The Development of English Negative Constructions and Communicative Functions in Early Child Language

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Abstract

How does the abstract concept of linguistic negation develop in early child language? Prior 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 since 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 trajectores 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 comparable to parents' levels after this age range. These findings are consistent with two hypotheses: first, that negation starts as an abstract concept that can convey multiple functions from the beginning; and second, that negation develops in distinct stages for separate communicative functions but the developmental patterns at different stages are early and quick, leaving our methods incapable of detecting them from the available corpus data.

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

Word count: X

The Development of English Negative Constructions and Communicative Functions in Early Child Language

Introduction

Negation is a basic human concept and foundational to many areas of human thought including logic and mathematics. All previously studied languages have a way of expressing negation using words or morphemes like *not* (English), *bu* (Mandarin Chinese), and *lā* (Arabic) (!citation: Jespersen, Haspelmath). An important feature of linguistic negation is that it has an abstract meaning and serves different communicative functions in different contexts. For example, a coffee shop can use it to divide the menu into "coffee" and "not coffee" sections, with "not coffee" bringing together diverse items such as tea and hot chocolate. The coffee shop can use it in a sign like "no mask, no entry" to regulate customer behavior, and an employee could say "I don't like Mondays" to express their dislike for coming back to work on Mondays. Despite its abstract meaning, a word like *no* is among the early words produced by children. Therefore, a fundamental question in cognitive development and language acquisition is how negation emerges and develops in the human mind. Are early stages of negation in child language specific to a few communicative functions? Or does negation emerge as an abstract and multi-functional concept from the beginning?

Previous literature has proposed that abstract negation develops from less abstract communicative functions in fixed and ordered stages (Bloom, 1970; Choi, 1988; McNeill & McNeill, 1968; Pea, 1978). For instance, Darwin (1872) hypothesized that headshake as a sign for negation develops from infants' habit to refuse or reject food from parents by withdrawing their heads. Similarly, Pea (1978) proposed that at first, children use *no* to convey "rejection." In a second stage, they conceptualize and express non-existence of objects (e.g. "no water [in the cup]"), and finally in the third stage, negation reaches an abstract status that can deny truth of statements (e.g. "that is not a cow"). For Pea (1978),

this order reflected a natural progression in the conceptual space: from the more primitive domain of internal desires to the more complex domain of external existence, and finally abstract truth. As we will discuss in the next section, the theoretical and empirical landscape is not so clean and clear. Over the past fifty years, many studies have proposed different communicative functions and stages of acquisition, without reaching a consensus. We will discuss some possible causes for this lack of consensus but here we only emphasize the main hypotheses in previous literature: that the abstract concept of negation develops in fixed ordered stages from concrete communicative functions, and that children's early linguistic productions reflect these stages.

In this study, we argue that evidence from children's linguistic productions does not unequivocally support the functional development of negation in fixed ordered stages. We provide evidence from child-speech corpora in English that suggests the functional development of negation in fixed ordered stages cannot be taken for granted. Given previous studies and our own, we conclude that it is possible that negation starts as an abstract concept that can be used to perform different communicative functions depending on the demands of early linguistic interactions. Alterantively, it is possible that negation develops in quick functional stages, becoming abstract between 18-36 months of age. Future research using denser corpora in this age range or testing children's comprehension rather than production can judge between these two possibilities. In the next section we review previous studies on children's productions of negative utterances before moving to our own study.

Previous Studies

Darwin (1872, Chapter 11) explained the emergence of linguistic negation using the function it plays in early communication. He hypothesized that nodding and shaking are the earliest expressions of affirmation and negation respectively and argued: "With infants, the first act of denial consists in refusing food; and I repeatedly noticed with my own infants, that they did so by withdrawing their heads laterally from the breast, or from anything

offered them in a spoon ... [moreover] ... when the voice is exerted with closed teeth or lips, it produces the sound of the letter *n* or *m*. Hence we may account for the use of the particle *ne* to signify negation, ..." In later research, this communicative function of negation was referred to as "rejection" or "refusal" (Bloom, 1970; Choi, 1988; Pea, 1978).

Unlike Darwin, McNeill and McNeill (1968)'s developmental account did not start with rejections. They studied the development of three Japanese negative morphemes (*nai*, *iya*, *iiya*) in the speech of a 27-month-old Japanese speaking girl called Izanami. According to McNeill and McNeill (1968), in Japanese, *nai* expresses falsity of statements (e.g. "*no* [that's not an apple]), *iya* expresses desires (e.g. "*no* [I don't want an apple]"), and *iiya* expresses contrast (e.g. *no* [I didn't have an apple. I had a pear]). Therefore their appearance in the speech of a child reflects the developmental stages for the respective communicative functions. They reported that in the first stage, Izanami used a simple negation like *nai* to express non-existence of events and objects. They also mentioned the early use of *shira-nai* ("I don't know") but did not incorporate it into their developmental account. In the second stage, Izanami used negation to mark incorrectness of statements - like saying"false". Such uses of negation were labeled as"denials" in later research. In stage three, negation was also used to express disapproval or rejection - like saying "I don't want that." In the fourth stage, Izanami used negation to express contrasts - as if to say "not this but something else." Finally in the last stage, Izanami had an abstract and multi-functional concept of negation. According to McNeill and McNeill (1968), these stages took about five months and started with expressing external states (non-existence of objects) before internal desires (rejection).

Bloom (1970) considered three communicative functions for early negation: non-existence, rejection, and denial. She studied three children, two from 19 months and another from 21 months of age. She argued that in all three children, negation was produced in the following order: non-existence, rejection, and denial. Table 1 provides a few examples for each category. Many of these examples do not immediately stand out as instances of

their category. This is partly because many early examples are minimal and underspecified constructions that rely heavily on context for their interpretation. 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 recorded in their homes for about 90 minutes every month. All negative utterances (e.g. containing *no*, *not*, *all gone*, *gone*, *away*, *stop*) and gestures (e..g headshakes and headnods) were annotated and analyzed. Pea (1978) reported that children first started by using negation to express internal states (i.e. rejection), then external states (i.e. disappearance), and finally they used negation to connect language and the external world, i.e. truth-functional negation or denials). This was in direct contradiction to McNeill and McNeill (1968) who proposed that children start with expressing external states (non-existence) before internal states (rejection).

de Villiers and de Villiers (1979) studied the communicative functions of negation in the speech of Adam (27-31 months), Eve (18-22 months), and their own child Nicholas (23-29 months). The first two children were recorded for an hour every two or three weeks (Brown, 1973). 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. Both functions were present from the earliest samples of children's speech and the authors concluded that there are individual differences that mirror child-directed speech.

Choi (1988) looked at the speech of 11 children (2 English, 4 Korean and 5 French speaking) between 19 to 40 months of age. She reported 9 communicative functions for children's negation shown in Table 2. She matched communicative functions with linguistic constructions that commonly convey them and proposed that these forms and functions developed 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 constructions 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 constructions emerged to distinguish the functions in the previous phase such as rejection as well (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	*no*+V	"*no more*" (after emptying a bag)
Failure	expressing absence of an event	*it won't*	"*not work*" (puzzle piece not fitting)

Function	Definition	Forms	Example
Prohibition	negating actions of others	*don't* + V	
Rejection	negating the child's own actions	*I don't want (to)*	
Denial	negating others' propositions	AUX + *not*	"*no that's a pony*" (in response to "Is this a car?")
Inability	expressing physical inability		"*can't!*" (taking two lego pieces apart)
Epistemic	lack of knowledge	*I don't know*	"*I don't know*" (in response to "what color is this?")
Normative	expressing expected norms	(you) *can't*	"*Him can't go on a boat*"
Inferential	child's inference about the listener	AUX + *not*	"*I not broken this*" (seeing a broken crayon)

Cameron-Faulkner, Lieven, and Theakston (2007) recorded an English speaking child for an hour five times a week between the ages of 27 to 39 months. They classified his negative utterances into seven communicative functions by using categories from Choi (1988) and leaving out normative and inferential negation. They found examples of all seven functions in Brian's early speech. Starting at 27 months, 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 27 months but switched to *can't* to express inability, and *don't* to express

prohibition at 39 months. Cameron-Faulkner, Lieven, and Theakston (2007) argued that at 27 months, Brian had a broad conceptualization of negation and likely represented it as a "unitary category in conceptual space."

In a recent study, Nordmeyer and Frank (2018) looked at twice-a-month recordings of five children between the 12-36 months of age (1-3 years) in the Providence corpus (Demuth, Culbertson, & Alter, 2006) and classified children's negative utterances into seven functional categories: disappearance, prohibition, self-prohibition, rejection (refusal), 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 found that refusals (rejections) and denials were the most common functions in children's productions and that children varied with respect to which function was produced first. In line with de Villiers and de Villiers (1979), 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.

Table 3

Summary of previous studies on the development of negation's communicative functions.

