1   English Negative Constructions and Communicative Functions in Early Child Language

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10   Abstract

11   How does abstract linguistic negation develop in early child language? Previous research has

12   suggested that abstract negation develops in stages and from more concrete communicative

13   functions such as rejection, prohibition, or non-existence. The evidence for the emergence of

14   these functions in stages is mixed, however, leaving the possibility that negation is an

15   abstract concept from the beginning that can serve multiple specific functions depending on

16   early communicative environment. Leveraging automatic annotations of large-scale child

17   speech corpora in English, we examine the production trajectores of seven negative

18   constructions that tend to convey communicative functions previously discussed in the

19   literature. The results demonstrate the emergence and gradual increase of these

20   constructions in child speech within the age range of 18-36 months. Production mostly

21   remains stable, regular, and close to parents' levels after this age range. These findings are

22   consistent with two hypotheses: first, that negation starts as an abstract concept that can

23   serve multiple functions from the beginning; and second, that negation develops in stages

24   from specific communicative functions but this development is early and quick, leaving our

25   corpus methods incapable of detecting them from the available corpus data.

26   *Keywords:* negation; syntactic construction; communicative function; development;

27   child language.

28   Word count: X

₂₉ English Negative Constructions and Communicative Functions in Early Child Language

₃₀ **Introduction**

₃₁ Negation is an abstract concept that serves different communicative functions in ₃₂ everyday communication. A coffee shop can divide its menu into "coffee" and "not coffee" ₃₃ sections, with "not coffee" bringing together diverse items with no common label like tea and ₃₄ hot chocolate. It could be used in a sign like "no mask, no entry" to regulate people's ₃₅ behaviors. An employee could say "I don't like Mondays" to communicate their desires or ₃₆ dislikes. But how does abstract multi-functional negation emerge and develop in the human ₃₇ mind? Are early stages of negation in child language specific to one or a few functions? Or ₃₈ does negation emerge as an abstract and multifunctional concept from the beginning?

₃₉ Previous literature has proposed that abstract negation develops from less abstract ₄₀ communicative functions in ordered stages (Pea, 1978). For instance, Darwin (1872) ₄₁ hypothesized that the earliest manifestation of negation in infants is when they refuse or ₄₂ reject food from parents by withdrawing their heads laterally. Similarly, Pea (1978) also ₄₃ proposed "rejection" as the first function of negation in child language. By contrast, Bloom ₄₄ (1970) argued that the use of negation to express "non-existence" emerges before "rejection". ₄₅ For example, when an object that children expect to be present is not, children may say: ₄₆ "there is no window". Follow-up study by Choi (1988) argued that "prohibition" emerges as ₄₇ early as rejections and non-existence. In cases of prohibition, children use negation to stop ₄₈ others or themselves from performing actions (e.g. "don't go"). A function similar to ₄₉ prohibition is "inability" (e.g. "I cannot zip it"), in that both involve conceptualizing actions ₅₀ and negating them. Choi (1988) suggested that expressions of inability emerge after the ₅₁ functions in the first phase, namely non-existence, rejection, and prohibition.

₅₂ Despite considerable research on early communicative functions of negation, their ₅₃ developmental trajectories in children's production have remained unclear. Recently,

54 Nordmeyer and Frank (2018) looked at the speech of five children in the Providence corpus

55 (Demuth, Culbertson, & Alter, 2006) and found a great deal of individual variation in how

56 early a negative function is attested. They reported that the developmental trajectory of

57 negation in their study was not as consistent as previously claimed. This leaves the

58 possibility that negation develops as an abstract concept that can serve multiple

59 communicative functions early in the development based on the context of use in parent-child

60 interactions. Therefore, across (a larger number of) children, distinct functions of negation

61 could develop within the same age range and share common production trajectories.

62   However, previous experiments have mainly relied on manual annotations of corpus

63 data to determine the communicative function of a given negative utterance, which in turn

64 has limited their work to only a handful of children per study. Here we aim to go beyond

65 existing work via utilizing a large collection of child speech corpora in English (MacWhinney,

66 2000) along with computational tools to automatically identify negative utterances that tend

67 to convey the communicative functions discussed in prior research (Table 1). In particular,

68 our study investigates three questions: (1) how does the developmental trajectory of the

69 negative constructions for each function look like? (2) for utterances expressing the same

70 function, does the developmental trajectory differ depending on particular lexical items that

71 negation modifies (e.g. *like* or *want* for rejection)? (3) taking all functions into account, do

72 they share similar developmental characteristics, or would there be function-specific

73 differences?

74   Given the automatic fashion of our approach, we focus on larger/longer negative

75 constructions at the single-sentence level. This is in opposition to short negative forms at the

76 discourse-level such as cases consisting of one morpheme (e.g. "no!") or repetition of negative

77 morphemes (e.g. "no no no"), which arguably could express multiple functions when not

78 taking the discourse context into account and accordingly leave more room for ambiguous

79 interpretation. Therefore the negative utterances in our study do not fully cover all negation

instances from the corpora investigated, nor reflect all possible communicative functions that could be played by negation more broadly, but it could provide at least a conservative estimate of the age range during which negation is developed gradually in child production.

