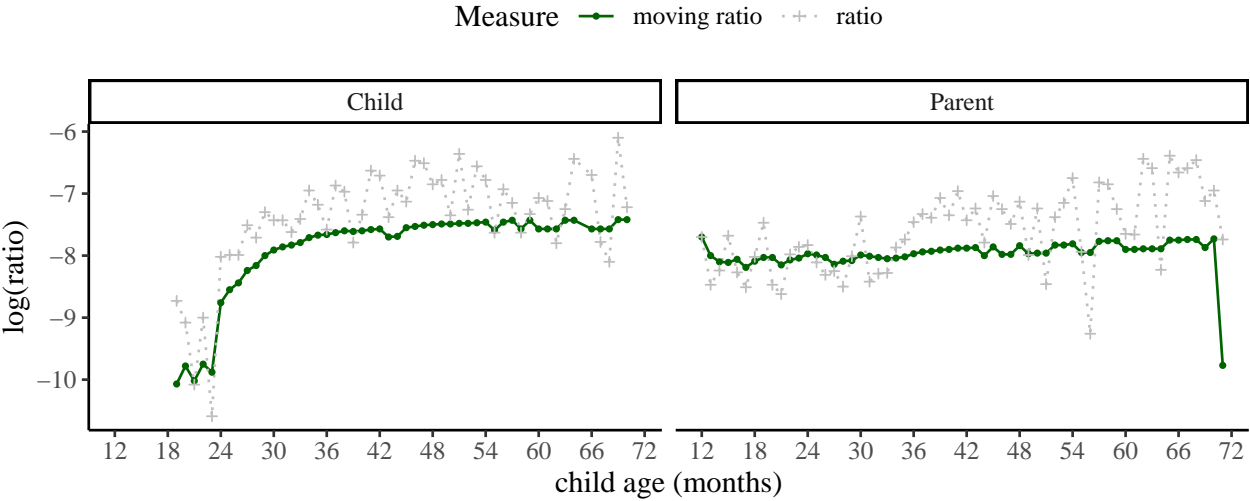


Figure 2. Ratios and cumulative ratios for the production of rejection at the discourse level for children between 1 to 6 years of age, and their parents.

Non-existence. For this function we searched for the English existential construction and extracted utterances that had *there*-expletives, followed by a copula, and a noun phrase (phrases headed by either nouns or pronouns). We classified utterances where the predicate was modified by negation as negative, and the rest as positive. This led to a total of 1,983 negative utterances (child: 498; parent: 1,485), and a total of 35,287 positive utterances (child: 8,385; parent: 26,902).

Table 5

Examples of positive and negative existential constructions in children’s speech at the sentence level

Non-existence (Negative)	Existentials (Positive)
<i>there’s no (more) water</i>	<i>there are books</i>
<i>there isn’t it</i>	<i>there is it</i>

At the sentence level, children produced negative constructions to express non-existence less frequently than the positive counterparts. As Figure 3 shows, the

cumulative ratio for the production of non-existence increases from 18 to 36 months. Around and after 36 months of age, children's productions reaches a stable cumulative ratio close to that of adults. Notice that there appears to be fluctuations of cumulative ratios between the age of 19 and 25 months in child production. A closer inspection of the data reveals that within that age range, the frequency of negative utterances at most ages is either one or zero. Therefore while the number of total utterances increases along the developmental trajectory, the cumulative ratio for negative utterances actually decreases.

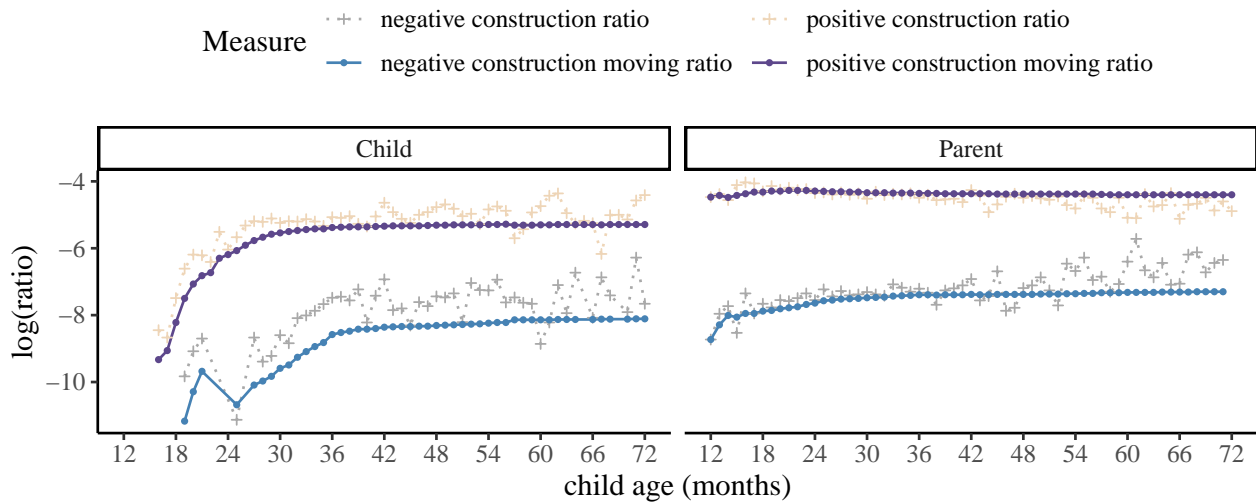


Figure 3. Non-existence and its positive counterparts.

For non-existence at the discourse level, we applied similar selection criteria and extracted negative utterances with existential constructions in their antecedents (Table 6). This led to a total of 220 utterances (child: 91; parent: 129). As Figure ?? shows, we could find an increase in children's responses with *no* to parents' existential utterances between the ages of 18 and 36 months. After 36 months, despite the fact that ratios show considerable fluctuations, the cumulative ratios of parents and children seem stable and similar. Therefore with non-existence, both sentence level and discourse level analyses point to substantial development in the age range of 18-36 months.

Table 6

Example antecedents existentials and discourse level negation in parents' and children's productions

Antecedent	Utterance
Parent: <i>Is there a bunny</i>	Child: <i>no no bunny</i>

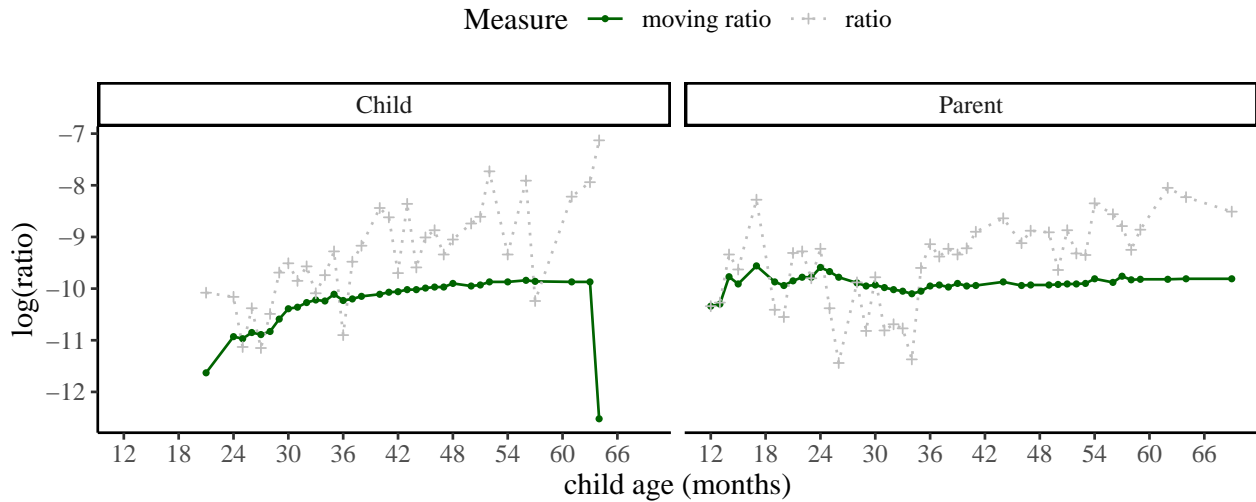


Figure 4. Discourse-level Non-existence.