Study	Number of Children	Age Range (Months)	Proposed Functional Stages
McNeill and McNeill (1968)	1	27-32 Months	non-existence > denial (non-contrastive) > rejection > denial (contrastive)
Bloom (1970)	3	19-28 Months	non-existence > rejection > denial
Pea (1978)	6	8-24	rejection > non-existence > denial

Study	Number of Children	Age Range (Months)	Proposed Functional Stages
de Villiers and de Villiers (1979)	3	18-31	rejection, denial (variable)
Choi (1988)	11	19-40	nonexistence, prohibition, rejection, failure > denial, inability, epistemic > normative, inferential
Cameron-Faulkner, Lieven, and Theakston (2007)	1	27-39	non-existence, failure, prohibition, rejection, denial, inability, epistemic
Nordmeyer and Frank (2018)	5	12-36	denial, rejection, prohibition, failure, disappearance (variable)

Table 3 provides a summary of previous research on the communicative functions of negation in children's speech. As the summary shows, there is currently no consensus on which functional categories should be included or in which order they are produced. Here we are going to discuss three possible reasons for this lack of consensus. First, de Villiers and de Villiers (1979) and Nordmeyer and Frank (2018) have emphasized that there is considerable variability among children and their parents in their use of negation. Given that previous studies have typically considered only a few children (3-4 on average), they could have reached conclusions that are true of their sample but not of the population of English-speaking children. Second, previous studies have used monthly or fortnightly recordings of children's speech for about 60-90 minutes per recording session. Given that children produce many hours of speech daily, such sparse sampling may have created

accidental gaps for certain communicative functions and consequently made it as if functions appear in ordered stages. The only study with relatively dense recording is Cameron-Faulkner, Lieven, and Theakston (2007) which reports the presence of all communicative functions in the child's speech from early on. However, the recordings for this study start at a later age than many other studies.

Third, previous research shows that defining and detecting the communicative functions of negation is not a trivial task. Different studies have sometimes used different basic categories and different definitions or criteria for classifying negative utterances. Therefore, what counts as an instance of rejection or non-existence may vary among studies and contribute to the reported variability. Most importantly, annotations focus on many underspecified utterances such as "*no car*" or "*no more*" which are highly ambiguous and can count as an instance of different communicative functions. Does *no car* mean "there is no car here" or "I don't want a toy car?" Researchers often have to rely on the context but the context is not fully represented in many child language corpora used for annotations. More importantly, this approach is not scalable to larger numbers of children and bigger corpora since manual annotations take considerable amount of time, energy, and training. In the next section, we discuss how the current study addresses these three issues.

Current Study

We build on previous research and address the methodological issues discussed in the previous section in two ways. First, in this study we use large corpora of parent-child interactions, aggregating speech samples from X children between the ages of 1-6 years (12-72 months). If the lack of consensus in previous research was mainly due to the small number of children, increasing this number should address the issue. Aggregating speech samples across children would also provide denser samples at each time interval and reduce the possibility of accidental gaps in age intervals. The reasoning behind this approach is that despite individual variation, if there are major developmental stages, they should be

detectable in large aggregate corpora of child speech.

Second, in this study we shift the focus from detecting and classifying negative communicative functions such as rejection to detecting and classifying negative constructions that typically communicate them. Here by negative constructions, we refer to syntactic constructions modified by any one of the three negative morphemes in English: *no*, *not*, *n't*. Table summarizes the constructions and communicative functions used in this study. This approach has several advantages. To begin with, negative constructions are more concrete and easier to define and classify. This way we can avoid inconsistent definitions and criteria for classification. For example, utterances that combine negation with the main verb *want* (e.g., "*I don't want that*") constitute a construction that typically conveys rejection. In addition, due to their concrete definitions, constructions can be detected and classified automatically in large corpora. While it is difficult to manually annotate for examples of rejection across thousands of utterances, it is relatively easier to automatically detect utterances containing the verb *want* modified by negative morphemes. This approach is similar in spirit to that of Choi (1988) who manually annotated for both communicative functions and their common linguistic forms (Table 3).

One downside of focusing on negative constructions is that it may systematically underestimate children's knowledge of negation. Due to early limited productive capacities, children produce shorter forms before longer ones. Therefore, they can convey a communicative function like rejection using a simple *no* before they can produce the full construction "*I don't want that*." Focusing on children's production of explicit constructions, we might arrive at a conservative estimate of when children are able to convey a communicative function. To make up for this, besides investigating negative constructions at the sentence level, we also investigate children and parents' use of *no* as a response particle and at the discourse level. Negative response particles like *no* can be used in isolation to negate the content of a previous utterance. For example, if a mother asks "do you want some

milk?" and the child responds with "no," the negative particle anaphorically targets the proposition "I want some milk" and negates it to convey "I don't want milk." By using negative discourse particles like *no*, children can convey complex negative content without actually producing them in words. This approach is useful early in their development when they have limited productive capacities. Therefore, we also look at children and parents' use of negative discourse particles. More specifically, we examine the constructions immediately preceding and negated by the response particle *no*. The analysis of these constructions can capture communicative functions that the response particle *no* conveys before children are capable of producing their full syntactic forms.

Table: Negative constructions used in this study that typically convey communicative functions studied in previous functional accounts of negation development

Data and preprocessing

For child speech data in English, 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 childes-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 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.

At the sentence level, we characterized the syntactic features of the negative utterances

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

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 ("I know" for "I don't know"). 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," where the dependency relation of these discourse particles is "discourse" by the dependency parser; we also included cases with just one or duplications of the discourse particles ("no no no"). 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 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 $f_{c,t}$ for construction c and age bin t as the number of utterances in construction c and age bin t divided by the total number of utterances

produced at age bin t. 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.

$$f_{c,t} = \frac{n_{c,t}}{n_t}$$

Second, we borrowed the measure of "cumulative (moving) ratio" from the analysis of time series data (Wei, 2006). We defined the cumulative ratio $F_{c,t}$ for a construction c at age bin t, as the sum of the number of utterances produced with construction c from the first age bin to age bin t, divided by the sum of all utterances produced between the first age bin and age bin t. 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.

$$F_{c,t} = \frac{\sum_{i=1}^{t} n_{c,i}}{\sum_{i=1}^{t} n_i}$$

The two ratios mentioned above were calculated for negative constructions and their positive counterparts at the sentence and discourse levels for children as well as parents. With that being said, for the sake of presentations, our figures focus on the results of cumulative ratios. In addition, in this study we use parents' speech as a benchmark for children's development. Therefore, the subfigures within each figure contrast children's production to that of parents at the corresponding age of the children. In what follows, we describe in detail the results for each communicative function and its associated negative constructions.

Negative Constructions

Rejection. For instances of "rejection" and positive counterparts, we selected utterances in which the lemma of the head verb of the phrase was 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 4 shows examples of negative utterances including those in which the speakers describe their own desires with or without an auxiliary verb, cases that express rhetorical inquiries of desires from one interlocutor to another, and instances where the speaker is describing the desires of somebody else. We classified a total of 20,641 negative utterances (child: 9,398; parent: 11,243), and a total of 180,881 positive utterances (child: 63,427; parent: 117,454).

Table 4

Examples of sentence-level rejections (negative) and their positive counterparts in children's speech.

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

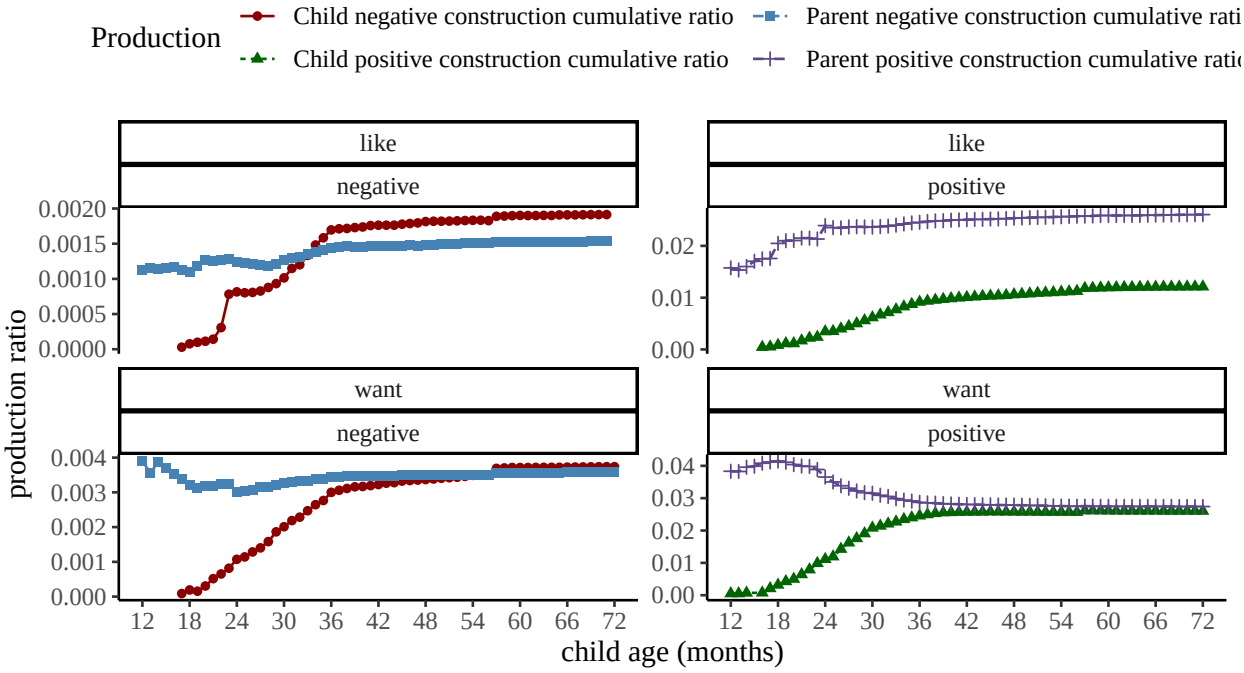

Figure 1. Cumulative ratios for the production of rejection at the sentence level for children between 12 to 72 months of age, and their parents. The y-axes are scaled differently for the panels to accommodate differences in relative frequencies.