Related Work

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 pro 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 pro 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 pro remained unclear. Different studies pro claimed

different order of acquisition (Pea, 1978). In a recent study, Nordmeyer and Frank (2018)

looked at the speech of five children in the Providence corpus (Demuth et al., 2006) and found a great deal of individual differences in how early a negative function is attested. This is partly because previous studies pro 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.

₁₃₆   **Experiments**

₁₃₇ **Data and preprocessing**

₁₃₈   For developmental production data of child speech in English, we turned to the

₁₃₉ CHILDES database (MacWhinney, 2000)[1] and focused on children with typical development

₁₄₀ within the age range of 12 - 72 months. Parents' and children's utterances were extracted via

₁₄₁ the childes-db (Sanchez et al., 2019) interface using the programming language R. Structures

₁₄₂ containing the morphemes *no*, *not* and *n't* were identified as negative. Cases with a single *no*

₁₄₃ or such repetitions (e.g. *no no no*!) were excluded. In order to obtain (morpho)syntactic

₁₄₄ representations for parents' and children's utterances, we used the dependency grammar

₁₄₅ framework (Tesnière, 1959). Dependency relations for all negative utterances were

₁₄₆ automatically derived with DiaParser (Attardi, Sartiano, & Yu, n.d.), a dependency parsing

₁₄₇ system that has been demonstrated to achieve excellent performance for English. To

₁₄₈ facilitate identification of negative constructions, we also utilized the available part-of-speech

₁₄₉ (POS) information initially provided by CHILDES (Sagae, Davis, Lavie, MacWhinney, &

₁₅₀ Wintner, 2010) when necessary.

₁₅₁   In this study, we consider seven communicative functions of negation shown in Table 1.

₁₅₂ For each function, using our parsed data set, we characterized the syntactic features of the

₁₅₃ negative construction associated with it. Based on these features, negative utterances were

₁₅₄ automatically extracted in a rule-based fashion with the help of POS information and

₁₅₅ syntactic dependencies.

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

Measures

As indexes of the developmental trajectory for negative constructions and their communicative functions in child speech, we measured the following two metrics at each given age of the children. The first one is the *ratio* of negative utterances. For instance, the number of utterances produced by children at the age of 30 months (not just all negative constructions at this age) is 52,491 in total. Among these utterances, negative structures that have the function of inability occur for 141 times; the ratio for this communicative function at 30 months is then calculated as 141 / 52,491 = 0.003.

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, another 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 negative 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 two ratio measures were calculated for parent speech in a similar fashion. Our plots accordingly

181 contrast the ratio / moving ratio of different negative constructions between children's and

182 parents' production at corresponding ages of the children.

183   In what follows, we describe in detail the results of each communicative function and

184 their negative constructions. While we computed both ratio and moving ratio for every

185 function, our analyses mainly rely on the latter.

Communicative functions of negative constructions and their positive counterparts

188   **Rejection.**   For the function of rejection, we examined cases where the lemma of the

189 head verb of the phrase is either *like* or *want*, and the head verb is modified by one of the

190 three negative morphemes. Other than expressions that the speakers used to describe their

191 own desires with (e.g. (1)) or without (e.g. (2)) an auxiliary verb, we also included cases that

192 express rhetorical inquiries of desires from one interlocutor addressed to another (e.g. (3)),

193 and instances where the speaker is describing the desires of somebody else (e.g. (4)). This

194 resulted in a total of 143,165 negative utterances (child: 53,948; parent: 89,217).