Prohibition. For constructions that typically convey prohibition, we extracted utterances that were annotated as imperatives in CHILDES. In particular, we selected instances where the head verbs do not take any subjects. As before, cases without any negative morphemes are considered as positive. For negative constructions, we chose structures where the negative morphemes are combined with the auxiliary verb *do* (*do*, *does*, *did*) and they together modify the head verbs of the sentences. In order to not have overlap with rejection, non-existence, epistemic negation and possession (see below), our search excluded utterances where the head verb had any of the following lemma forms: *like*, *want*, *know*, *think*, *remember*, *have*. This resulted in a total of 1,069 negative utterances (child: 309; parent: 760), and a total of 25,542 negative utterances (child: 8,659; parent: 16,883).

Figure 5 shows the ratios and cumulative ratios of prohibitions and their positive counterparts in parents’ and children’s speech at the sentence level. In both child and parent speech, negative constructions for prohibition are consistently produced less frequently than their positive counterparts. Children produce prohibitions (negative imperatives) more and more often between 24 and 36 months. In comparison, the cumulative ratio in parent speech gradually decreases at the beginning when children between 12 - 36 months. Yet overall, child production is remains consistently lower than parent production of prohibition. This might be due to the social nature of parent-child interactions, in which it is more likely for parents to explicitly command and direct children’s actions than the other way round.

Table 7

Examples of positive and negative imperatives in children’s speech at the sentence level

Prohibition (Negative)	Imperatives (Positive)
<i>don't blame Charlotte</i>	<i>cook it</i>

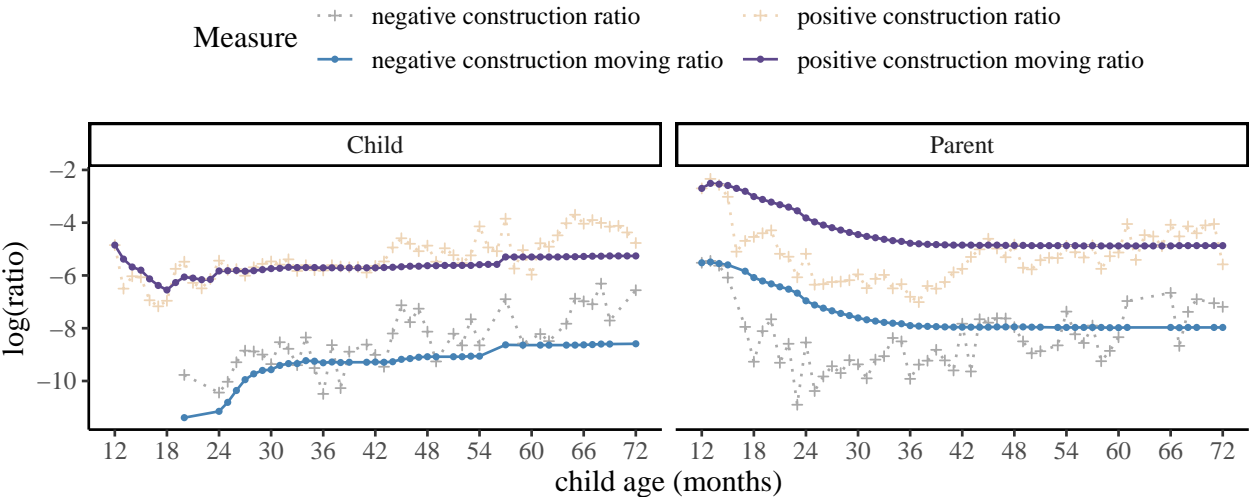


Figure 5. Prohibition and its positive counterparts.

At the discourse level, we selected *No*-utterances with antecedents that were subjectless imperatives headed by a verb, excluding the following lemma forms: *like*, *want*,

336 *know, think, remember, nor have*. This resulted in a total of 238 utterances (child: 8,968;
 337 parent: 17,643). As shown in Figure 6, children’s usage of negation as a response particle to
 338 express prohibition is comparable to their productions at the sentence level. Their negative
 339 productions increases within the age range of 24 to 36 months, and parent production
 340 decreases when the children are between 12 to 36 months.

Table 8

Example antecedents imperatives and discourse level negation in parents’ and children’s productions

