English Negative Constructions and Communicative Functions in Child Language

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Abstract

How does negation emerge in early conceptual and linguistic development? Previous research has hypothesized that negation develops to express communicative functions such as rejection, non-existence, or prohibition. However, findings from prior work have mostly relied on manual annotations to identify negative utterances of different functions, leading the number of children as well as the size of the data sets analyzed to be relatively small. This study considers specific syntactic constructions combined with negative morphemes (*no*, *not*, *n't*) in English as expressions of different communicative functions for negation. Leveraging larges-scale corpora of child-parent interactions along with computational tools, we examine the developmental trajectory of seven different functions and their corresponding negative constructions. Our analyses demonstrate a gradually increasing usage of negation in all functions between the ages of 24 - 36 months; yet there are notable differences in the earlier developmental stages of negation depending on the particular function investigated.

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

Introduction

Negation is an abstract concept crucial to everyday communication. It can help a coffee shop divide its menu into "coffee" and "not coffee" sections, with the "not coffee" section bringing together diverse items with no common label. It can inform us to regulate each others' actions in a sign like "no mask, no entry". It can also communicate our deepest wants and dislikes as in "I don't like Mondays". But how does the abstract concept of negation emerge in the human mind? What are the specific communicative functions that negation combines with in early language development?

Starting a century and a half ago, Darwin (1872) thought that negation has roots in the expression of human emotions and desires. He hypothesized the earliest manifestation of negation and affirmation in infants is when they refuse food from parents, by withdrawing their heads laterally, or when they accept the food, by inclining their heads forward. He suggested that head shaking and nodding as common gestures for negation and affirmation have developed from this early habit. Similarly, many researchers studying early functions of negative morphemes like *no* proposed that children use them to "reject" or "refuse" (Bloom, 1970; Choi, 1988; Pea, 1978). For example, when they are asked "do you want juice?", they may say "no", "not want it", or "don't like it". Pea (1978) proposed this negation function is the first to emerge in children's early speech.

Bloom (1970) argued that the use of negation to expresses "non-existence" emerges before rejection or refusal. For example, when an object that children expect to be present is not present, children may say: "no window", "no fish in the bathroom", or "I do not have underpants". Two close concepts to non-existence are "disappearance" and "non-occurrence" (Pea, 1978; Villiers & Villiers, 1979). Disappearance refers to situations where an object disappears and children use negation to express it (e.g. "no food. all gone" or "no more noise"). Non-occurrence refers to cases when an expected action or event does not occur as in "not working" or "doggie not barking". Some researchers referred to these cases as "failures" and included examples like "no fit in da box" or "it don't fit" (Cameron-Faulkner, Lieven, & Theakston, 2007; Choi, 1988). Non-existence can also be expressed by negation of locative prepositional phrases (e.g. "no in there" or "daddy was not on the phone"). While rejection was hypothesized to interact with human emotions and desires, non-existence (broadly construed to include "disappearance" and "non-occurrence") likely interacts with human perception. Choi (1988) proposed that children's early linguistic negation is used to express both rejection and non-existence.

Additionally, Choi (1988) introduced "prohibition" and suggested that it emerges as early as rejection and non-existence. In cases of prohibition, children use negation to stop others from performing actions; for example "don't go" or "do not spill milk". A special case of prohibition is "self-prohibition". For example, a child may approach prohibited food but immediately say "no, don't eat" to stop themselves. A function similar to prohibition is "inability" (e.g. *I can't reach* / *I cannot zip it*), in that both involve conceptualizing actions and negating them, possibly interacting with early development of motor control. Choi (1988) suggested that expression of inability emerges after the first phase, namely non-existence, rejection, and prohibition.