195   (1) *I no like sea*

196   (2) *don't wanna go*

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

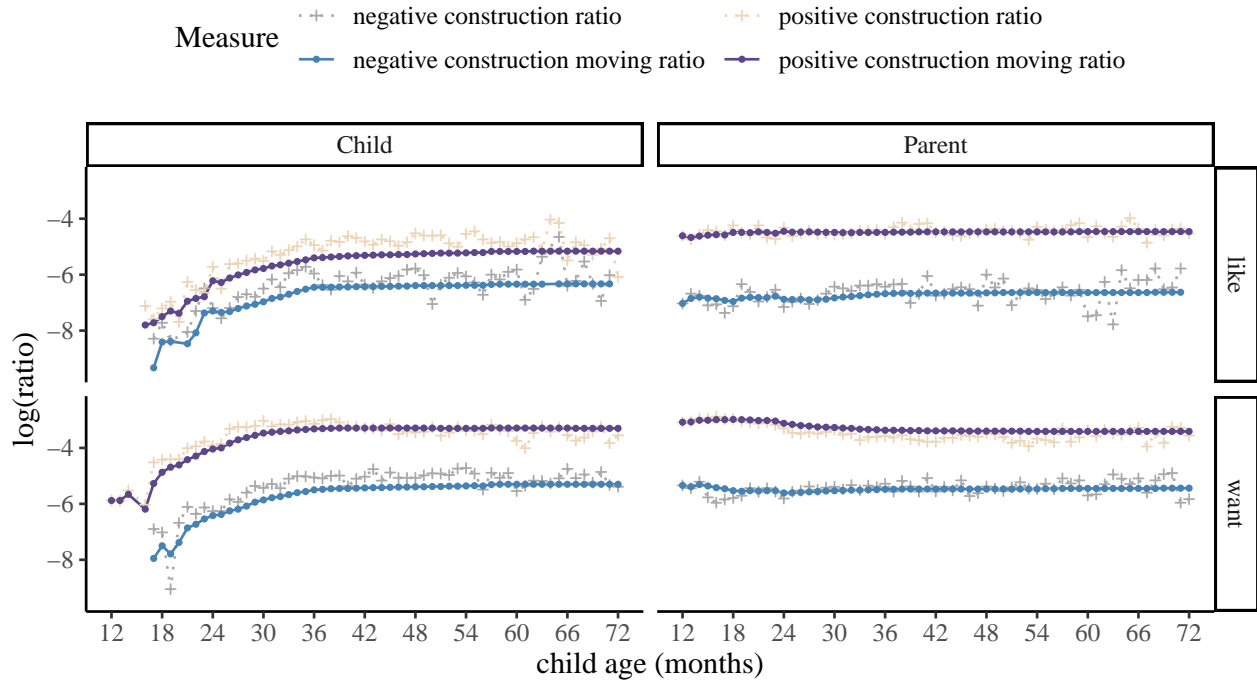198   (4) *Sarah doesn't like that either*

Figure 1. Rejection and its positive counterparts

As presented in Figure 1, the overall pattern for children's usage of negative morphemes for rejection is comparable regardless of the particular head verb. Comparing child and parent speech, it seems that children's production of rejection is gradually increasing between the age of 18 to 36 months. And the production moving ratio in child speech appears to be more comparable to that of parent speech after 32-34 months.

For both negative and positive:

Model: Production ratio ~ Age + MLU + Parent_negative_ratio + Parent_Positive_ratio + Parent_negative_MLU + Parent_positive_MLU

Table 1

Estimating Production Ratio of Rejection in Child Speech, when head verb is like

Predictor	B	SE	t	p
Intercept	-30.77	5.797	-5.31	<0.001
Age	0.01	0.002	3.55	<0.001
MLU	-0.51	0.113	-4.52	<0.001
log(Parent_negative_ratio)	4.50	0.403	11.17	<0.001
log(Parent_positive_ratio)	-10.53	1.159	-9.08	<0.001
Parent_negative_MLU	-1.02	0.220	-4.63	<0.001
Parent_positive_MLU	2.36	0.128	18.42	<0.001

Table 2

Estimating Production Ratio of Positive Counterparts for Rejection in Child Speech, when head verb is like

Predictor	B	SE	t	p
Intercept	-52.05	5.901	-8.82	<0.001
Age	0.00	0.003	0.46	0.645
MLU	0.55	0.099	5.54	<0.001
log(Parent_negative_ratio)	0.97	0.416	2.33	0.024
log(Parent_positive_ratio)	-9.86	1.136	-8.68	<0.001
Parent_negative_MLU	-1.07	0.222	-4.81	<0.001
Parent_positive_MLU	1.91	0.123	15.51	<0.001

Table 3

Estimating Production Ratio of Rejection in Child Speech, when head verb is want

Predictor	B	SE	t	p
Intercept	14.90	4.954	3.01	0.004
Age	-0.01	0.003	-1.73	0.090
MLU	-0.36	0.043	-8.45	<0.001
log(Parent_negative_ratio)	4.55	0.650	7.01	<0.001
log(Parent_positive_ratio)	2.80	0.960	2.92	0.005
Parent_negative_MLU	-1.73	0.337	-5.12	<0.001
Parent_positive_MLU	4.27	0.474	9.01	<0.001

Table 4

Estimating Production Ratio of Positive Counterparts for Rejection in Child Speech, when head verb is want

Predictor	B	SE	t	p
Intercept	-21.50	7.946	-2.71	0.009
Age	-0.01	0.005	-2.67	0.010
MLU	-0.02	0.028	-0.60	0.549
log(Parent_negative_ratio)	-0.82	0.963	-0.85	0.399
log(Parent_positive_ratio)	0.63	1.400	0.45	0.652
Parent_negative_MLU	-0.20	0.678	-0.30	0.766
Parent_positive_MLU	2.39	0.703	3.40	0.001

207   **Non-existence.**   For the function of non-existence, we extracted utterances that

208 have expletives marked by *there* (e.g. (5) and (6)), and that the predicate modified by the

209 negative morphemes is a nominal phrase (headed by either nouns or pronouns). This led to a

210 total of 30,609 negative utterances (child: 6,639; parent: 23,970).