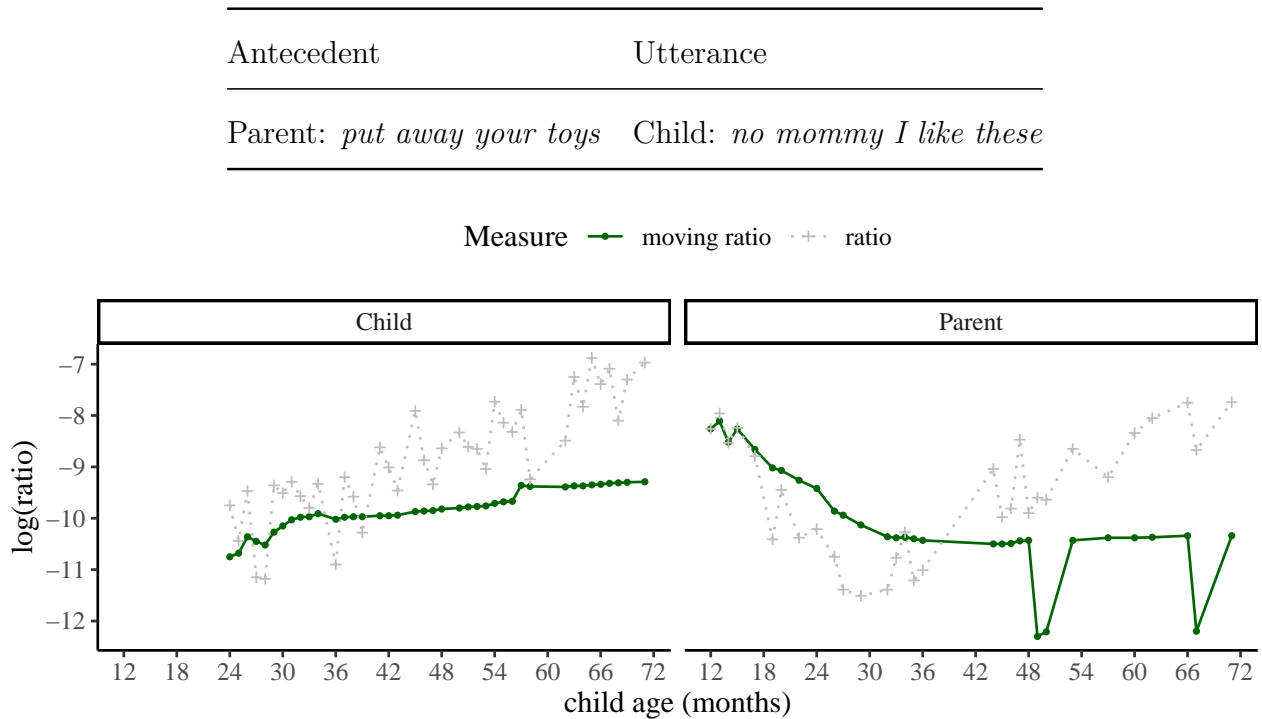


Figure 6. Discourse-level Prohibition.

341 **Inability.** For the function of inability, we analyzed instances with head verbs that
 342 are modified by the modal auxiliaries *can* and *could*. If the head verb was also modified by a
 343 negative morpheme, we classified it as negative. Otherwise, we considered it positive. Cases
 344 without a subject (e.g. “can’t play”) or with subjects that were not first person singular
 345 (e.g. “you can’t do that,” “this can’t go in the box”) were excluded. This is because such
 346 cases often yield readings other than “(in)ability.” Depending on the larger context, they

could be deontic (e.g. “you are not allowed to do that”) or epistemic (e.g. “it is not possible for it to go in the box”). To avoid this ambiguity and focus more on constructions that convey an individual’s ability, we restricted our analyses only to cases with the first person singular subject *I*. This led to 7,115 negative utterances (child: 3,917; parent: 3,198), and 14,433 positive utterances (child: 7,589; parent: 6,844). Table 9 shows a few example of the cases we considered.

Table 9

Examples of constructions that convey ability and inability in children’s speech at the sentence level

Inability (Negative)	Ability (Positive)
<i>I can’t see</i>	<i>You could do it</i>

Figure 7 shows ratios and cumulative ratios of parents and children’s productions of inability constructions as defined above. Similar to previous constructions, positive instances are generally more frequent than negative ones. Children produce inability negation more and more frequently between 18-36 months. After 36 months, their productions are stable and close to parent ratios.

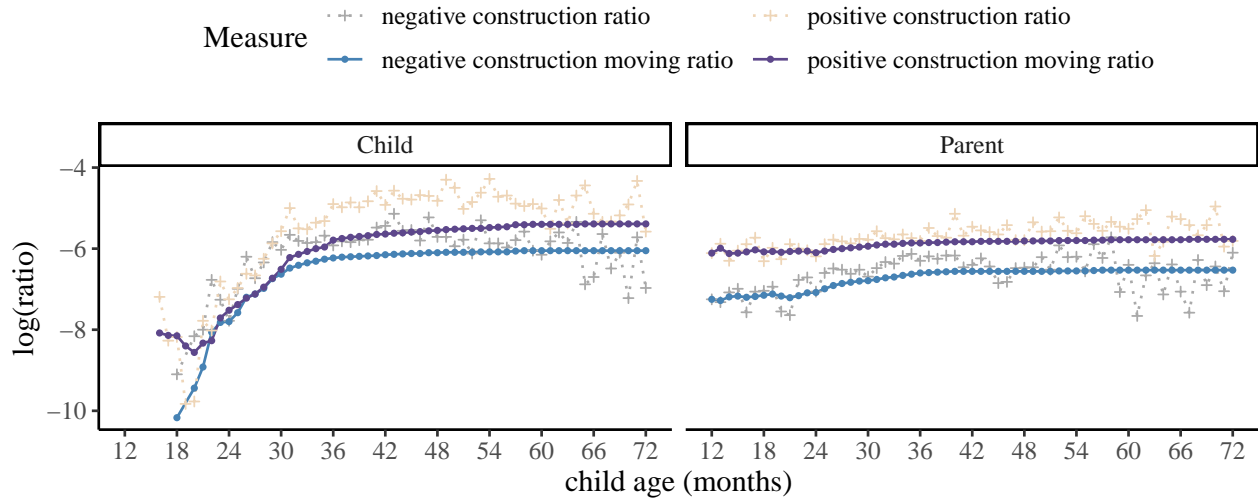


Figure 7. Ratios and Cumulative Ratios for parents and children's productions of the inability construction and its positive counterpart.

At the discourse level, we selected utterances with the negative particle *no* in response to antecedents that had a similar structure to the inability construction defined above. This yielded a total of 313 negative utterances (child: 11,506; parent: 10,042). Figure 8 shows the ratios and the moving ratios for parents' and children's production of discourse level inability construction. Considering cumulative ratios, children's productions gradually increase from 24 to 36 months and stabilize after 36 months at a similar rate to that of parent's.

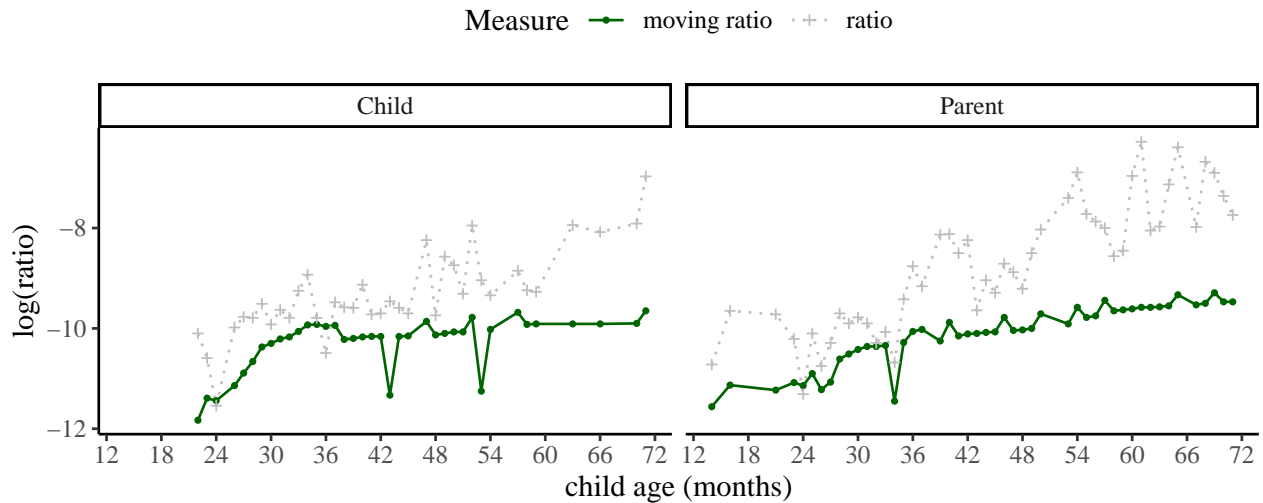


Figure 8. Discourse-level Inability.