"Denial" is another function of negation that is argued to be late in development. Bloom (1970) defined it as asserting that "an actual or supposed predication was not the case", for example "It's not sharp". Later researchers formulated it as "truth-functional negation" because it is used to negate the truth of a proposition (Cameron-Faulkner et al., 2007; Pea, 1978). However, this definition depends on the assumed logical system and its assumptions on what type of propositions receive truth values. A particular sub-function of denial is

"labeling", which is realized as the negation of nominal or adjectival predicates such as "this is not a bunny" or "not red". These utterances are often used to introduce new linguistic labels by parents and in turn may facilitate word learning (Clark, 2010). Conversely, labeling and word learning may aid the development of abstract negation.

Despite considerable research on early functions of negation, their developmental trajectories in children's productions have remained unclear. Different studies have claimed different order of acquisition (Pea, 1978). In a recent study, Nordmeyer & Frank (2018) looked at the speech of five children in the Providence corpus (Demuth, Culbertson, & Alter, 2006) and found a great deal of individual differences in how early a negative function is attested. This is partly because previous studies have had to rely on human annotation and identification of functions from corpus data, a time-consuming and difficult process that has limited previous studies to a handful of children and a relatively small sample of their speech.

Our study addresses this question by using syntactic constructions as a proxy for communicative functions. We used a large collection of child speech corpora in English (MacWhinney, 2000) with part of speech tags and syntactic dependency relations. We automatically selected constructions that conveyed the functions discussed in prior research and asked: (1) how early do these constructions emerge in children's speech and what's their trajectory? (2) within the same communicative 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?

Q1: How does the developmental trajectory of each communicative function look like? Q2: How do the developmental trajectories of different communicative functions vary?

Mention in Introduction (and/or connect in Experiments section after things are finalized): these negative constructions do not cover everything that negation could be combined with, and that the negative constructions are not the only ways of conveying different communicative functions

Experiments

Data and preprocessing

For developmental production data of child language in English, we turned to the CHILDES database (MacWhinney, 2000).[1]. We focused on speech produced by children with typical development within the age range of 12 - 72 months. Utterances of child and parent speech were extracted via the childes-db (Sanchez et al., 2019) interface using the programming language R. Negative structures were then identified based on whether a structure contains any of the three negative morphemes: *no*, *not* and *n't*. Since the matters of interest here are syntactic structures *combined* with negation, cases consisting of one negative morpheme (e.g. *no*!) or repetition of negative morphemes (e.g. *no no no*!) were not considered.

In order to conduct analysis of negative syntactic constructions and the particular communicative functions that they serve, we need to first obtain (morpho)syntactic representations of child and parent speech. To do that, we opted for the dependency grammar framework (Tesnière, 1959); the syntactic dependency relations of all negative utterances were automatically derived with DiaParser(Attardi, Sartiano, & Yu, n.d.), a dependency parsing system that has been demonstrated to achieve excellent performance for English. And to further facilitate identifications of negative constructions, we also utilized the available part-of-speech (POS) information initially provided by CHILDES (Sagae, Davis, Lavie, MacWhinney, & Wintner, 2010) when necessary.

Besides the communicative function of rejection, nonexistence, prohibition, inability and labeling (the subfunction of denial), we expanded with two other functions: epistemic negation (Choi, 1988) and possession (see Table 1). For each function, using our parsed data set, we characterized the syntactic features of the negative constructions associated with that function. Based on these features, negative utterances were automatically extracted in a rule-based fashion, with the help of POS information and syntactic dependencies.

Measures

As indexes of the developmental trajectory for negative constructions and their communicative functions in child speech, we measured the following three metrics at each given age of the children. The first one is the *ratio* of negative utterances. For instance, given a total of 52,491 child utterances at the age of 30 months, where negative structures that have the function of inability occur for 141 times, the ratio for this communicative function at this specific age, is then calculated as: 141 / 52,491 = 0.003.