Starting with our analysis at the sentence level, Figure 1 shows the cumulative ratios of parents' and children's instances of rejections and their positive counterparts (y-axis) with age along the x-axis. Overall, we see a similar pattern of production for rejection whether the head verb is *want* or *like* in child speech. Comparing the cumulative ratios between parents and children, children's production of rejection gradually increases between the ages of 18 and 36 months. After about 36 months of age, children's production of these constructions stays at a relatively constant rate and close to parent levels. The main exception is positive instances with the head verb *like*. Parents produced such constructions more frequently than children across at different ages. In all age bins, the production ratio for negative utterances was lower than that for their positive counterparts.

On the discourse level, we investigated discourse interactions (antecedent + negative

utterance) in which the antecedent has one of the head verbs *like* or *want*, yet the head verb does not have to be modified by negative morphemes (Table 5). We found a total of 11,021 such utterances (child: 7,903; parent: 3,118). As shown in Figure 2, children's production of *no* to convey rejection increases regularly from the age of 18 - 36 months[2]. Overall, negation is produced at the discourse level more frequently in child speech compared to parent speech.

Table 5

Examples of discourse-level rejections and their antecedents in parents' and children's speech.

Antecedent	Utterance
Parent: *I want you to try it*	Child: *no no no*
Parent: *would you like to go*	Child: *no no*
Child: *I don't like that*	Parent: *no honey you have to try it*
Child: *I want it*	Parent: *no this is not for you*

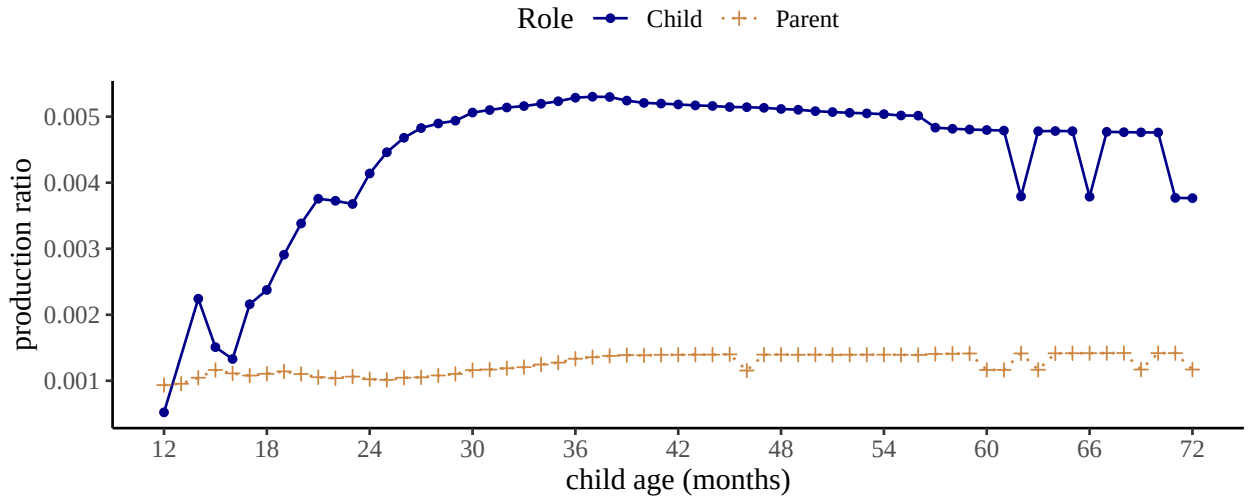

Figure 2. Cumulative ratios for the production of rejection at the discourse level for children between 12 to 72 months of age, and their parents.

[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

Non-existence. For the function of non-existence we searched for the English expletive 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 6

Examples of sentence-level non-existence (negative) and positive counterparts in children's speech.

Non-existence (Negative)	Existentials (Positive)
there's no (more) water	*there are books*
there isn't it	*there is it*

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 production reaches a stable cumulative ratio but stays below parents' level. Notice that there appears to be slight 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 as the number of total utterances increases along the developmental trajectory, the cumulative ratio for negative existential utterances actually decreases in this brief period.

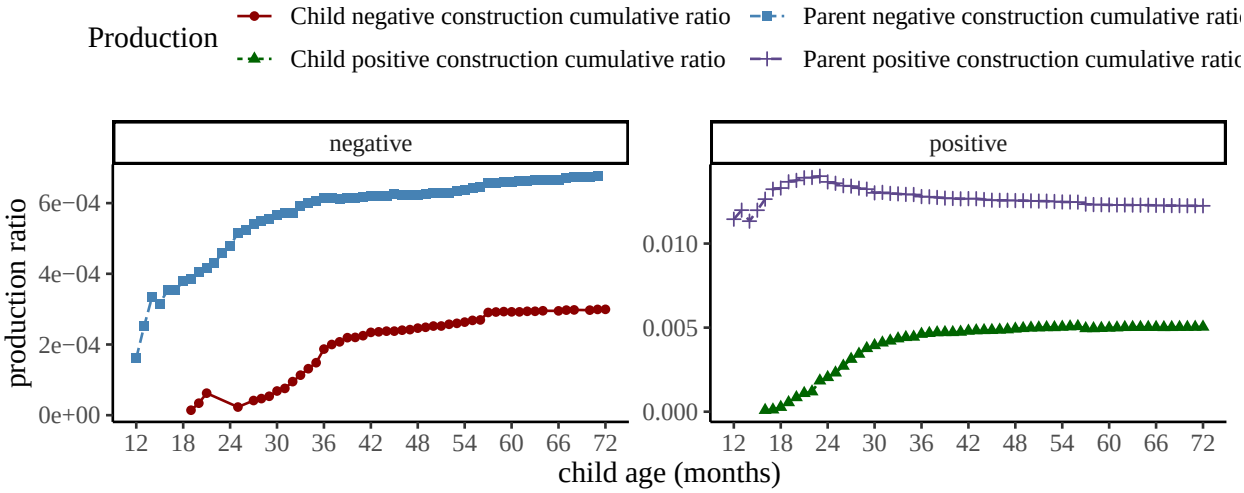

Figure 3. Cumulative ratios for the production of non-existence at the sentence level for children between 12 to 72 months of age, and their parents.

For non-existence at the discourse level, we applied similar selection criteria and extracted negative utterances with existential constructions in their antecedents (Table 7). This led to a total of 1,202 utterances (child: 828; parent: 374). As Figure 4 shows, there is 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 fluctuations, the cumulative ratios of children's production seem stable and similar. Therefore with non-existence, both sentence level and discourse level analyses point to substantial development in the age rage of 18-36 months.

Table 7

Examples of discourse-level non-existence and their antecedents in parents' and children's speech.

Antecedent	Utterance
Parent: *is there a bunny*	Child: *no no bunny*
Child: *there is my ball*	Parent: *no that's not yours*

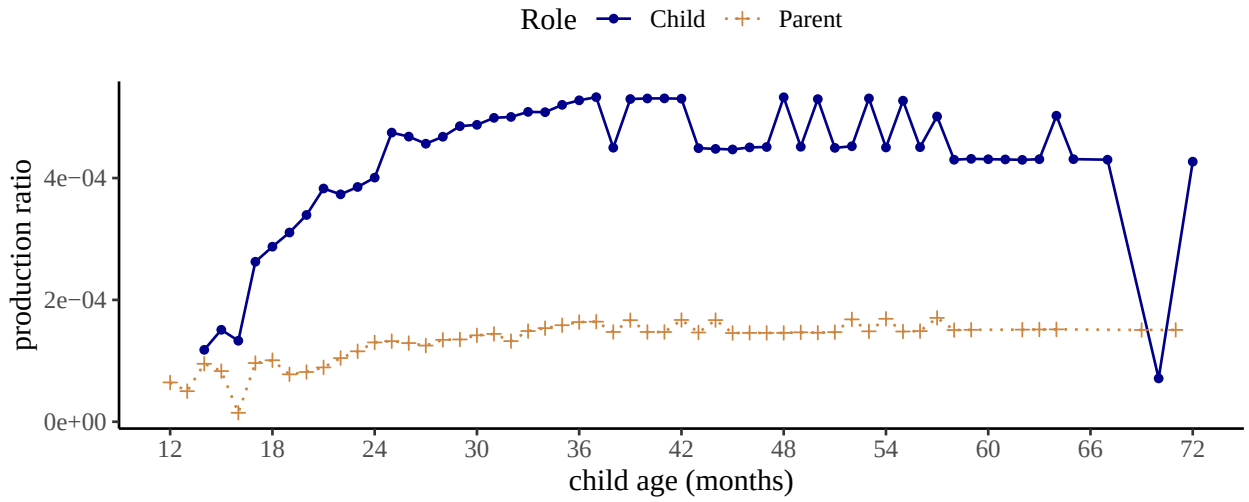

Figure 4. Cumulative ratios for the production of non-existence at the discourse level for children between 12 to 72 months of age, and their parents.

Prohibition. For constructions that typically convey prohibition, we extracted utterances that were labeled 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* (as well as *does* or *did* to include possible errors) 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 positive utterances (child: 8,659; parent: 16,883).