Labeling. To capture the function of labeling at the sentence level, we concentrated on copula structures in which the predicate is a nominal or an adjectival phrase. Specifically, the nominal predicates exclude possessive pronouns in order to not overlap with the communicative function of possession (see below). We considered instances where the predicate is modified by negative morphemes as negative, and others as positive. To also avoid overlap with cases of non-existence, none of the utterances contained expletives (e.g. “there is no book”). This resulted in a total of 36,410 negative utterances (Child: 6,193; Parent: 30,217), and 484,679 positive utterances (Child: 121,107; Parent: 363,572).

Table 10

Examples of the labeling construction in children’s speech at the sentence level

Labeling (Negative)	Labeling (Positive)
<i>that’s not a farmer</i>	<i>this is a book</i>
<i>I’m not a heavy baby Mum</i>	<i>it’s a nice bowl</i>
<i>It’s no good</i>	<i>she’s pretty</i>

Figure 9 shows ratios and cumulative ratios for parent’s and children’s production of the labeling construction at the sentence level. In both parents and children, the frequency of positive counterparts is consistently higher than that of negative labeling instances. Children’s productions of negative labeling increased between 18-36 months, and remained stable and close to the parent ratios after 36 months.

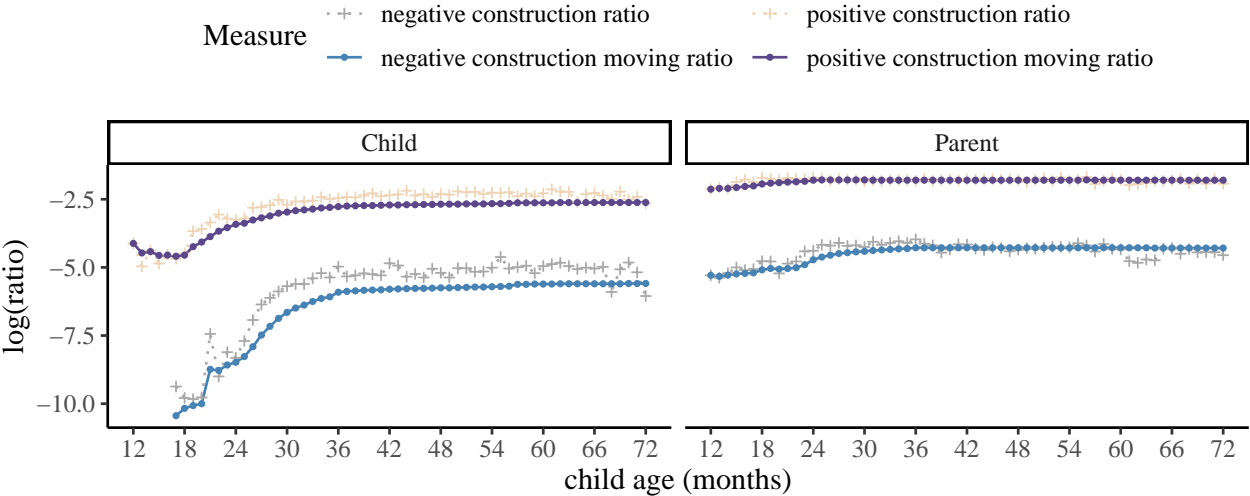


Figure 9. Ratios and cumulative ratios for instances of (negative) labeling and its positive counterparts in parents' and children's speech.

At the discourse level, we selected antecedent utterances with copula structures that combined with a nominal or an adjectival predicate. Table 11 shows a few examples. We found 4,079 utterances (Child: 2,234; Parent: 1,845). Figure 10 shows the log ratios and cumulative ratios for labeling instances at the discourse level. Children used negation to respond to labeling utterances more frequently between 18 to 30 months. After 30 months, children's productions of negative labeling continues to increase but remains close to parents' level more generally.

Table 11

Example antecedent labeling and discourse level negation in parents' and children's productions

Antecedent	Utterance
Child: <i>that's the one</i>	Parent: <i>no it's the green one</i>

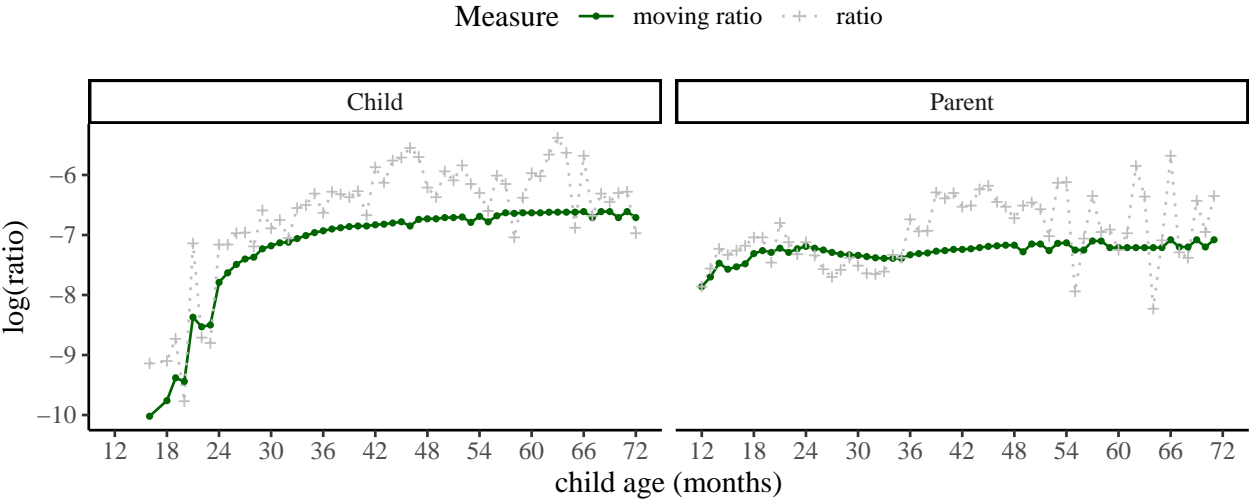


Figure 10. Log ratios and cumulative ratios of discourse level labeling instances in parents’ and children’s productions.

Epistemic Negation. Previous studies have reported instances in which children combined negative morphemes with mental state verbs such as *know*, *think*, and *remember* to express “epistemic negation” (Choi, 1988). For defining epistemic constructions we also focused on these three verbs. For sentence level epistemic negation, we analyzed negative utterances where these verbs were modified by negative morphemes, possibly after combining with an auxiliary verb like *do*. Table 12 shows a few examples. Instances where the speaker asked about or describes the negative epistemic state of another speaker were also included, leading to 31,696 negative utterances in total (child: 9,852; parent: 21,844). For the positive counterparts, we selected instances with the same head verbs except that these verbs were not modified by negation. This resulted in a total of 95,679 negative utterances (child: 16,322; parent: 79,357).