The ratios computed as described above allowed us to measure the average amount of variability in the production of the specific function across the age span of the children. More precisely, we used entropy (Cover & Thomas, 1991) to calculate variation. For example, give the ratio of the negative constructions for a function at a particular age ($P(x_i)$), we first compute its production variability, do the same calculation for all ages of the children, then take the average.

$$H(X) = -\sum_{i=1}^{N} P(x_i) log_2 P(x_i) \quad (1)$$

Given the noisy nature of child production data in general, and the facts that there are different numbers of utterances and children at each age, the last measure that we utilized is *moving ratio*, borrowed from the model of moving average in analyses of time series data (Wei, 2006). For a communicative function, the goal of the moving ratio is still to reflect the production of the negative utterances at the given age; meanwhile it takes into account the previous production of all neg-

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

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

Table 1: Communicative functions of negation in early child language of English.

ative constructions of the same function before the specified age. This would allow us to have a more balanced look at individual developmental stage (e.g. age) of a communicative function, in relation to its development patterns thus far.

The computation of the moving ratio is as follows. For instance, given that the number of negative utterances that express inability in child speech is 141 at the age of 30 months, we: (1) count the total number of negative constructions with the same function produced by children *at and before* 30 months old (682); (2) compute the total number of utterances (419,949) within the same age range; (3) divide the number of (1) by that of (2) (682 / 419,949 = 0.002).

While our focus is negative utterances in child production, we used parents' speech as comparative references. Therefore for every communicative function, the same three measures were calculated for parent speech in a similar fashion. Our plots accordingly contrast the ratio / moving ratio of different negative constructions between children's and parents' production at corresponding ages of the children.

In what follows, we describe in detail the results of each communicative function and their corresponding negative constructions. While we computed both ratio and moving ratio for every function, our analyses mainly rely on the latter.

Communicative functions of negative constructions

Rejection For the function of rejection, we examined cases where the lemma of the head verb of the phrase is either *like* or *want*, and the head verb is modified by one of the three negative morphemes. Each of the utterances either takes a subject or has no subject at all. And the existence of a subject was determined via searching for a word in the utterance that has the *nsubj* dependency relation with the head verb.

Additionally, other than expressions that the speakers used to describe their own emotion, with (e.g. (1)) or without (e.g. (2)) an auxiliary verb, we also included cases that express rhetorical inquiries of emotions from one interlocutor addressed to another (e.g. (3)) as well as instances where the speaker is describing the emotion of somebody else (e.g. (4)). Overall our data extraction resulted in a total of 17,436 utterances (child: 7,395; parent: 10,041).

(1) *I no like sea*

(2) *don't wanna go*

(3) *don't you wanna try it*

(4) *Sarah doesn't like that either*

As presented in Figure 1, within the context of the corpus data that we analyzed, the overall pattern for children's usage of negative morphemes for rejection is comparable regardless of the particular head verb. With that being said, the amount of average production variability for cases where the head verb is *like* is slightly lower than those when the head verb is *want* (child *like*: 0.017, child *want* 0.04; parent *like*: 0.013, parent *want*: 0.035).

Comparing child and parent speech, it seems that children's production of rejection in terms of the negative utterances investigated here gradually increases from the age of 19 months. And the production moving ratio in child speech becomes comparable to that of parent speech around 36 months.

Non-existence For the function of non-existence, in order to not confuse with the function of labeling (see below), we extracted utterances that have expletives marked by *there* (e.g. (5) and (6)), and that the predicate modified by the negative morphemes is a nominal phrase (headed by either nouns or pronouns). This led to a total of 1,611 utterances (child: 406; parent: 1,205).

(5) *there's no (more) water*

(6) *there isn't it*

In child speech, the production of negative constructions to express non-existence starts to become more regular around 27 months (Figure 2). This is by contrast later than that for the communicative function of rejection presented in Figure 1, an observation that is in opposition to what was initially proposed by Bloom (1970), which proposed that the development of non-existence is earlier than that of rejection. Children's production gradually increases until 36-38 months, approaching the production moving ratio in parent speech around similar age. The amount of production variability in child speech approximates 0.006 (parent: 0.008).