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

212   (6) *there isn't it*

213   In child speech, the production of negative constructions to express non-existence is

214 gradually increasing from 25 to 36 months (Figure 2), which is by contrast later than that

215 for the communicative function of rejection presented in Figure 1. This observation does not

216 seem to align with Bloom (1970), which initially proposed that the development of

217 non-existence is earlier than that of rejection. On the other hand, children's production

218 moving ratio gradually approaches that in parent speech at 36-38 months.

219   Notice that there appears to be fluctuations of moving ratios between the age of 19 and

220 25 months regarding child production. A closer inspection of the data reveals that within

221 that age range, the frequency of negative utterances at most ages is either one or zero.

222 Therefore while the number of total utterances increases along the developmental trajectory,

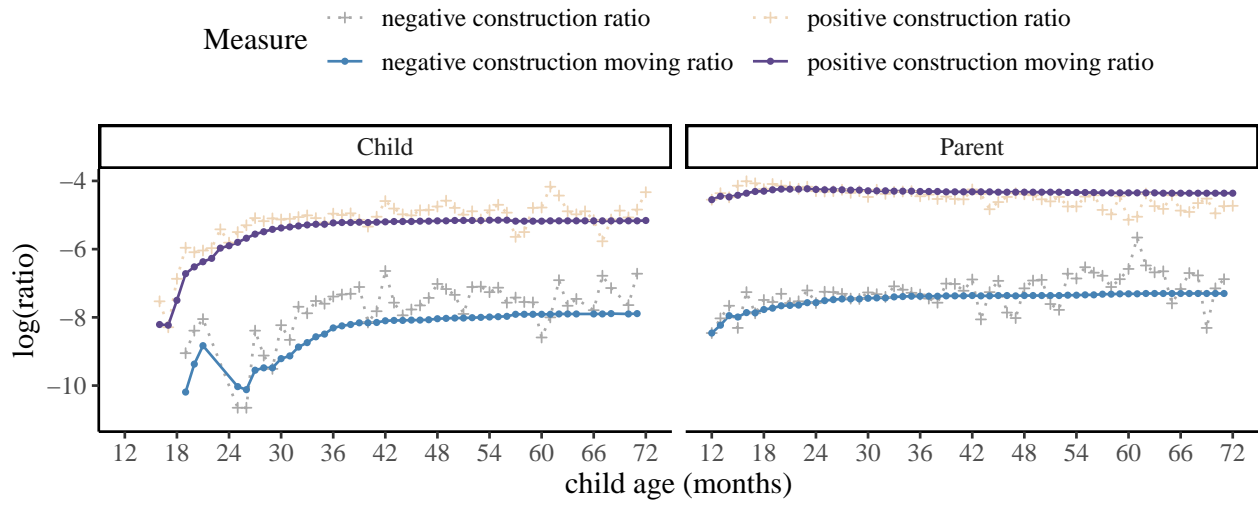223 the moving ratio for negative utterances actually decreases.

Figure 2. Non-existence and its positive counterparts

Table 5

Estimating Production Ratio of Non-existence in Child Speech

Predictor	B	SE	t	p
Intercept	-162.14	53.399	-3.04	0.004
Age	-0.02	0.012	-1.53	0.133
MLU	-0.25	0.399	-0.62	0.538
log(Parent_negative_ratio)	1.34	3.943	0.34	0.735
log(Parent_positive_ratio)	-41.24	14.917	-2.76	0.008
Parent_negative_MLU	-1.16	0.695	-1.67	0.102
Parent_positive_MLU	-0.33	1.659	-0.20	0.841

Table 6

Estimating Production Ratio of Positive Counterparts for Non-existence in Child Speech

Predictor	B	SE	t	p
Intercept	45.48	5.023	9.05	<0.001
Age	-0.01	0.003	-3.10	0.003
MLU	0.05	0.122	0.37	0.712
log(Parent_negative_ratio)	3.72	0.559	6.66	<0.001
log(Parent_positive_ratio)	7.20	1.151	6.26	<0.001
Parent_negative_MLU	-0.04	0.126	-0.29	0.773
Parent_positive_MLU	1.08	0.248	4.34	<0.001

²²⁴   **Prohibition.**   For constructions that articulate the function of prohibition, we

²²⁵ focused on cases that are annotated as imperatives from the initial CHILDES annotations.

²²⁶ These utterances do not take any subject; the negative morphemes are combined with the

²²⁷ auxiliary verb *do* (*do*, *does*, *did*) and they together modify the head verbs of the sentences.

²²⁸ In order to not overlap with rejection, non-existence, epistemic negation and possession (see

²²⁹ below), our search excluded cases where the head verb has any of the following lemma forms:

²³⁰ *like, want, know, think, remember, have.* This resulted in a total of 18,586 negative

²³¹ utterances (child: 6,431; parent: 12,155).