Table 12

Examples of the epistemic construction in children’s speech at the sentence level

Epistemic (Negative)	Epistemic (Positive)
<i>I not know</i>	<i>I knows</i>

Epistemic (Negative)	Epistemic (Positive)
<hr/>	
<i>I didn't remember</i>	
<i>I don't think so</i>	<i>I think this one is good</i>
<i>don't you remember</i>	
<i>She doesn't know this</i>	<i>She knows about this</i>

Figure 11 shows log ratios and cumulative ratios of the epistemic construction as defined above in parents' and children's speech at the sentence level. Overall, positive epistemic utterances were more frequent than negative epistemic utterances, with the possible exception of *know* for children. The production of negative utterances headed by *know* was comparatively the highest among children, and became more frequent at an earlier age (17-18 months) compared to that of *remember* (~19 months) or *think* (~20 months). Across the three head verbs, children's productions with *know* and *remember* gradually approaches that of parents' around 30 - 36 months, whereas cases with the head verb *think* tend to be produced less frequently by children.

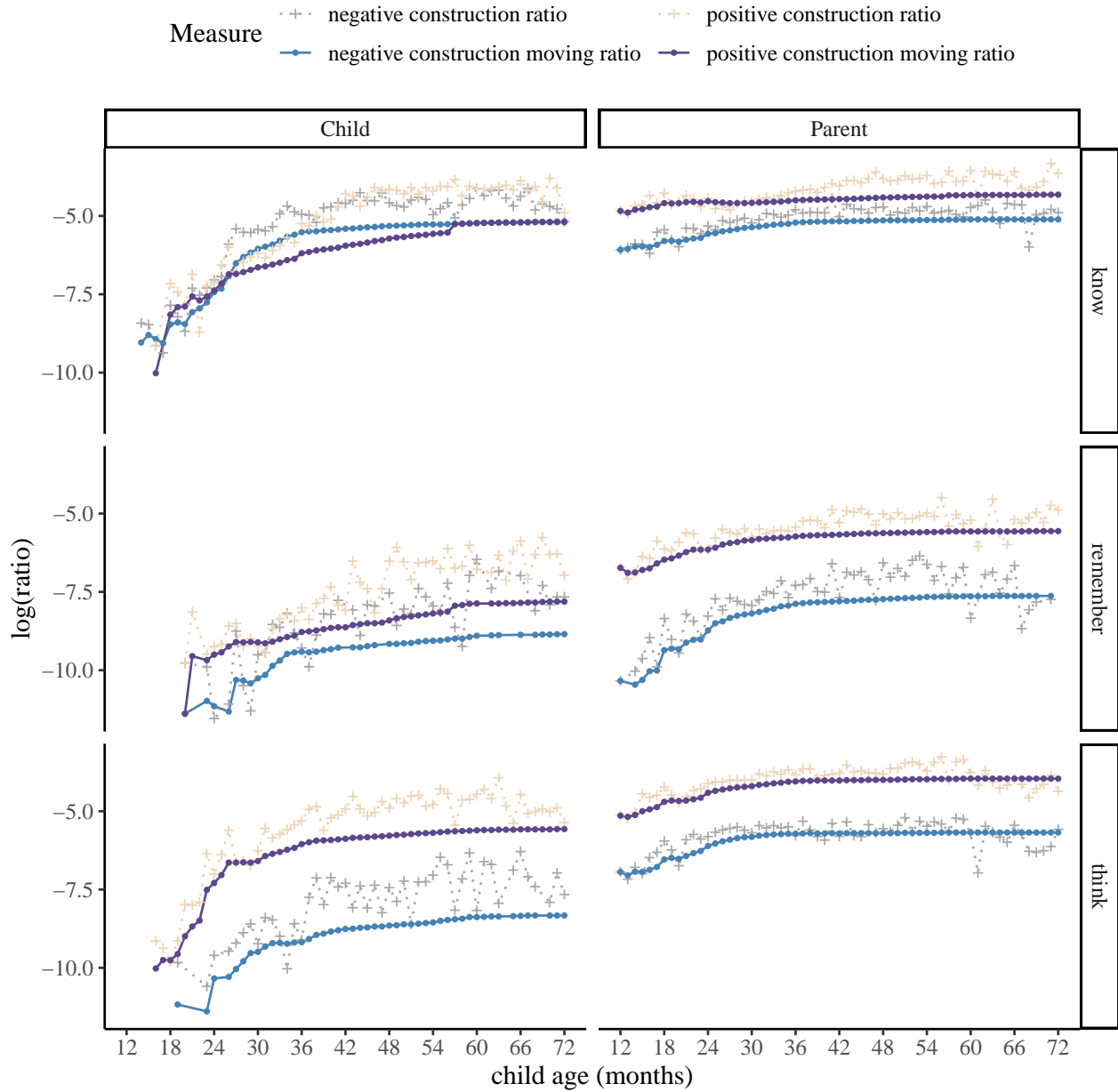


Figure 11. Log ratios and cumulative ratios of negative and positive epistemic utterances in parents' and children's speech.

For epistemic negation at the discourse level, we examined interactions in which the antecedent utterances took any of the three head verbs *know*, *remember* and *think*, leading to a total of 985 utterances (child: 26,174; parent: 101,201). Figure 12 shows log ratios and cumulative ratios for epistemic negation at the discourse level. Children's productions

increase rapidly between 24-36 months and after 36 months, they produce this construction close to parent levels.

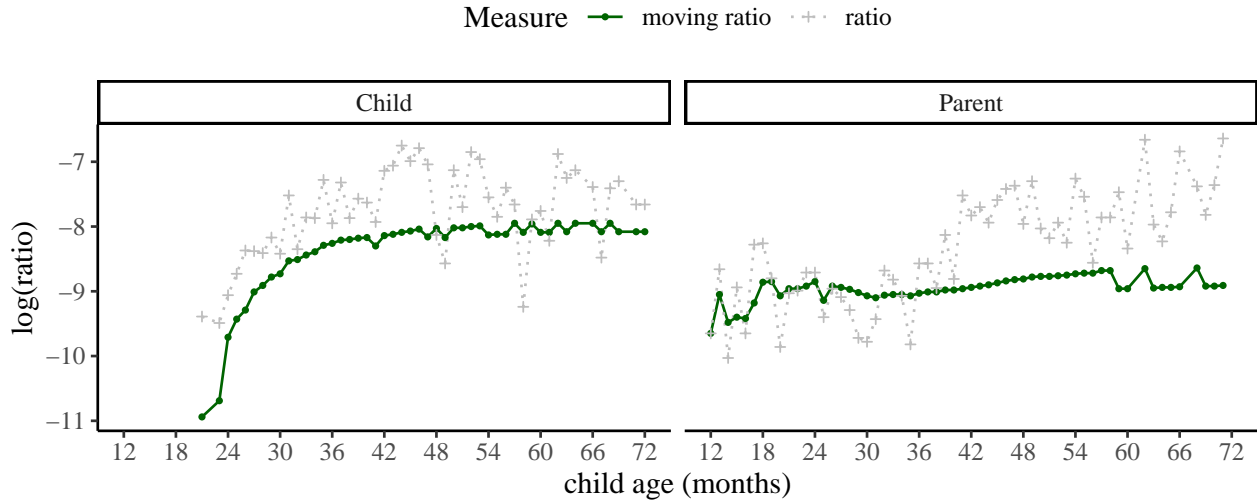


Figure 12. Log ratios and cumulative ratios for discourse level Epistemic negation in parents' and children's speech.