Notice that there appears to be fluctuations of moving ratios between the age of 19 and 27 months regarding 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 value of moving ratio actually decreases.

Prohibition For constructions that articulate the function of prohibition, we focused on cases that are annotated as imperatives from the initial CHILDES annotations. These utterances do not take any subject; 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 overlap with rejection, non-existence, epistemic negation

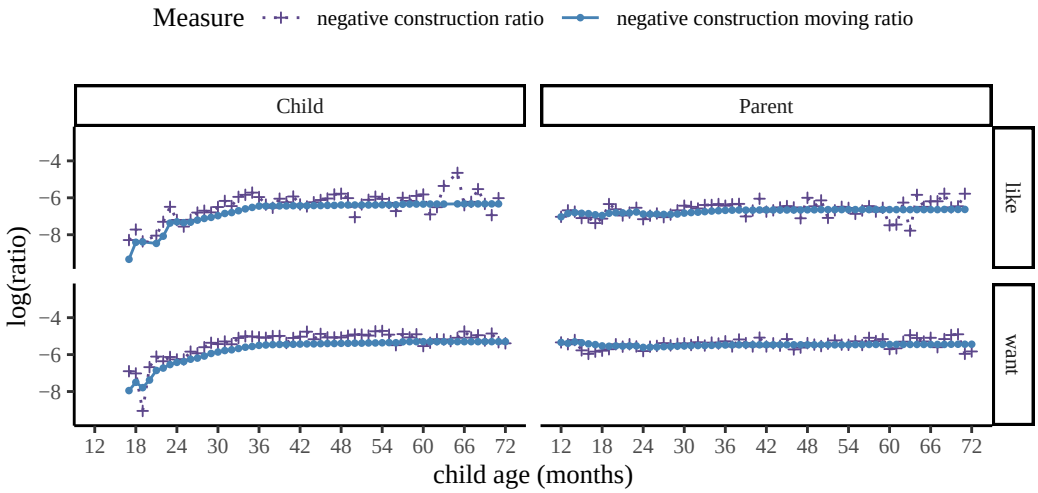

Figure 1: Rejection.

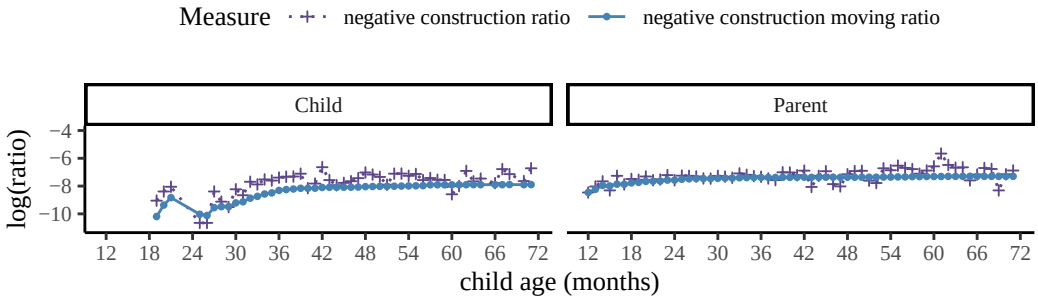

Figure 2: Non-existence.

and possession (see below), our search excluded cases where the head verb has any of the following lemma forms: *like*, *want*, *know*, *think*, *remember*, *have*. This resulted in a total of 938 utterances (child: 267; parent: 671).

After applying our metrics, the amount of production variability for this function approximates 0.005 in child speech (parent: 0.008). Based on Figure 3, children started to more regularly combine negative morphemes for prohibition around the age of 24 months, which is comparable to that of the function of non-existence, but later than that of rejection. This finding contrasts the proposal from (Choi, 1988), which suggested that the development of these three functions starts around similar time. In comparison, the production moving ratio in child speech for prohibition is consistently lower than that in parent speech at any age of the children.