Figure 5 shows the 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 are between 12 - 24 months. Yet overall, child production 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 8

Examples of sentence-level prohibition (negative) and positive counterparts in children's speech.

Prohibition (Negative)	Imperatives (Positive)
don't blame Charlotte	*cook it*
don't do that	*try this*

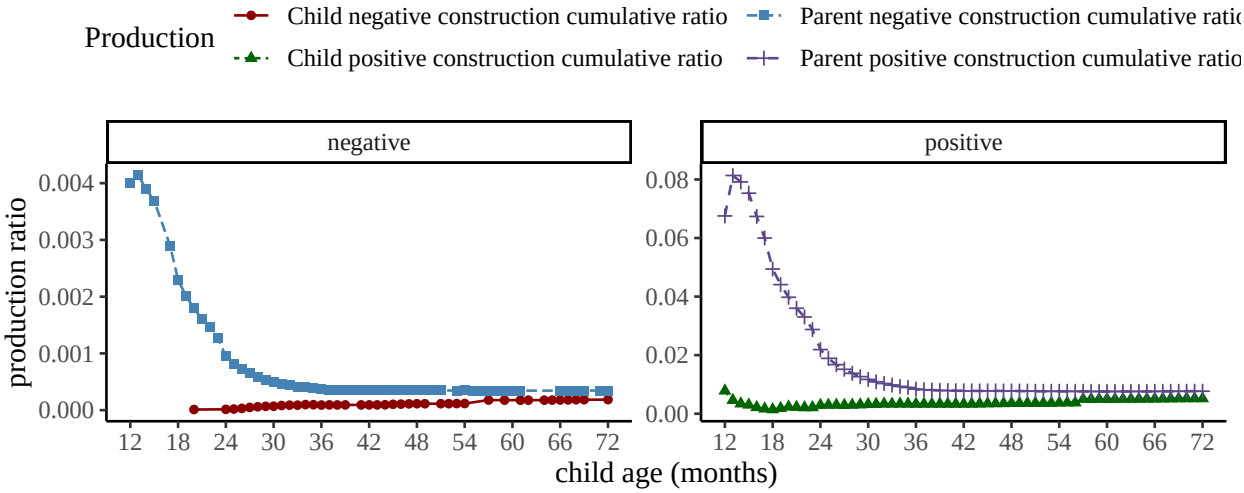

Figure 5. Cumulative ratios for the production of prohibition at the sentence level for children between 12 to 72 months of age, and their parents.

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*, *know*, *think*, *remember*, and *have*. This resulted in a total of 1,270 utterances (child: 1,055; parent: 215). As shown in Figure 6, children's usage of negation as a response particle to express

prohibition increases within the age range of 18 to 24 months, and stays relatively stable after. Parents productions decreases when the children are between 12 to 36 months.

Table 9

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

Antecedent	Utterance
Parent: *put away your toys*	Child: *no mommy I like these*

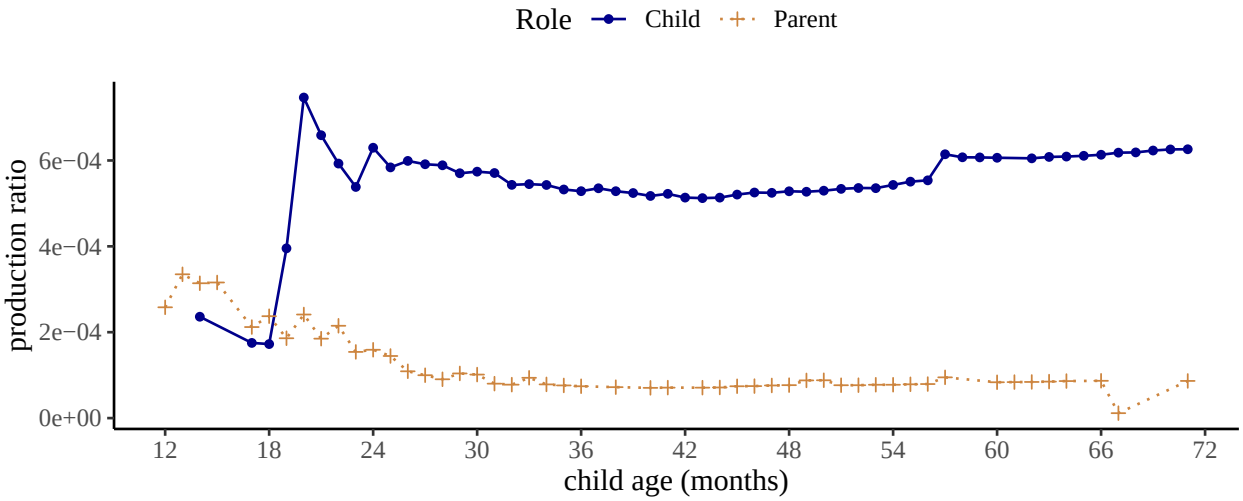

Figure 6. Cumulative ratios for the production of prohibition at the discourse level for children between 12 to 72 months of age, and their parents.

Inability. For the function of inability, we analyzed instances with head verbs that are modified by the modal auxiliaries *can* and *could*. If the head verb was also modified by a negative morpheme, we classified it as negative. Otherwise, we considered it positive. Cases without a subject (e.g., "can't play") or with subjects that were not first person singular (e.g., "you can't do that," "this can't go in the box") were excluded. This is because such 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 10 shows a few example of the cases we considered.

Table 10

Examples of sentence-level inability (negative) and positive counterparts in children's speech.

Inability (Negative)	Ability (Positive)
I can't see	*you could do it*
She can't go	*mommy could help me*

Figure 7 shows 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 higher than parent ratios.

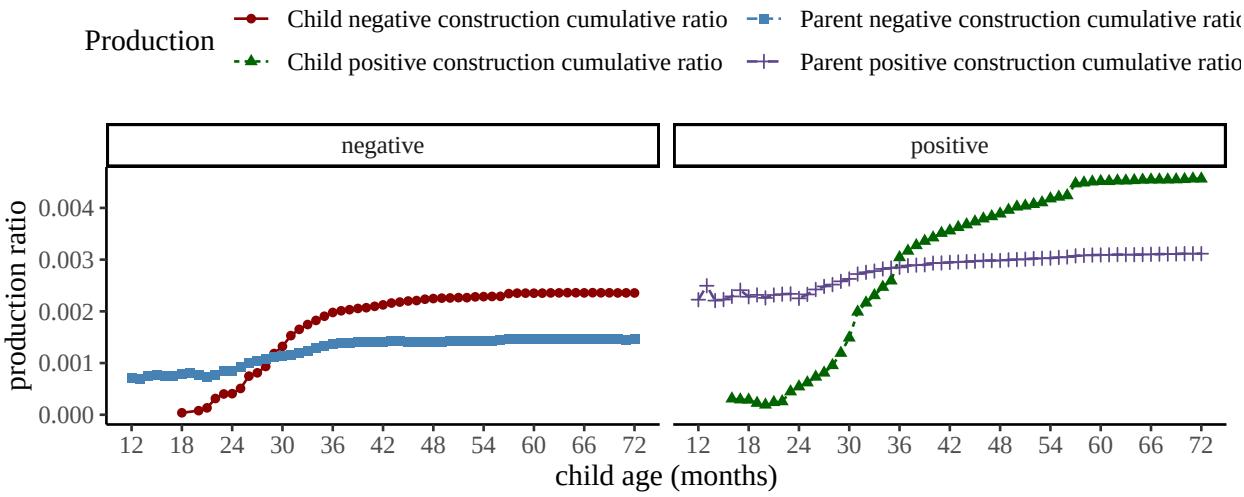

Figure 7. Cumulative ratios for the production of inability at the sentence level for children between 12 to 72 months of age, and their parents.

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 1,275 negative utterances (child: 621; parent: 654). Figure 8 shows the ratios and the cumulative 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 stabalizes after 36 months at a similar rate to that of parent's.

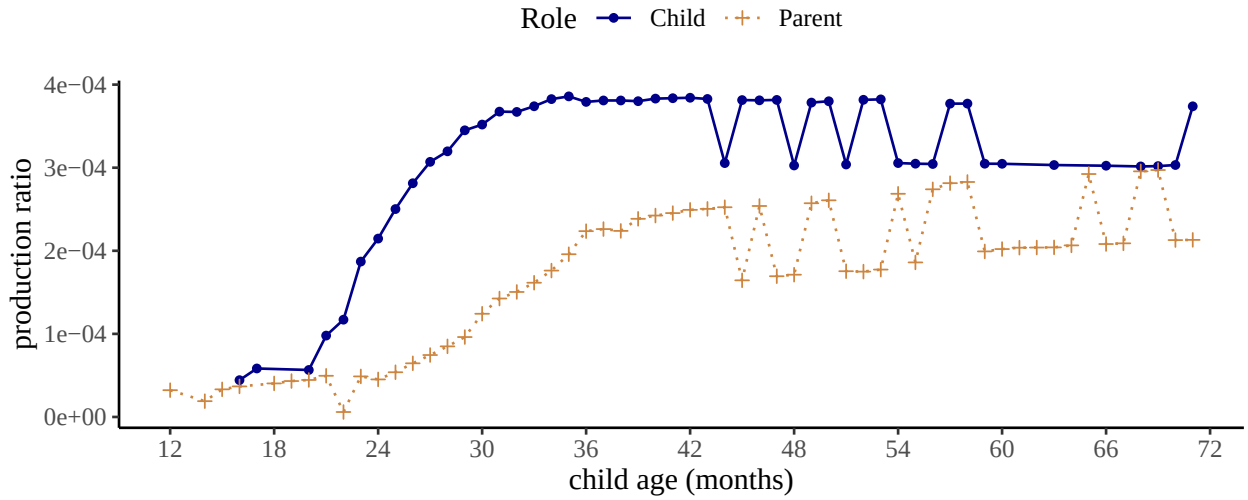

Figure 8. Cumulative ratios for the production of inability at the discourse level for children between 12 to 72 months of age, and their parents.