Possession. The last function we explored was “possession.” At the syntactic level, for negative structures we selected cases where negative morphemes were combined with auxiliary verbs to modify a head verb with the lemma form *have* and a POS tag of VERB. We also included individual noun phrases with possessive pronouns as heads and modified by negative morphemes. Table 13 shows a few examples. Cases in which the syntactic head of the negative morphemes is a predicate of a copula verb (e.g. “this is not mine”) were excluded to separate them from the function “labeling.” The number of negative utterances that were subjected to analysis for this function is 8,892 (child: 2,830; parent: 6,062). Again the positive counterparts share similar structures except with no negation, leading to a total of 86,665 (child: 27,730; parent: 58,935). One thing to note here is that for the positive structures with the head verb *have*, we restricted to cases where the verb takes a direct object (with the dependency relation *obj*). This is to avoid potential parsing errors of instances such as *I have*, where the verb could ambiguously be an auxiliary.

Table 13

Examples of negative and positive possession in children and parents' speech at the sentence level

Possession (Negative)	Possession (Positive)
<i>I don't have it</i>	<i>you have that</i>
<i>not mine</i>	<i>hers</i>

Figure 13 shows log ratios and cumulative ratios of the negative and positive possession construction at the sentence level. The production trajectory for possession in child speech appears to have notable differences depending on what the negative morpheme modifies. With *have* as the syntactic head, children increase their productions between 18-36 months, and stay close to parent levels of production after 36 months. However, for utterances headed by possessive pronouns, productions increase rapidly between 18-24 months and stays close to parent levels as early as 24 months of age.

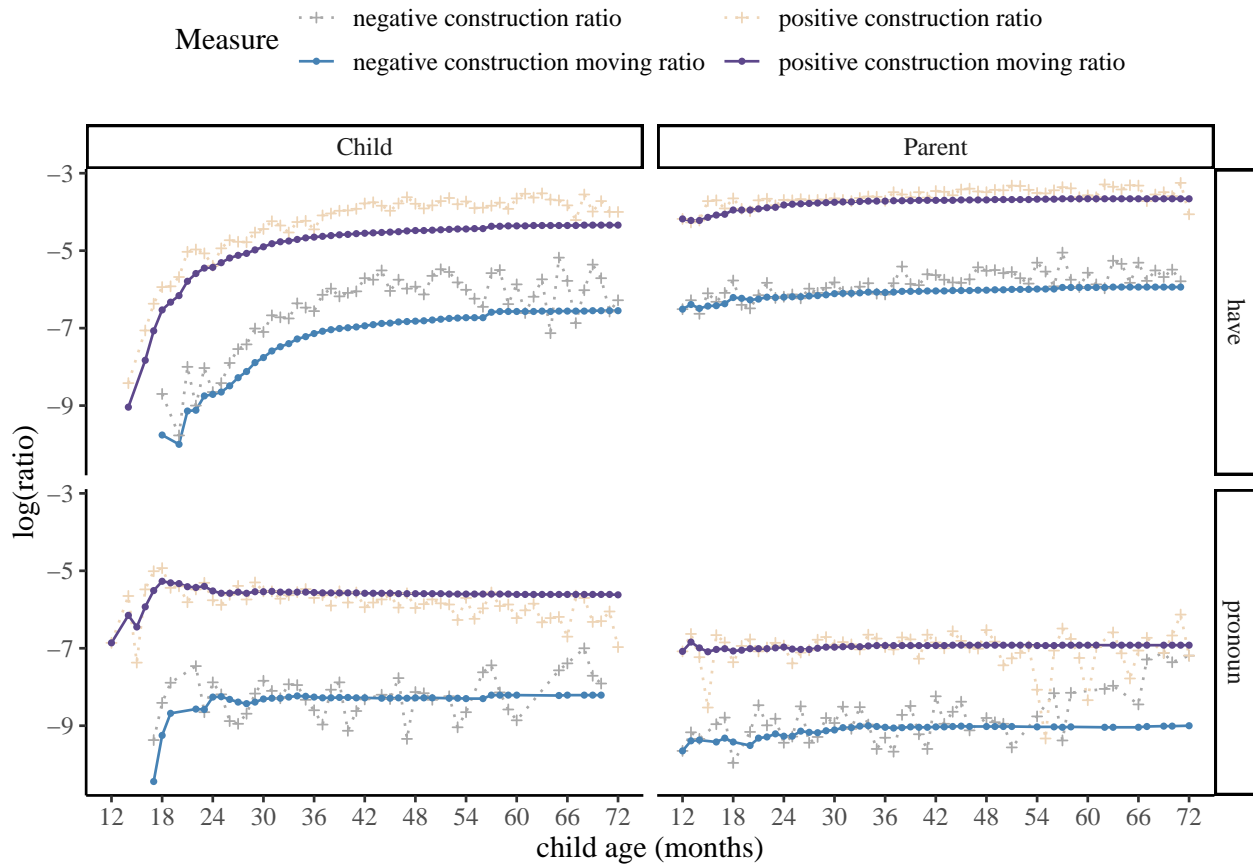


Figure 13. Log ratios and cumulative ratios of the construction ‘possession’ in parents’ and children’s speech.

At the discourse level, we selected antecedents to discourse level negative utterances (e.g. *no!*) which themselves had structures similar to both the negative and positive constructions at the syntactic level. Table 14 provides a few examples and Figure 14 shows log ratios and cumulative ratios of such utterances in parents’ and children’s speech. Overall, the production pattern for discourse level possession suggests that children produce such utterances frequently and at parents’ level after 30 or 36 months of age.

Table 14

Example antecedents with the possession construction and discourse level negation in parents’ and children’s productions

Antecedent	Utterance
Child: <i>I don’t have the book</i>	Parent: <i>no no mommy please read it to me</i>
Parent: <i>not yours</i>	Child: <i>no it’s mine mine</i>

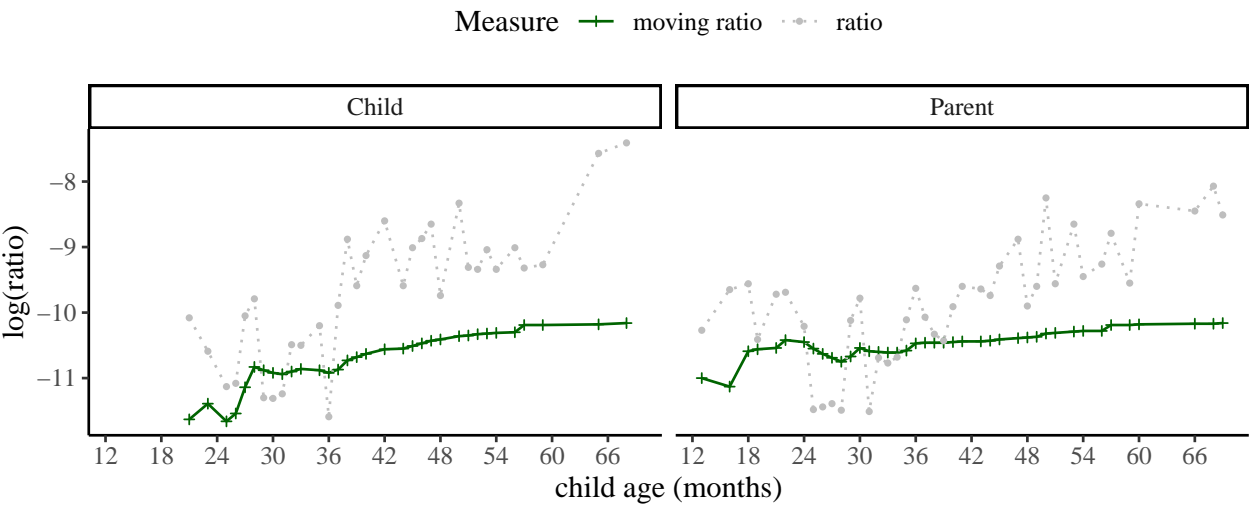


Figure 14. Log ratios and cumulative ratios of the possession construction at the discourse level in parents’ and children’s speech.