(7) *don't blame Charlotte*

Inability For the function of inability, we analyzed instances where the negative morphemes co-occur with the auxiliary *can* (*can* and *could*; e.g. (8)) and both of them modify the head verbs of the utterances. Again, we filtered out cases where the head verbs are the focus for other functions. Cases without a subject (e.g. *can't play*) or where the subject is not *I* (e.g. *you can't do that*) could yield ambiguous readings when not taking a larger discourse context into account; they could be a rhetorical question or also express the concept of prohibition. Therefore to avoid potential ambiguity, we restricted our analyses only to cases with a subject *I*. This led to a subset of 6,369 utterances (child: 3,237; parent: 3,132).

(8) *I can't see*

As shown in Figure 4, the developmental trajectory of inability is similar to that for rejection; the negative morphemes are applied more regularly starting around the age of 19 months. The amount of production variability in child speech for inability is near 0.026 (parent: 0.016).

On the other hand, the pattern for inability is different from those of non-existence and prohibition; the production trajectories of the latter two both begin at a later age (27 and 24 months, respectively), an observation different from the original argument by Choi (1988), which proposes vice versa.

Labeling To capture the function of labeling, we concentrated on cases where negative morphemes are adopted to indicate the identity (e.g. (9)), and/or characteristics (e.g. (10)) of a predicative nominal. In addition, we also included instances where the negative morphemes are used to modify a predicative adjective (e.g. (11)). Following these criteria, utterances where the negative morpheme is modifying a nom-

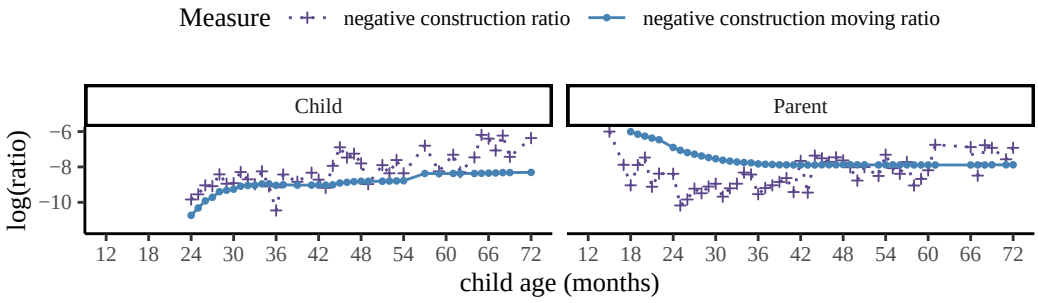

Figure 3: Prohibition.

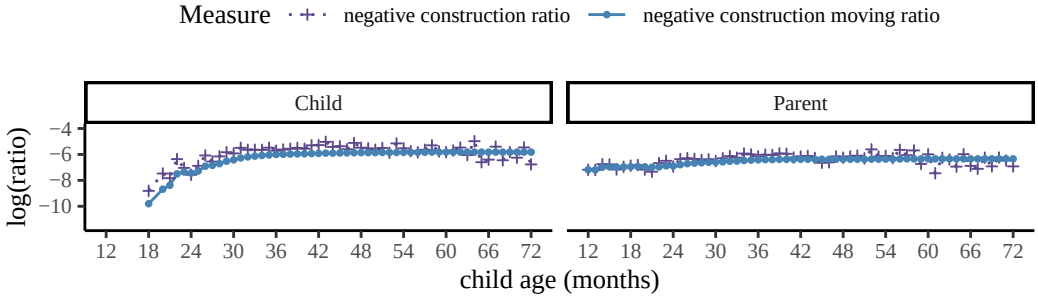

Figure 4: Inability.