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 (e.g., "mine") as well as nominals with a possessive dependent (e.g., "my book") 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 11

Examples of sentence-level labeling (negative) and positive counterparts in children's speech.

Labeling (Negative)	Labeling (Positive)
that's not a farmer	*this is a book*
this is not the book	*this is nice*
I'm not a heavy baby Mum	*it's a nice bowl*
It's no good	*she's pretty*

Figure 9 shows 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 after then; though the production ratios remained lower than those of parents' production.

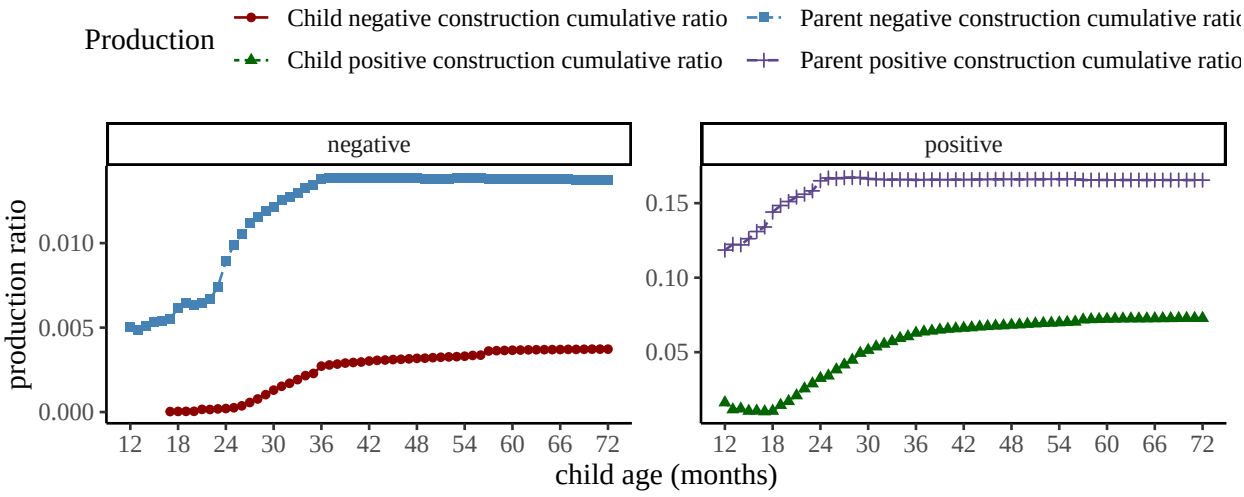

Figure 9. Cumulative ratios for the production of (negative) labeling at the sentence level for children between 12 to 72 months of age, and their parents.

At the discourse level, we selected antecedent utterances with copula structures that combined with a nominal or an adjectival predicate. Table 12 shows a few examples. We

found 18,037 utterances (Child: 12,501; Parent: 5,536). Figure 10 shows the cumulative ratios for labeling instances at the discourse level. There is an increase in children use of negation to respond to labeling utterances between 18 to 36 months. After 36 months, however, these productions stay at a stable rate above parents level.

Table 12

Examples of discourse-level labeling (negative) and their antecedents in parents' and children's speech.

Antecedent	Utterance
Parent: *is this one good*	Child: *no it's not*
Parent: *are you a captain*	Child: *no I'm not*
Child: *that's the one*	Parent: *no it's the green one*
Child: *this is the key*	Parent: *no no*

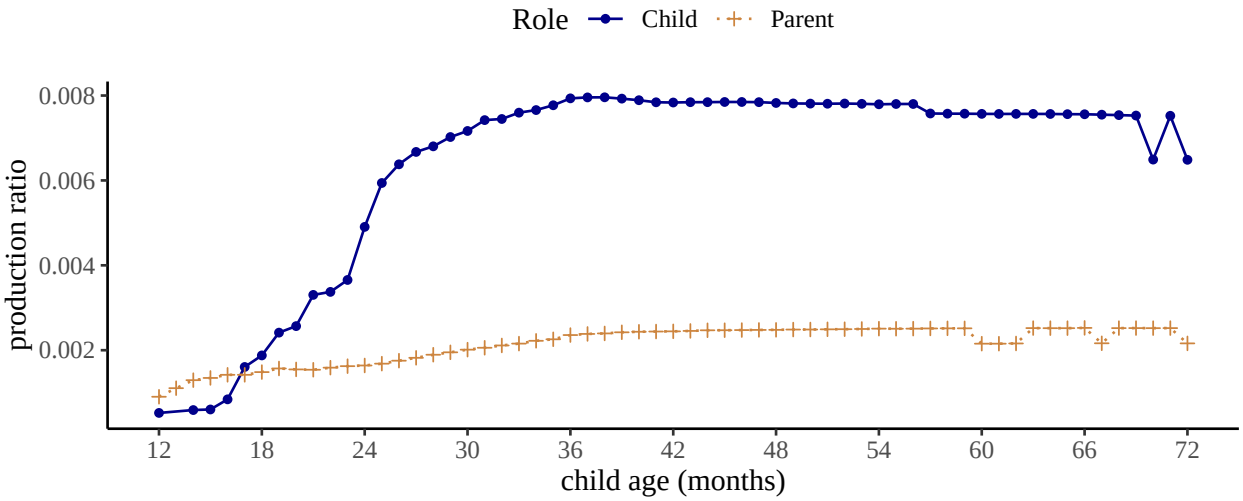

Figure 10. Cumulative ratios for the production of (negative) labeling at the discourse level for children between 12 to 72 months of age, and their parents.

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 14 shows a few examples. Instances where the speaker asked about or described 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 13

Examples of sentence-level epistemic negation and positive counterparts in children's speech.

Epistemic (Negative)	Epistemic (Positive)
I not know	*I knows*
I didn't remember	*she remembers*
I don't think so	*he thinks this one is good*
She doesn't know this	*She knows about this*

Figure 11 shows the 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. Across the three head verbs, children's productions with *know* gradually approached that of parents' around 30 - 36 months, whereas cases with the head verb *remember* and *think* were produced less frequently by children.

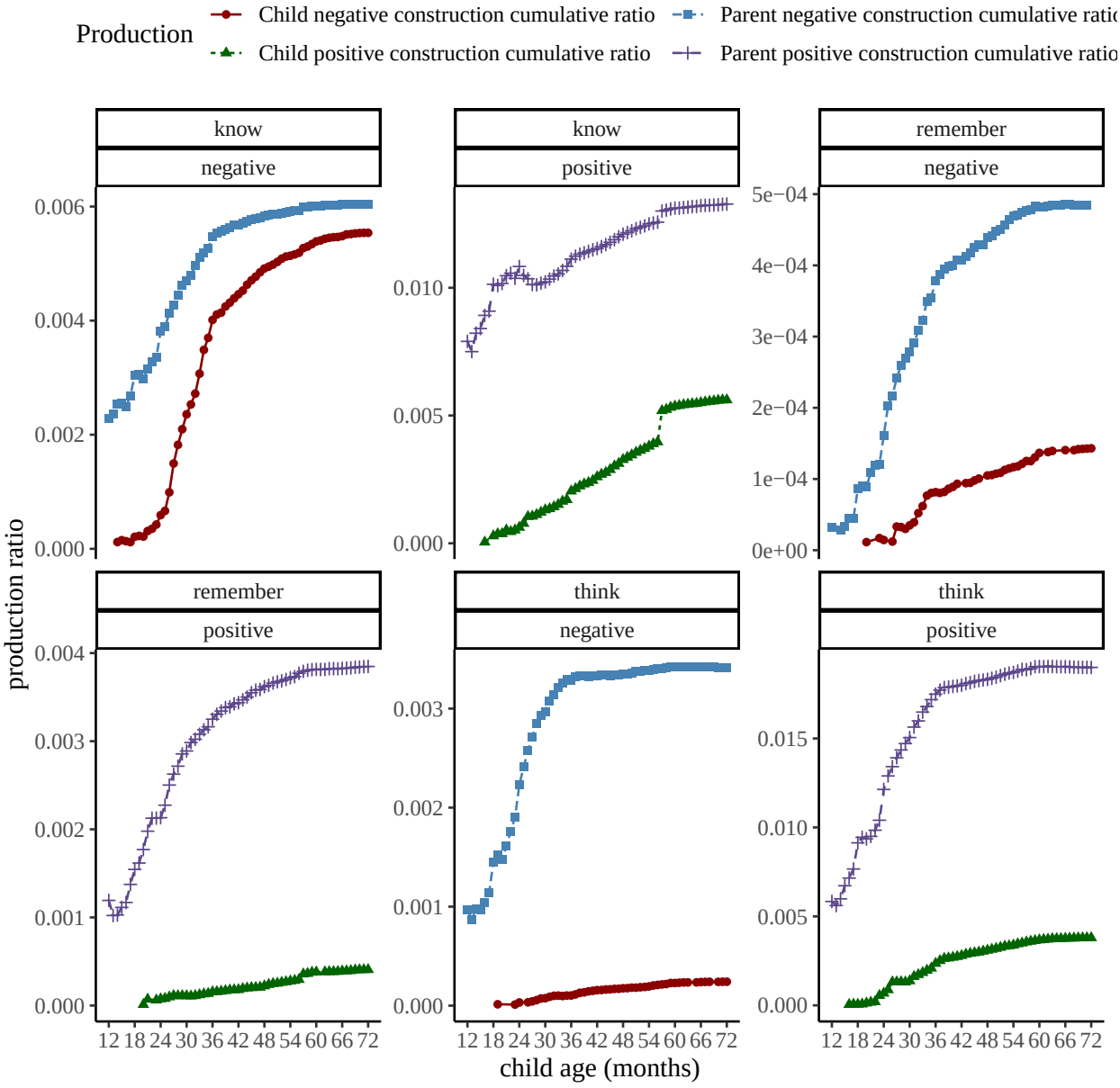

Figure 11. Cumulative ratios for the production of epistemic negation at the sentence level for children between 12 to 72 months of age, and their parents.