²³² Based on Figure 3, children are combining negative morphemes for prohibition more

²³³ and more regularly between 24-36 months, which is comparable to that of the function of

²³⁴ non-existence, but slightly later than that of rejection. In comparison, the production

²³⁵ moving ratio in child speech for prohibition is consistently lower than that in parent speech

²³⁶ at any age of the children.
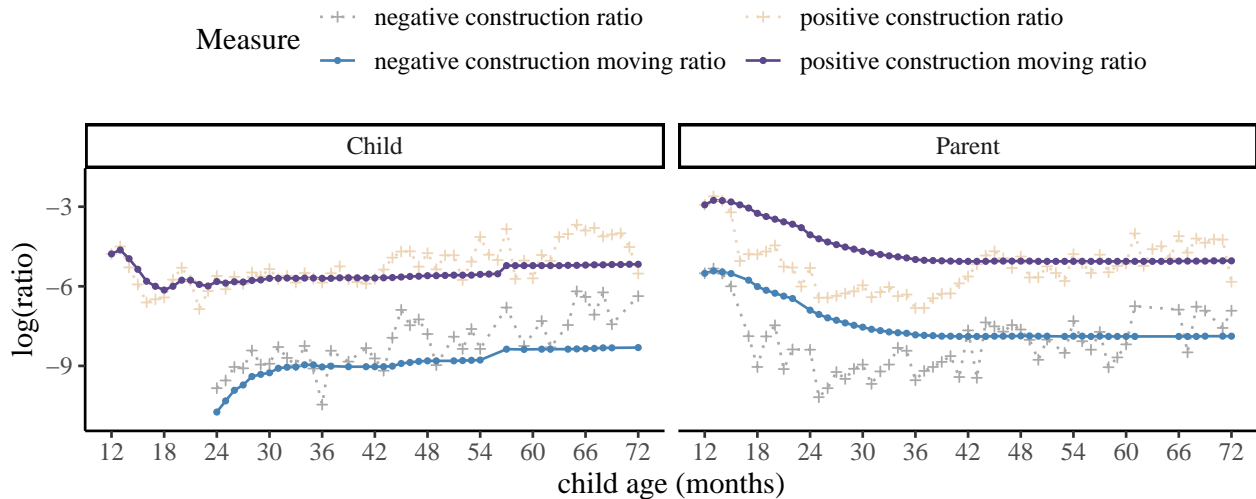
²³⁷   (7) *don't blame Charlotte*

Figure 3. Prohibition and its positive counterparts

Table 7

Estimating Production Ratio of Prohibition in Child Speech

Predictor	B	SE	t	p
Intercept	-43.00	7.989	-5.38	<0.001
Age	0.01	0.005	1.63	0.115
MLU	-0.58	0.134	-4.32	<0.001
log(Parent_negative_ratio)	-7.24	1.621	-4.47	<0.001
log(Parent_positive_ratio)	5.57	1.646	3.39	0.002
Parent_negative_MLU	-1.82	0.791	-2.29	0.029
Parent_positive_MLU	3.55	0.882	4.03	<0.001

Table 8

Estimating Production Ratio of Positive Counterparts for Prohibition in Child Speech

Predictor	B	SE	t	p
Intercept	5.63	7.189	0.78	0.438
Age	0.00	0.008	-0.24	0.809
MLU	0.47	0.157	2.98	0.005
log(Parent_negative_ratio)	3.87	0.961	4.02	<0.001
log(Parent_positive_ratio)	-3.10	1.041	-2.97	0.005
Parent_negative_MLU	-1.61	1.241	-1.30	0.202
Parent_positive_MLU	2.08	1.280	1.62	0.112

238   **Inability.**   For the function of inability, we analyzed instances where the negative

239 morphemes co-occur with the auxiliary *can* (*can* and *could*; e.g. (8)) and both of them

240 modify the head verbs of the utterances. Again, we filtered out cases where the head verbs

241 are the focus for other functions. Cases without a subject (e.g. "can't play") or where the

242 subject is not *I* (e.g. "you can't do that") could yield ambiguous readings when not looking

243 at a larger discourse context; they could be a rhetorical question or also express the concept

244 of prohibition. Therefore to potentially avoid less ambiguity, we restricted our analyses only

245 to cases with a subject *I*. This led to 110,879 negative utterances (child: 61,300; parent:

246 49,579).