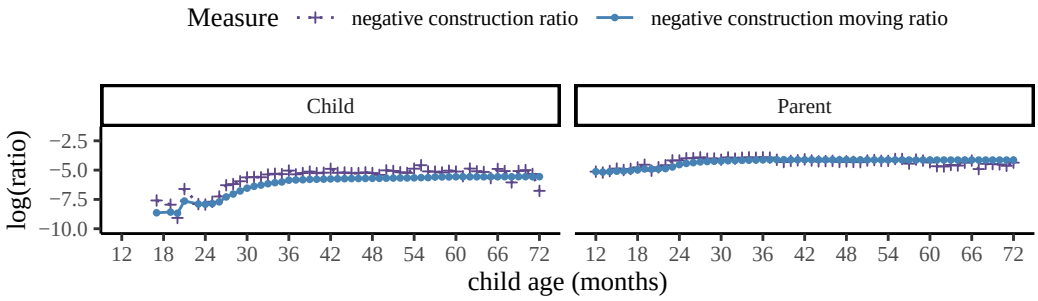

Figure 5: Labeling.

inal or adjectival predicate of a copula verb were extracted. None of the utterances contained expletives (*there is no book*) to distinguish from non-existence. This resulted in a total of 32,474 utterances (Child: 4,180; Parent: 28,294).

(9) *that's not a farmer*

(10) *I'm not a heavy baby Mum*

(11) *It's no good*

Based on results from Figure 5, the developmental trajectory of using the negative morphemes for labeling is comparable to rejection and prohibition. Children started using the negative morphemes more frequently around the age of 19 months, and the amount of production variability on average in child speech is around 0.034 (parent: 0.084).

Epistemic negation The function of epistemic negation was originally discussed by Choi (1988). Although there has been no proposal for negation originating in children's understanding of their own or others' epistemic/mental states, previous studies have reported many instances where the negative morphemes are combined with mental state verbs such as *know*, *think*, and *remember*. Here we focused on these three verbs and analyzed utterances that articulate the concept of unknowing (e.g. (12)) or uncertainty (e.g. (13)). The verbs in these cases are modified by the negative morphemes directly or the combination of negation with auxiliaries. By these search criteria, instances where the speaker inquires about or describes the negative epistemic state of another speaker (e.g. (14)) were also selected, leading to a subset of 21,844 utterances in total (child: 4,074; parent: 17,770).

(12) *I not know* / *I didn't remember*

(13) *I don't think so*

(14) *don't you remember* / *She doesn't know this*

As presented in Figure 6, comparing the developmental trajectories of labeling with different head verbs, the production of negative utterances headed by *know* becomes more regu-