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 5,695 utterances (child: 26,174; parent: 101,201). As shown in Figure 12, children's production of epistemic negation at the discourse level increase rapidly between 18-36

445 months and was in general higher than the production ratio of parents.

Table 14

Examples of sentence-level epistemic negation and positive counterparts in children's speech.

Epistemic (Negative)	Epistemic (Positive)
I not know	*I knows*
I didn't remember	*she remembers*
I don't think so	*he thinks this one is good*
She doesn't know this	*She knows about this*

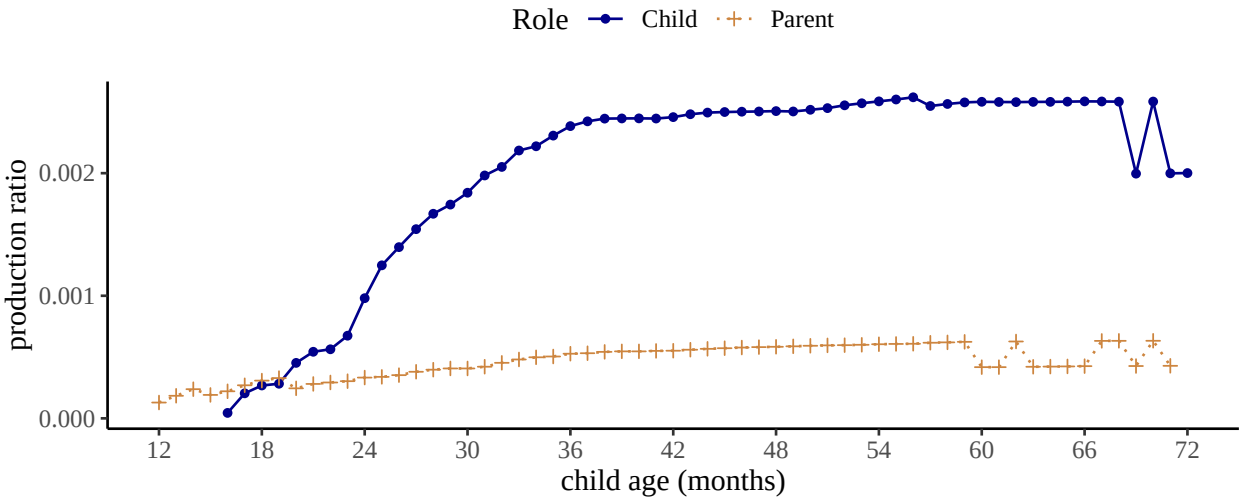

Figure 12. Cumulative ratios for the production of epistemic negation at the discourse level for children between 12 to 72 months of age, and their parents.

446 **Possession.** The last function we explored was "possession." At the syntactic level,
447 for negative structures we selected cases where negative morphemes were combined with
448 auxiliary verbs to modify a head verb with the lemma form *have* and a POS tag of VERB.
449 We also included cases of which the syntactic head is a nominal predicate; the nominal
450 predicate can either be a possessive pronoun (e.g., "yours") or a noun phrase with a
451 possessive modifier (e.g., "her book"). Table 15 shows a few examples. The number of
452 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 our search 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 15

Examples of sentence-level possession and positive counterparts in children's speech.

Posession (Negative)	Posession (Positive)
I don't have it	*you have that*
you don't have my toy car	*she has it*
not mine	*this is hers*
not yours either	*mine mine mine*

Figure 13 presents 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 below parent levels of production even after 36 months. However, for utterances headed by possessive pronouns, productions increase rapidly between 18-24 months and stays above parent levels as early as 24 months of age.

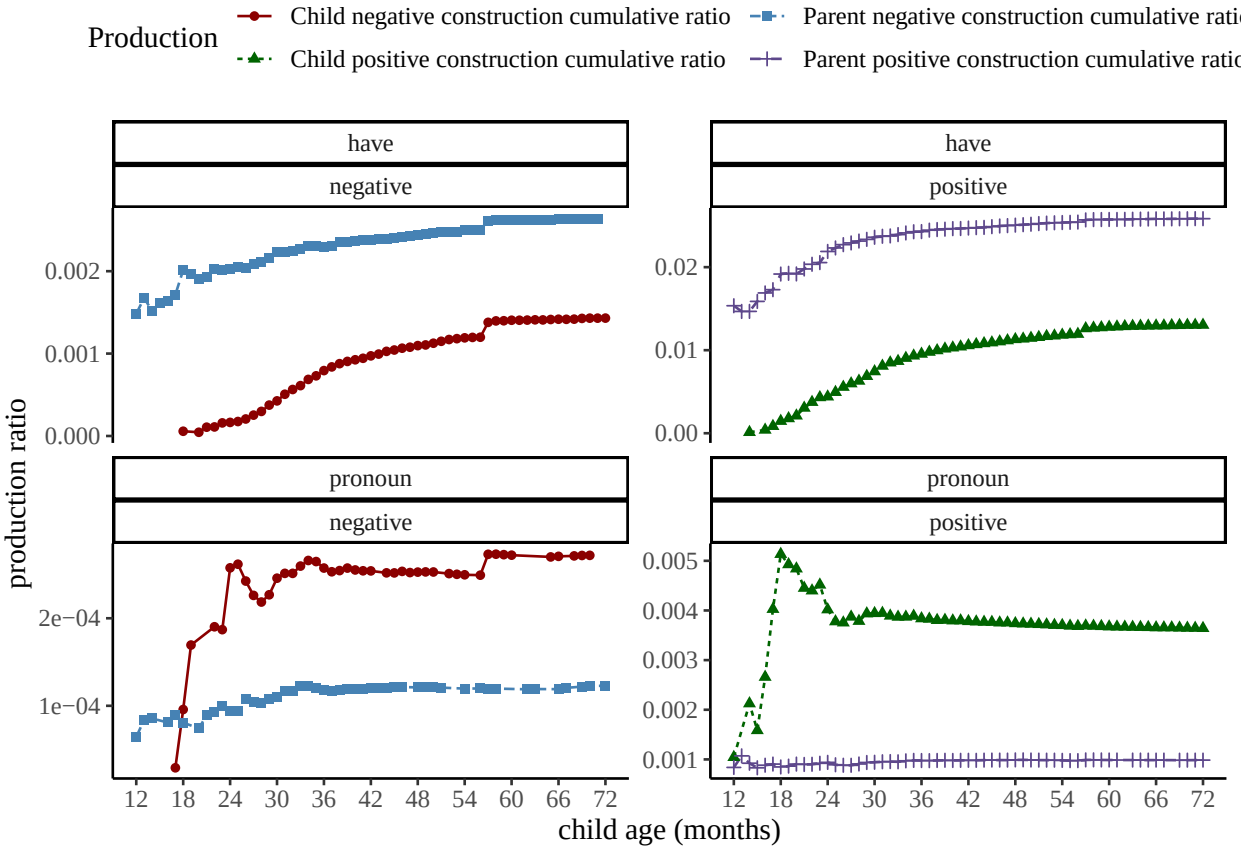

Figure 13. Cumulative ratios for the production of possession at the sentence level for children between 12 to 72 months of age, and their parents.

For discourse level possessives, we selected antecedents to discourse level negative utterances (e.g., *no!*) which themselves had structures similar to both the negative and positive constructions of possession at the syntactic level (Table 16). Based on Figure 14, the overall patterns indicate that children's production of discourse level possession increases gradually within the age range of 18 to 36 months; and their production is mostly higher than that of parents.

Table 16

Examples of discourse-level possession and their antecedents in parents' and children's speech.