247   (8) *I can't see*

248   As shown in Figure 4, the developmental trajectory of inability is similar to that of

249 rejection. Negation is applied more and more regularly between 18-36 months. By contrast,

250 it is different from those of non-existence and prohibition. It seems that the production

251 trajectories of the latter two are both becoming more regular at a later age (25 and 24
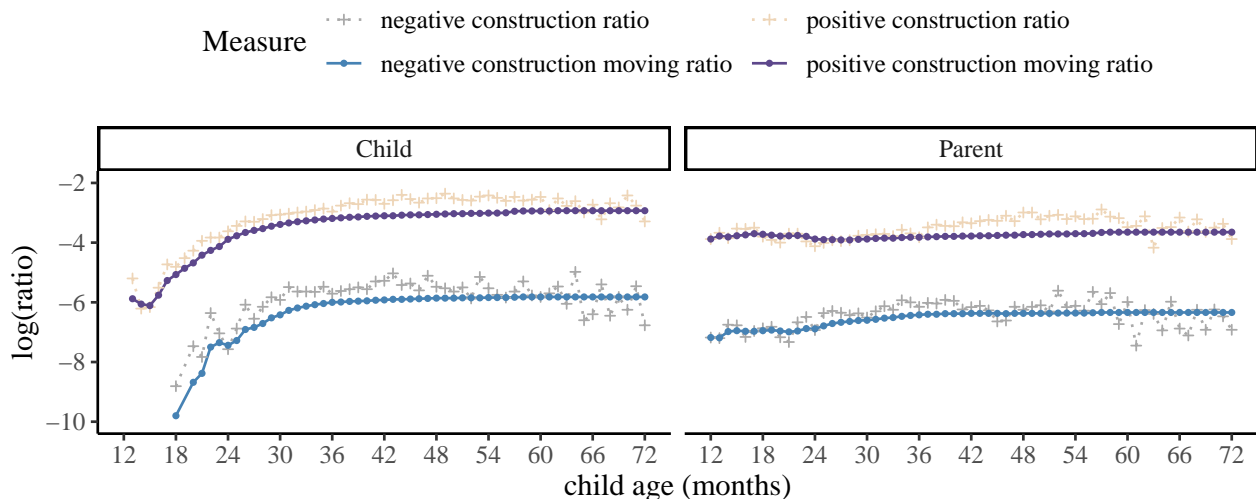
252 months, respectively).

Figure 4. Inability and its positive counterparts

Table 9

Estimating Production Ratio of Inability in Child Speech

Predictor	B	SE	t	p
Intercept	-4.20	4.644	-0.90	0.371
Age	0.00	0.008	-0.22	0.824
MLU	1.28	0.162	7.88	<0.001
log(Parent_negative_ratio)	2.46	0.269	9.15	<0.001
log(Parent_positive_ratio)	-1.96	0.641	-3.06	0.004
Parent_negative_MLU	0.35	0.401	0.87	0.390
Parent_positive_MLU	-0.50	0.539	-0.92	0.362

Table 10

Estimating Production Ratio of Positive Counterparts for Inability in Child Speech

Predictor	B	SE	t	p
Intercept	-2.74	3.435	-0.80	0.428
Age	0.01	0.004	1.69	0.097
MLU	-0.14	0.037	-3.74	<0.001
log(Parent_negative_ratio)	1.96	0.204	9.65	<0.001
log(Parent_positive_ratio)	-2.02	0.402	-5.02	<0.001
Parent_negative_MLU	-0.42	0.184	-2.26	0.028
Parent_positive_MLU	1.03	0.102	10.04	<0.001

253   **Labeling.**   To capture the function of labeling, we concentrated on cases where

254   negative morphemes indicate the identity (e.g. (9)), and/or characteristics (e.g. (10)) of a

255   predicative nominal. We also included instances where negation is used to modify a

256   predicative adjective (e.g. (11)). Utterances where negative morphemes modify a nominal or

257   adjectival predicate of a copula verb were extracted. None of the utterances contained

258   expletives (e.g. "there is no book") to distinguish from non-existence. This resulted in a total

259   of 377,128 negative utterances (Child: 88,552; Parent: 288,576).

260   (9) *that's not a farmer*

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

262   (11) *It's no good*

263   Based on Figure 5, the developmental pattern for labeling is comparable to

264   non-existence and prohibition; children are increasing their use of the negative morphemes

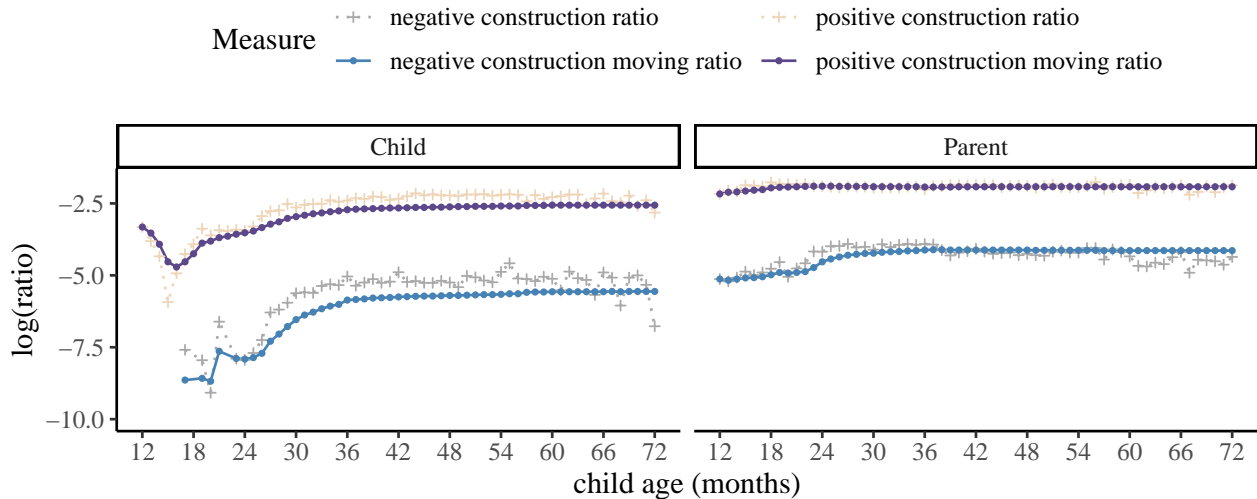265   around the age range of of 22-36 months.