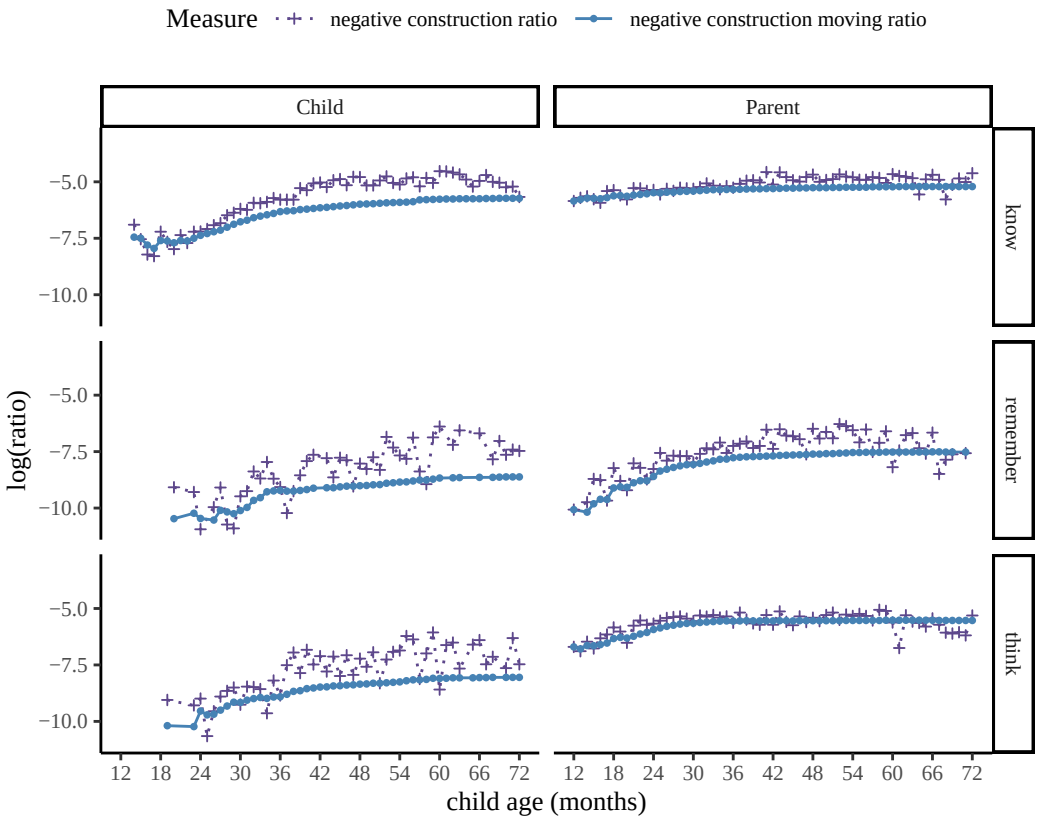

Figure 6: Epistemic negation.

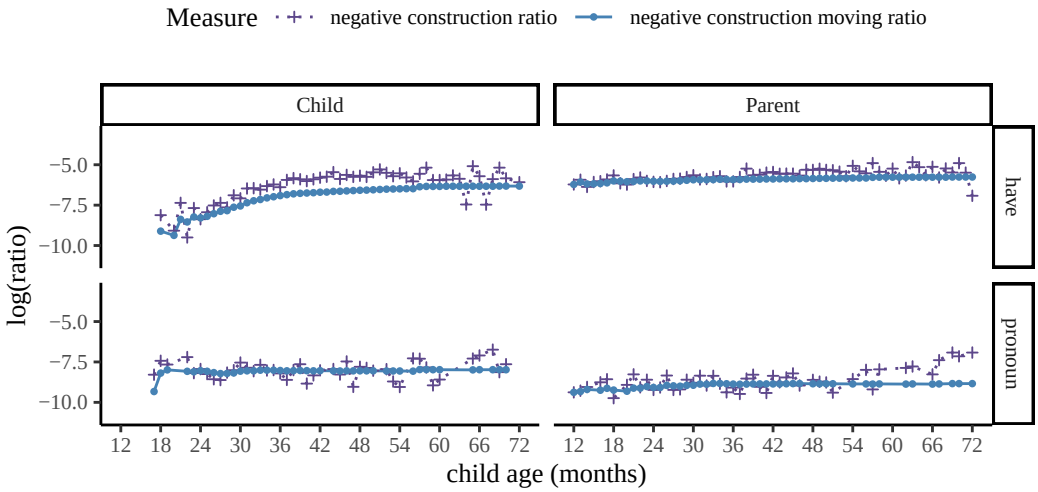

Figure 7: Possession.

lar at an earlier age (17-18 months), whereas the production of cases with *remember* (˜19 months) or *think* (˜20 months) begin slightly later. Overall the production moving ratio of utterances with *know* is also comparatively the highest.

Possession The last function that we investigated includes negative utterances that denote possession. Specifically, we selected cases where the negative morphemes are combined with auxiliary verbs to modify a head verb with the lemma form *have* (e.g. (15)), as well as instances where the negative morphemes are modifying a possessive pronoun (e.g. (16)). To separate from instances of labeling, we excluded cases in which the syntactic head of the negative morphemes is a predicate of a copula verb (e.g. *this is not mine*). The number of utterances that were subjected to analysis for this function is 8,187 (child: 2,331; parent: 5,856).