Antecedent	Utterance
Parent: *not yours*	Child: *no it's mine mine*
Parent: *do you still have that picture*	Child: *no*
Child: *I don't have the book*	Parent: *no no mommy please read it to me*
Child: *mommy has it*	Parent: *no mommy gave it back to your auntie*

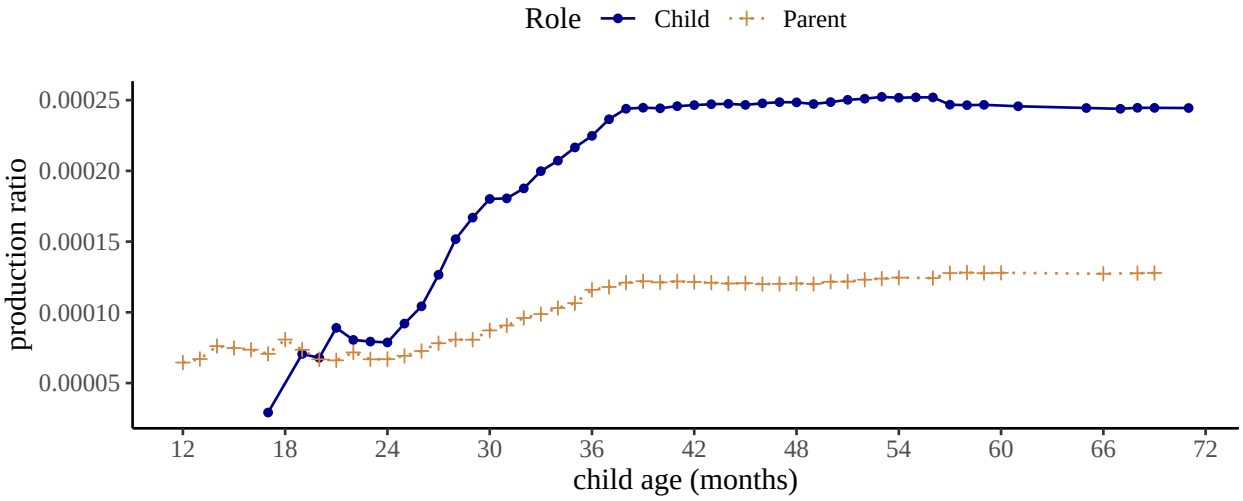

Figure 14. Cumulative ratios for the production of possession at the discourse level for children between 12 to 72 months of age, and their parents.

Discussion and Analysis. Figure 15 shows the cumulative ratios of all our negative constructions at the sentence level for children (left panel) and parents (right panel). For most constructions, parents produce them at relatively constant rates across most of the age bins. Notable exceptions are labeling, epistemic, and prohibitions between 12-36 months. Parents seem to increase their productions of labeling and epistemic constructions in this period and produce them at a relatively constant rates between 36-72 months. This may be due to the substantial change in the nature of parent-child interactions and conversations

around 36 months. Children become more conversant and interactive around this age which in turn may affect parent productions and affect certain constructions more than others. Prohibitions start as one of the most frequent constructions at 12-18 months of age and end up as the least frequently used construction after around 30 months. One obvious reason for this trend may be that when children are younger, parents guide their actions through imperatives and commands a lot more frequently than later in the child's life. Children start producing most constructions in the 12-24 age range. Two constructions, non-existence and prohibition, seem to show some delay. With non-existence, even though there are examples between 18-24 months, there is a discontinuity between 22 - 24 months instead of a slow and steady increase seen in most of the other functions. This may be partly due to the samples available at that age range and with more data a clearer pattern may emerge. With prohibitions, we see a relatively smooth pattern. Children start to produce them later than other functions (more regularly between 24-30 months) and its rate of production stays below parents' levels. It is possible that parent-child interaction does not provide many contexts for children to prohibit parents. Nevertheless by 36 months of age, the production of most constructions appears to be stable.

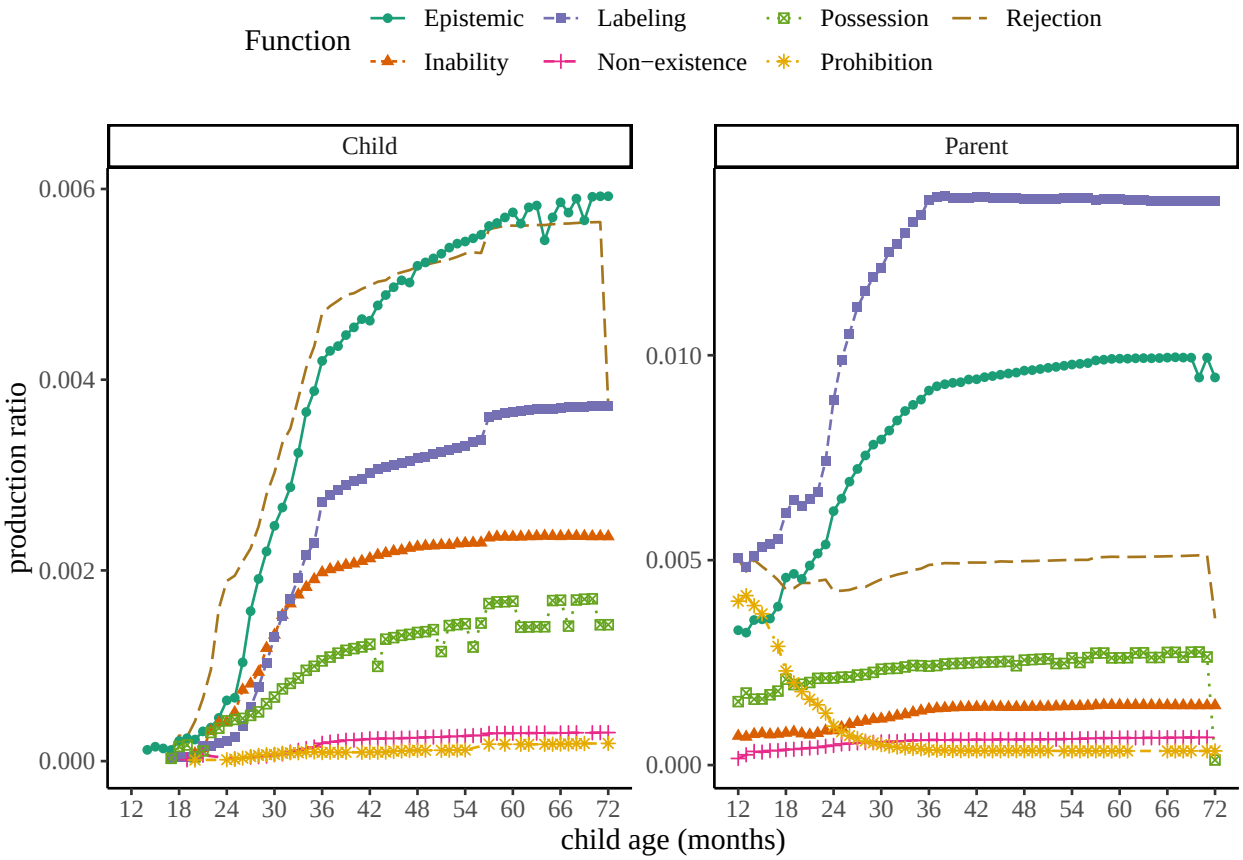

Figure 15. Cumulative ratios for all negative constructions at the syntactic level.

Figure 16 shows the cumulative ratios of all positive counterparts to our negative constructions at the sentence level for children (left panel) and parents (right panel). For almost all constructions, parents productions are stable and constant. Notable exceptions are labeling and positive counterparts to prohibitions (positive imperatives) between 12-30 months. Similar to negative instances of labeling, positive instances increase in frequency between 12-30 months but stay stable and constant after. Positive prohibitions are produced much more frequently at the beginning and between 12-36 months, but their production decreases later. This pattern mirrors what we see in Figure 15 with (negative) prohibitions. Children started producing all positive counterparts to our negative constructions before 24 months of age. By 36 months, almost all positive constructions are being produced at a relatively constant rate close to parents' levels. Another noteworthy pattern is the relative

high frequency of positive counterparts to prohibitions in the 12-24 months age period. Unlike (negative) prohibitions that were produced with some delay (compared to other constructions) around 24-30 months, positive imperatives are produced with high frequency even before 24 months of age. In other words, even though children do not frequently prohibit parents, they seem to be frequently ordering or commanding parents to do things for them; a conclusion that may not surprise many parents or caregivers.