Figure 5. Labeling and its positive counterparts

Table 11

Estimating Production Ratio of Learning in Child Speech

Predictor	B	SE	t	p
Intercept	-37.24	10.643	-3.50	0.001
Age	-0.01	0.009	-0.82	0.418
MLU	1.15	0.185	6.21	<0.001
log(Parent_negative_ratio)	3.78	0.813	4.65	<0.001
log(Parent_positive_ratio)	-20.02	3.266	-6.13	<0.001
Parent_negative_MLU	0.06	0.816	0.08	0.940
Parent_positive_MLU	0.20	0.872	0.23	0.822

Table 12

Estimating Production Ratio of Positive Counterparts for Learning in Child Speech

Predictor	B	SE	t	p
Intercept	7.47	5.347	1.40	0.168
Age	-0.01	0.005	-2.00	0.051
MLU	1.48	0.217	6.78	<0.001
log(Parent_negative_ratio)	1.12	0.275	4.08	<0.001
log(Parent_positive_ratio)	3.14	1.170	2.68	0.010
Parent_negative_MLU	-0.11	0.439	-0.24	0.812
Parent_positive_MLU	-0.86	0.447	-1.92	0.060

266 **Epistemic Negation.**   Previous studies have reported instances where negative

267 morphemes are combined with mental/epistemic state verbs such as *know*, *think*, and

268 *remember* in child speech to express epistemic negation. Here we focused on these three

269 verbs and analyzed negative utterances that articulate the concept of not knowing (e.g. (12))

270 or uncertainty (e.g. (13)). The verbs in these cases are modified by the negative morphemes

271 directly or by the combination of negation with auxiliaries. Instances where the speaker asks

272 about or describes the negative epistemic state of another speaker (e.g. (14)) were also

273 selected, leading to 109,325 negative utterances in total (child: 18,581; parent: 90,744).

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

275   (13) *I don't think so*

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

277 Based on the data analyzed here (Figure 6), the production of negative utterances

278 headed by *know* are becoming more regular at an earlier age (17-18 months) compared to

279 that of *remember* (~19 months) or *think* (~20 months). Overall the production moving ratio