Discussion. Figure 15 shows the log cumulative ratios of all our negative constructions at the syntactic level.

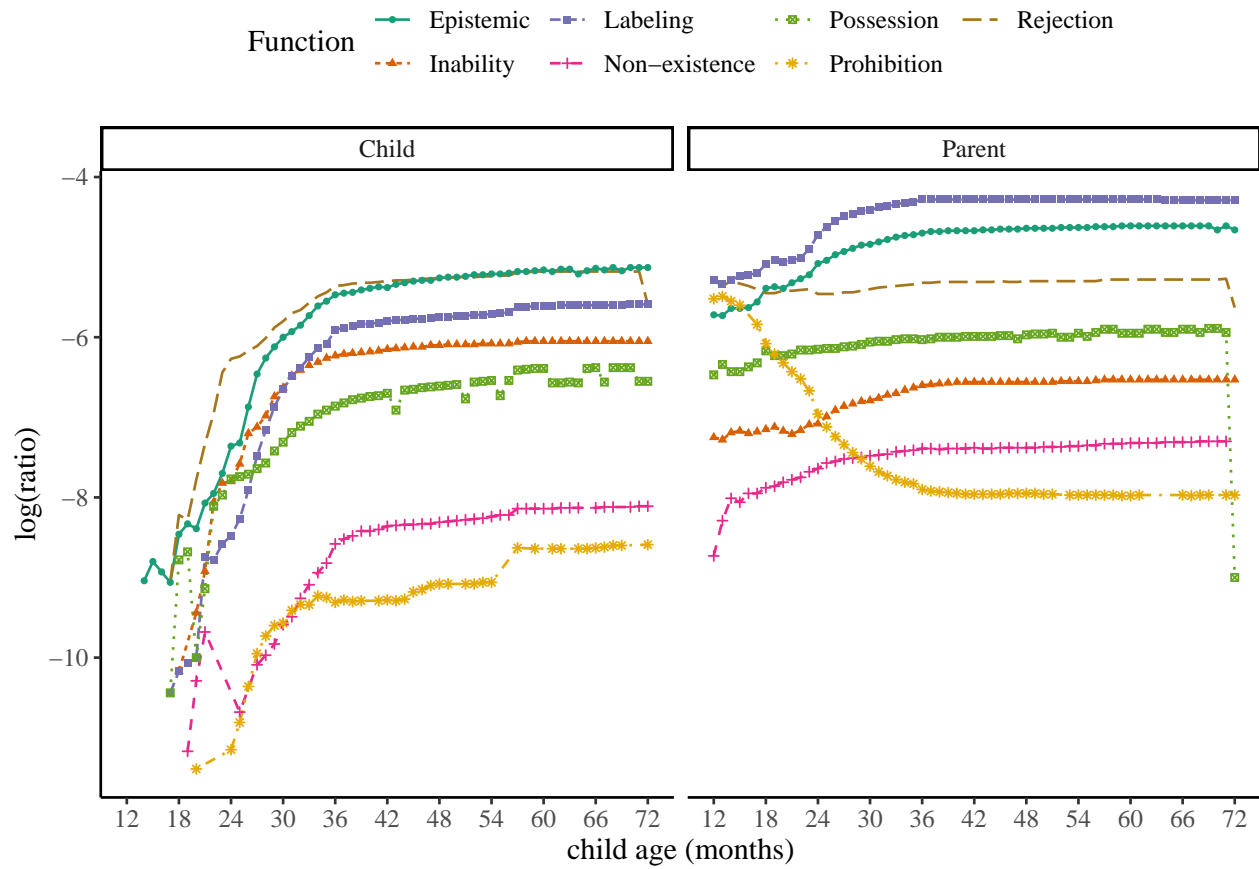


Figure 15. Log cumulative ratios for all negative constructions at the syntactic level.