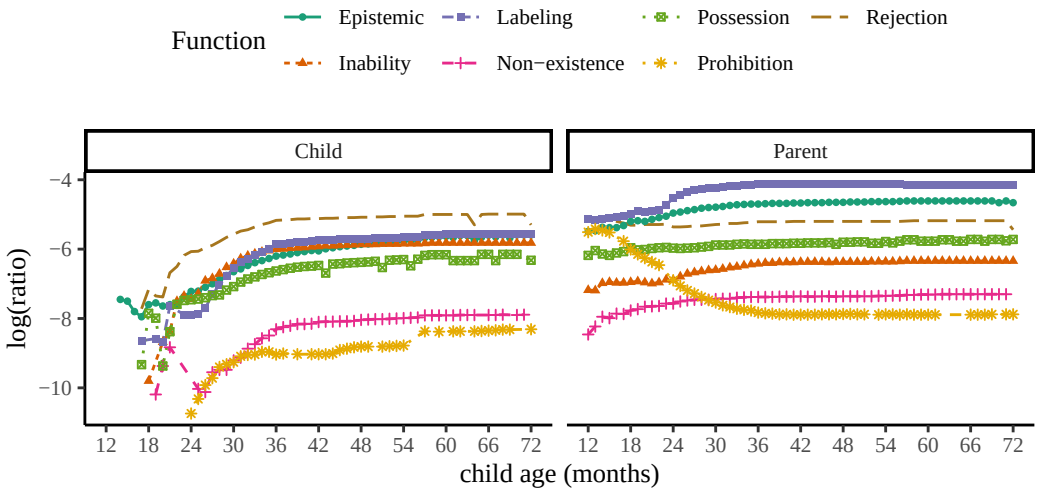

Figure 8: All functions; ratio measured plotted here are moving ratios.

(15) *I don't have it*

(16) *not mine*

The developmental trajectory for this function in child speech has notable differences depending on whether the negative morphemes are modifying a head verb *have* or a pronoun. When they are modifying *have*, as shown in Figure 7, the pattern is comparable to the functions such as rejection and labeling, where children started to combine negative morphemes around the age of 19 months. The amount of production variability for these cases is around 0.02 (parent: 0.03) By contrast, the production for when negation is modifying a pronoun is relatively consistent across the developmental range (child: 0.004; parent: 0.003)

Discussion

With large-scale corpora of child-parent interactions as well as automatic annotations, we presented analyses of negative utterances that rejection, non-existence, prohibition, inability, labeling, epistemic states and possession. Taking an overall look at the developmental trajectories of all functions combined together, shown in Figure 8, it appears that for most of these communicative functions, the usage of negation starts being more regular around the age range of 22-24 months. The production patterns for these functions gradually become stable around the age of 36 months.

It is important to note that similar to prior studies, our conclusions are limited to children's production. While it is possible that patterns in children's production reflect their comprehension and semantic development overall, this is not guaranteed. Systematic experiments testing children's comprehension of negative utterances with different communicative functions are necessary to understand the origin of negation more thoroughly. And the data presented in our experiments could be useful stimuli for experiments as such.

For future work, we would like to explore several directions. First, one limitation of our work here is that to more thoroughly analyze and potentially model the developmental trajectories of child production, certain production-specific factors (e.g. length of utterance, ease of pronunciation) should be taken into account as well, which we plan to incorporate in future work. 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*). This would allow us to compare the production of positive and negative constructions and control for the production trajectory of specific constructions regardless of whether negation is present.

We also intend to focus on individual differences among children given our methods and analyses. Lastly, our experiments thus far have concentrated on multi-word syntactic structures at the utterance level, therefore cases where negations are used as discourse markers in single-word or few-word expressions were excluded. However, discourse markers as responses to previous utterances 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*). Inclusions of negative structures at the discourse level would allow us to paint a more clear picture about the development of negation.

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