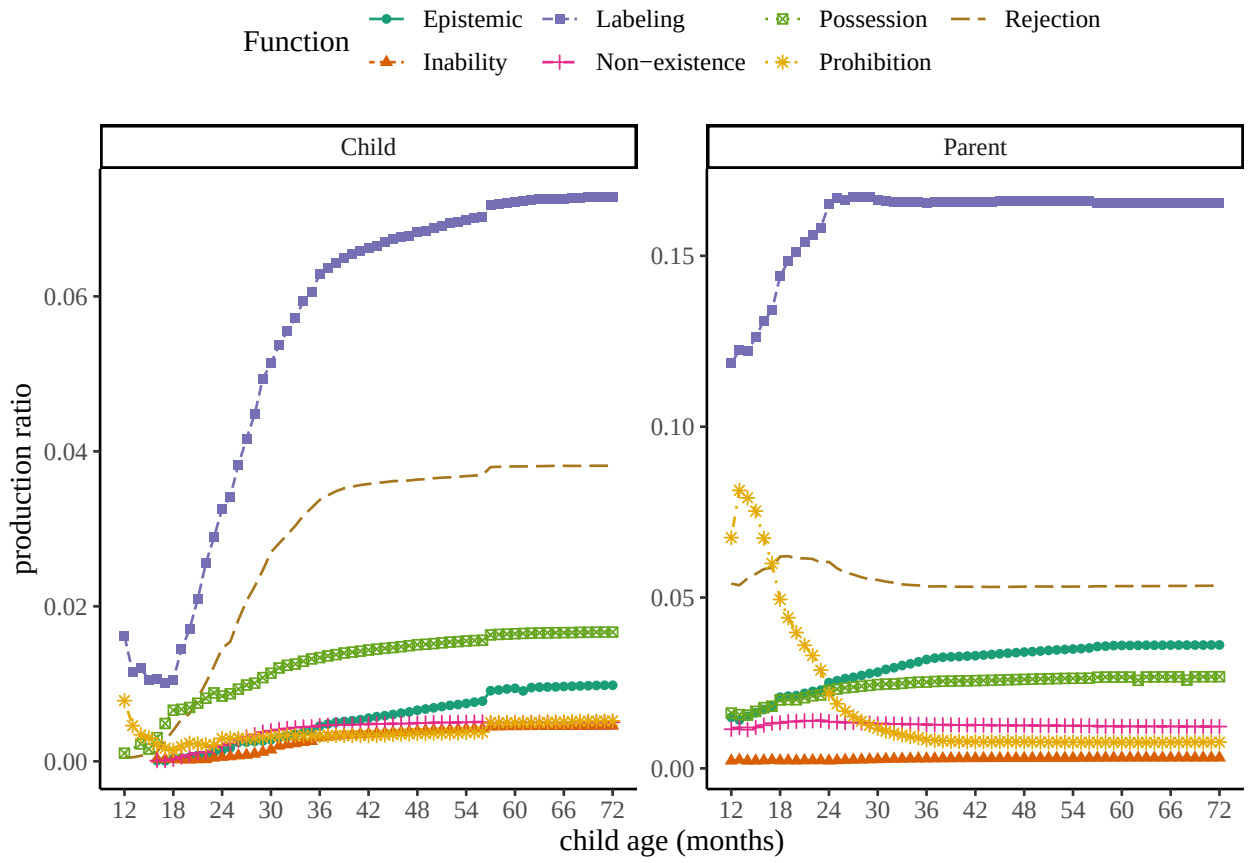

Figure 16. Cumulative ratios for the positive counpterparts to all negative constructions at the syntactic level.

Finally, Figure 17 shows the cumulative ratios of all negative responses to a previous utterance that used the negative constructions or their positive counterparts. Starting with parents' productions on the right, we see again a relatively constant rate of producing negative responses to each construction after 36 months. Before 36 months, however, most

constructions show a gradual increase with the exception of prohibitions. Parents' start with more frequent "*no!*"-responses to imperatives produced by children, but the frequency of these negative responses drops to a relatively low and stable level after children are 36 months of age. Looking at children's negative responses on the left panel, we see that productions begin for all functions before 30 months of age and by 36 months children are already producing negative responses at a relatively constant rate or even higher than parents' production levels. Compared to the sentence level, the most frequent communicative functions expressed by these discourse interactions are still rejection, epistemic, and labeling.

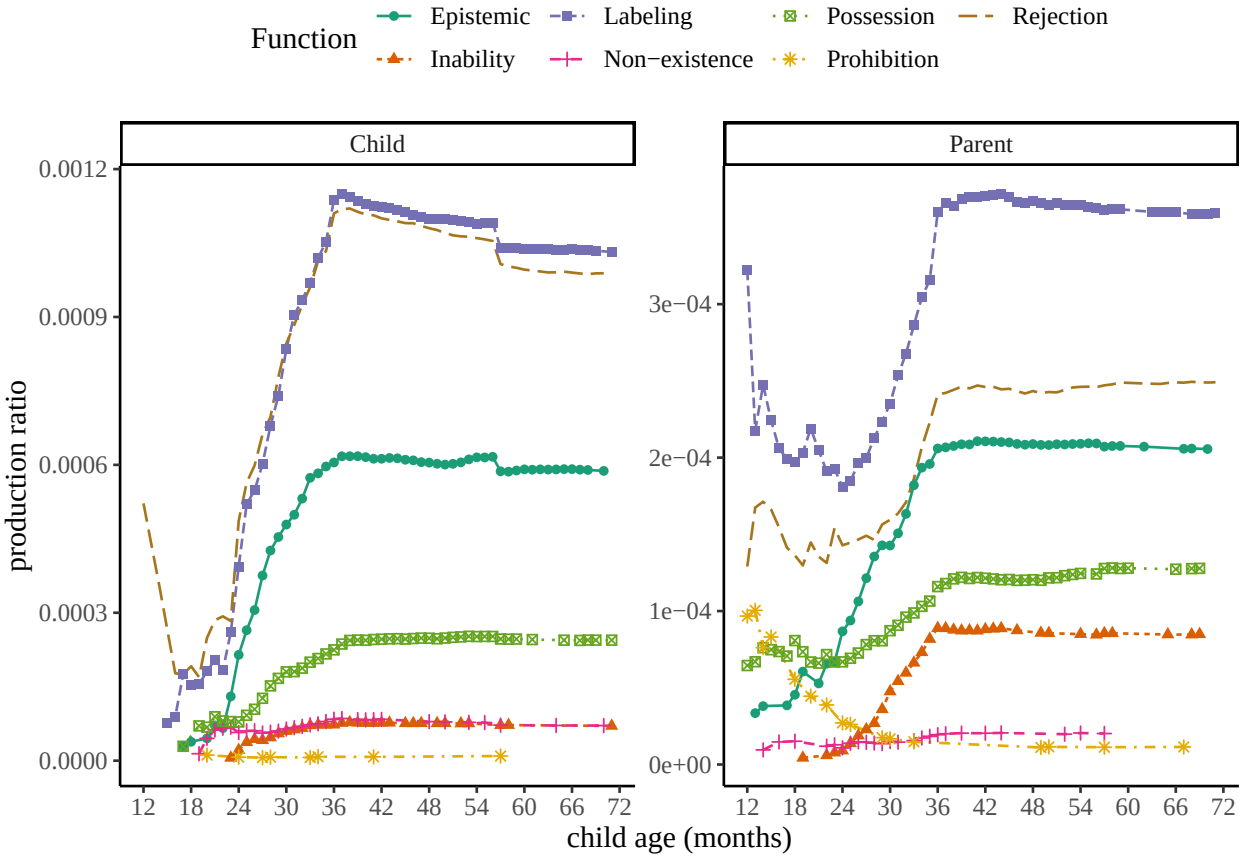

Figure 17. Cumulative ratios for all negative constructions at the discourse level.

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 comparable 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.

ZL: I didn't understand the next paragraph. It could be just me. It also feels like general discussion. Maybe I remembered it wrong.

A different hypothesis is that from the start, negation is an abstract concept that can serve different communicative functions. The main task of the learner is to break the speech stream, detect negative morphemes like *no*, *not*, or *nt'*, and map them to this abstract meaning. She should then learn to use them appropriately in composition with other words to convey the right communicative function in context. There is either no substantial conceptual development for a logical concept such as negation, or this development is complete by the time the process of form-meaning mapping starts. This account predicts that conceptualy speaking, different communicative functions should be learnable and expressable early on and around the same time. Any delays in the comprehension or production of negative constructions and functions must be due to lack of experience with that construction or limitations in children's productive capacity. Therefore, it is possible for communicative functions of negation to not be comprehended or produced in fixed and ordered stages. Children may vary considerably on what constructions or functions they comprehend or produce earlier.

There are a few theoretical and methodological caveats, however. Studies that

hypothesize stages in the development of negation almost exclusively study children's productions. Our methods of data collection and analysis may also affect our ability to provide data for or against these hypotheses.

Nevertheless, there seems to be some consensus among researchers that the crucial period for the development of negation is the period between 18 and 30 months of age. Some researchers suggest that by 36 months, children have an abstract concept of negation that is used to convey a variety of communicative functions (Cameron-Faulkner, Lieven, & Theakston, 2007; McNeill & McNeill, 1968; Pea, 1978).

Fourth, previous studies have almost exclusively focused on children's production of negation. A tacit assumption is that children's linguistic production provides a straightforward window into their conceptual development. However, children's linguistic comprehension may differ substantially from their production, and these in turn may differ from their conceptual representations. ... Therefore, developmental patterns

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 order to paint a more clear picture about the development of negation. Additionally, to avoid as much ambiguity resulted from the automatic parser as possible, we tried to be restrictive when identifying the negative constructions of interest in our study. This means that the structures analyzed here do not include all constructions modified by the three negative morphemes in English, such as instances where the syntactic head is a noun phrase that does not fall under the category of possession (e.g., "not table"). It would be worthwile for future studies to take upon these cases as well to investigate more broadly what lexical items negative morphemes co-occur with, and how the lexical diversity of these structures change along the developmental trajectory.

Given previous studies and our own, we conclude that it is possible that negation starts as an abstract concept that can be used to perform different communicative functions, and it is possible that it develops relatively quickly in functional stages becoming more abstract between 18-30 months of age.

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Function	Negative morpheme combines with	Negative Examples
Rejection	*like*/*want*	*I not like it*; *not want it*
Non-existence	*there*-expletive	*there is no soup*
Prohibition	imperative subjectless *do*	*do not spill milk*
Inability	*can*	*I cannot zip it*
Labeling (Denial)	nominal/adjectival predicates	*that's not a crocodile*; *it's no interesting
Epistemic	*know*/*think*/*remember*	*I not know/think/remember*
Possession	*have*/possesive pronouns	*not have the toy*; *not mine*

Table 17

English negative communicative functions and constructions used in this study.