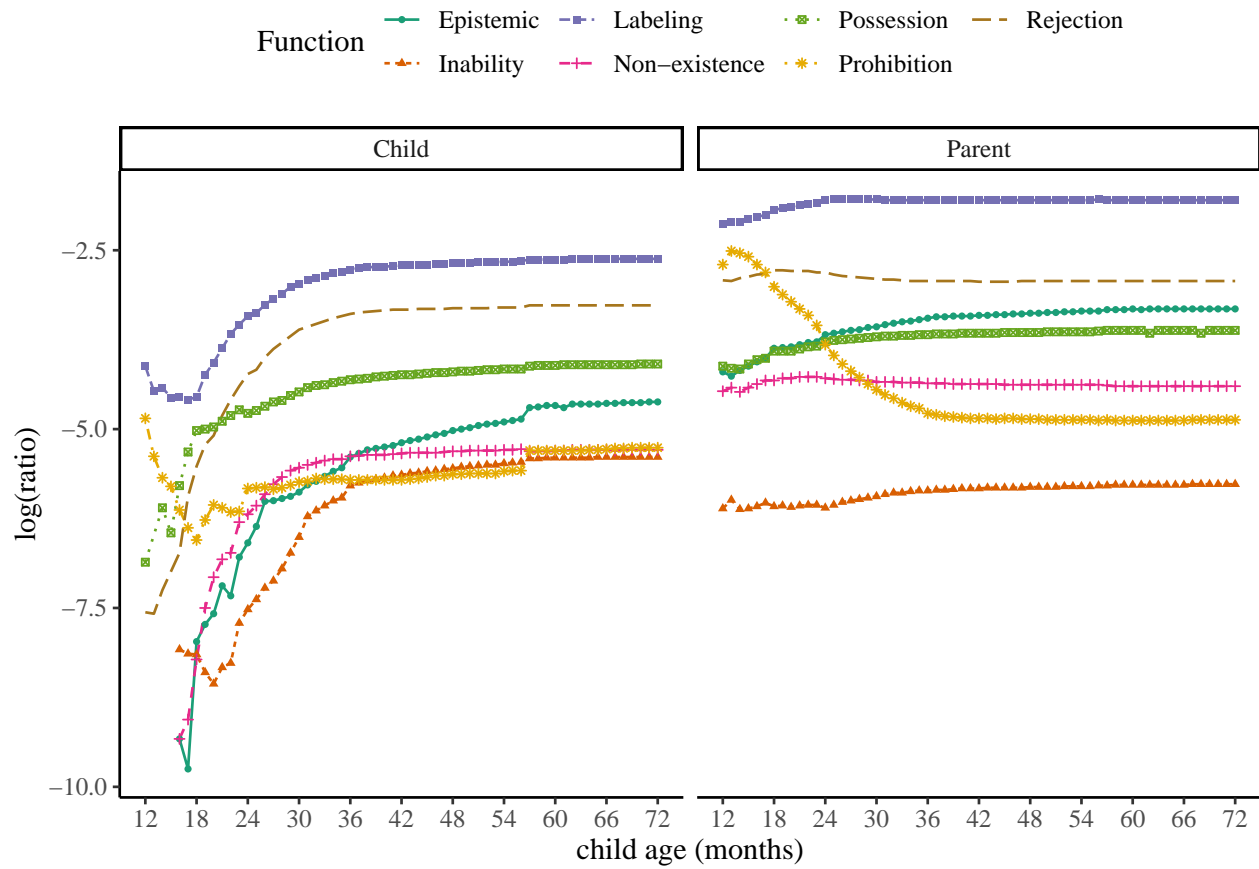


Figure 16. Log cumulative ratios for the positive counterparts to all negative constructions at the syntactic level.

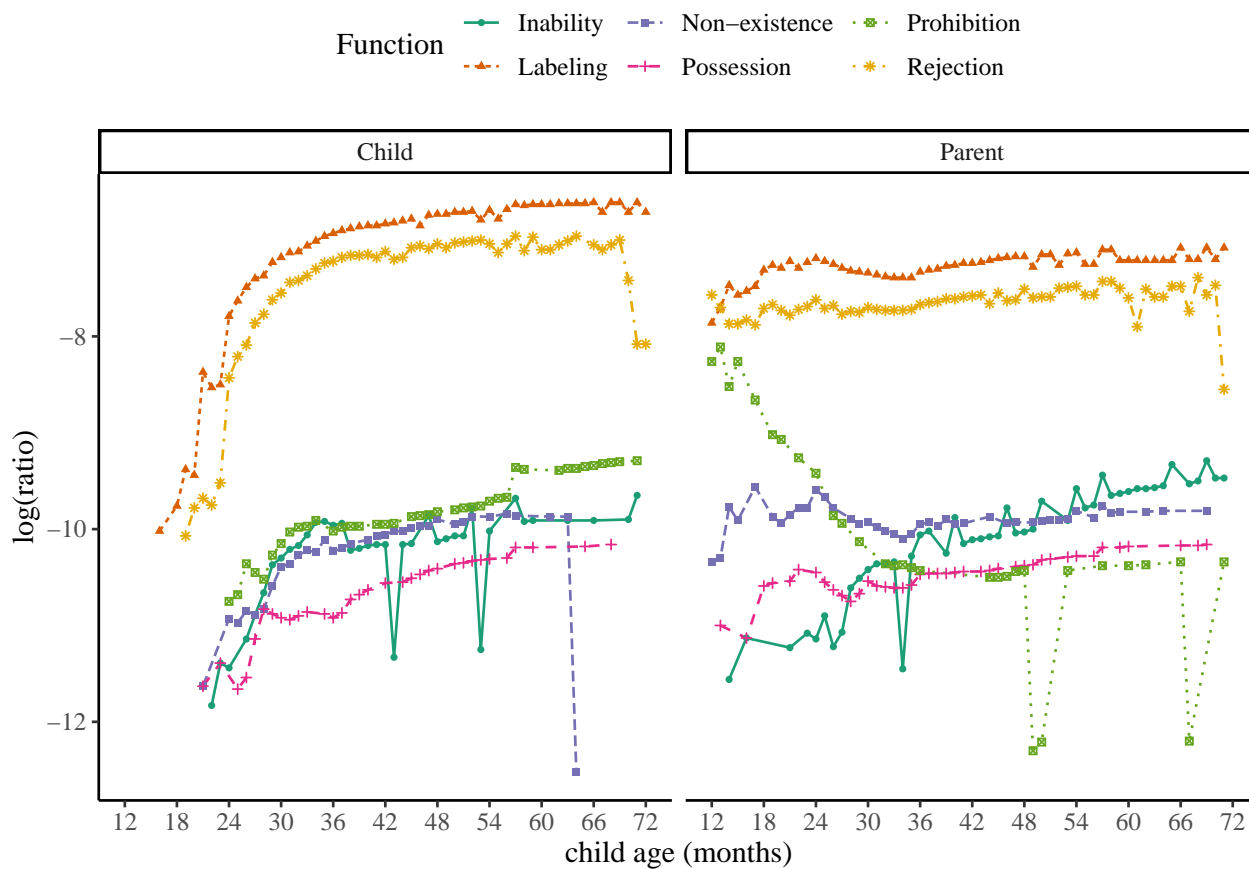


Figure 17. Cumulative ratios for all negative constructions at the discourse level.

Conclusion

Using automatic annotations of large-scale corpora of child-parent interactions, we presented production trajectories for seven negative constructions that tend to express rejection, non-existence, prohibition, inability, labeling, epistemic states, and possession (Table 1). The results suggest that the production of almost all these negative constructions (except for prohibition) emerges and gradually increases within the 18-36 months age range (Figure 8). Their production frequencies remain stable and regular after 36 months and relatively close to parents' levels of production. It is important to note that similar to prior studies, our conclusions are limited to negation in children's production. Systematic experiments testing children's comprehension of negative utterances with different

communicative functions are necessary to better understand the origins and developmental trajectory of negation.

For future work, we would like to explore several directions. First, to more thoroughly examine and potentially model the developmental trajectories of negation in child production, certain production-specific factors (e.g. length of utterance, ease of pronunciation) should be taken into account as well. In addition, we aim to investigate the production trajectory of positive counterparts to our negative structures (e.g. “I know” for “I don’t know”). Comparisons of negative utterances in relation to their positive counterparts would allow us to further analyze the developmental paths of negation within specific constructions.

Lastly, our experiments have concentrated on larger syntactic structures at the utterance level, hence cases where negation is used as discourse markers to respond to previous utterance(s) were excluded. However, these instances also have important semantic and conceptual roles in the communication between children and parents (e.g. parent: *do you want some bread?*; child: *no no no*). Thus inclusions of negative structures at a more comprehensive level would be able to paint a more clear picture about the development of negation.

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Function	Linguistic Composition	Examples
Rejection	with <i>like</i> or <i>want</i>	<i>I not like it; not want it</i>
Non-existence	expletives	<i>there is no soup</i>
Prohibition	with imperative subjectless <i>do</i>	<i>do not spill milk</i>
Inability	with modal <i>can</i>	<i>I cannot zip it</i>
Labeling	modifying nominal or adjectival predicatives	<i>that's not a crocodile; it's no interesting</i>
Epistemic negation	with <i>know</i> , <i>think</i> , <i>remember</i>	<i>I not know/think/remember</i>
Possession	with <i>have</i> ; or possessive pronouns	<i>not have the toy; not mine</i>

Table 15

Communicative functions of negation in early child language of English.