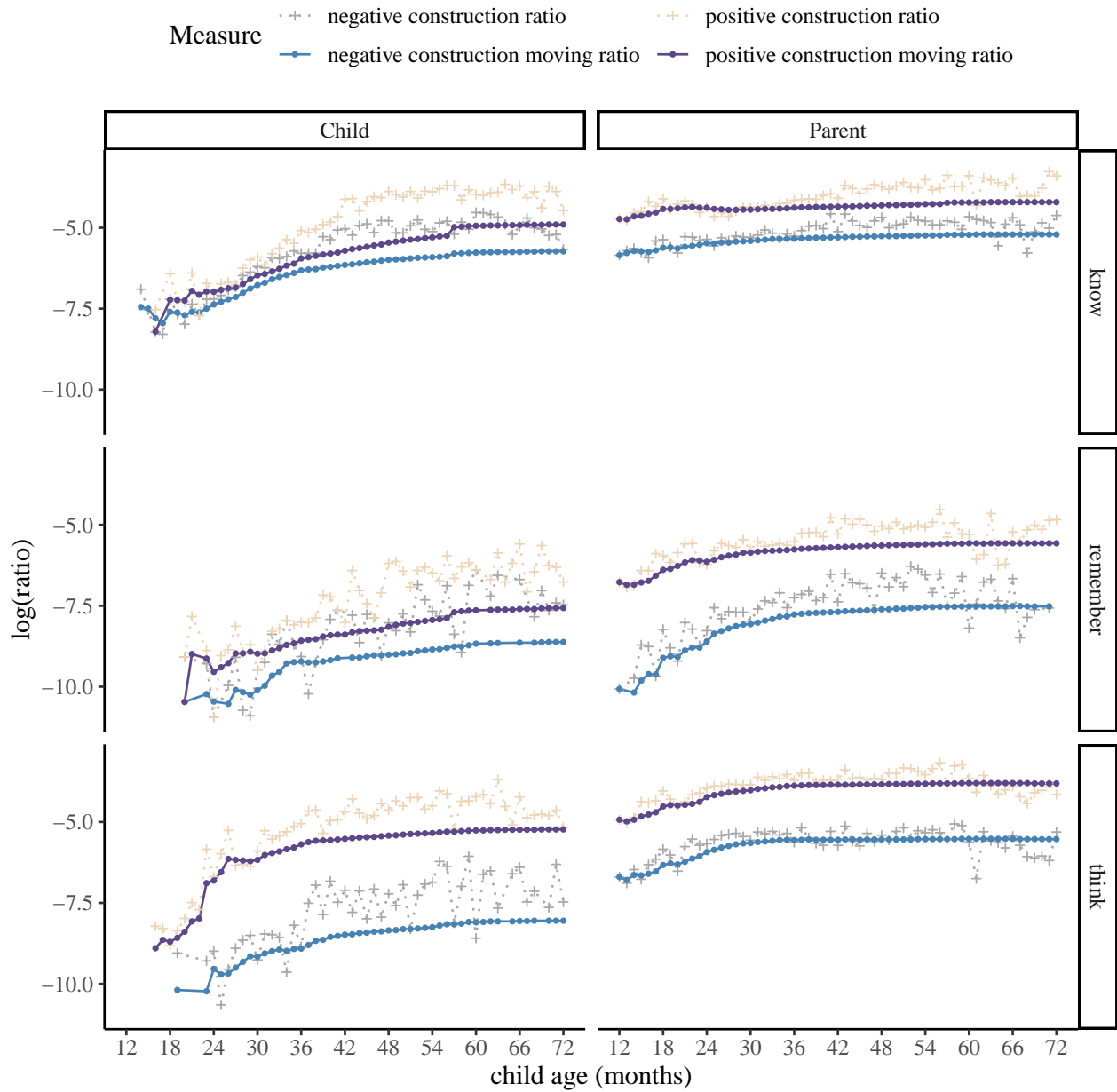280 of utterances with *know* is comparatively the highest.

Figure 6. Epistemic negation and its positive counterparts

Table 13

Estimating Production Ratio of Epistemic Negation in Child Speech, when head verb is know

Predictor	B	SE	t	p
Intercept	22.27	2.160	10.31	<0.001
Age	0.00	0.002	2.06	0.044
MLU	0.02	0.031	0.53	0.598
log(Parent_negative_ratio)	3.97	0.401	9.90	<0.001
log(Parent_positive_ratio)	0.62	0.357	1.72	0.091
Parent_negative_MLU	-0.12	0.151	-0.81	0.419
Parent_positive_MLU	-0.45	0.108	-4.13	<0.001

Table 14

Estimating Production Ratio of Positive Counterparts for Epistemic Negation in Child Speech, when head verb is know

Predictor	B	SE	t	p
Intercept	28.95	2.986	9.70	<0.001
Age	0.00	0.002	1.25	0.216
MLU	0.11	0.039	2.91	0.005
log(Parent_negative_ratio)	4.03	0.504	8.00	<0.001
log(Parent_positive_ratio)	2.78	0.398	6.98	<0.001
Parent_negative_MLU	0.11	0.184	0.57	0.569
Parent_positive_MLU	-0.34	0.143	-2.40	0.020

Table 15

Estimating Production Ratio of Epistemic Negation in Child Speech, when head verb is remember

Predictor	B	SE	t	p
Intercept	27.11	8.811	3.08	0.004
Age	0.02	0.005	3.85	<0.001
MLU	0.11	0.080	1.40	0.169
log(Parent_negative_ratio)	-3.51	1.207	-2.91	0.006
log(Parent_positive_ratio)	8.79	1.879	4.68	<0.001
Parent_negative_MLU	-1.17	0.298	-3.93	<0.001
Parent_positive_MLU	-0.63	0.407	-1.55	0.130

Table 16

Estimating Production Ratio of Positive Counterparts for Epistemic Negation in Child

Speech, when head verb is remember

Predictor	B	SE	t	p
Intercept	0.57	7.728	0.07	0.941
Age	0.00	0.005	0.72	0.474
MLU	0.21	0.073	2.89	0.006
log(Parent_negative_ratio)	1.24	0.825	1.50	0.142
log(Parent_positive_ratio)	0.67	1.118	0.60	0.554
Parent_negative_MLU	0.53	0.203	2.61	0.013
Parent_positive_MLU	-0.15	0.351	-0.42	0.675

Table 17

Estimating Production Ratio of Epistemic Negation in Child Speech, when head verb is think

Predictor	B	SE	t	p
Intercept	-12.07	3.255	-3.71	<0.001
Age	0.01	0.003	3.65	<0.001
MLU	0.13	0.052	2.44	0.019
log(Parent_negative_ratio)	-0.69	0.815	-0.84	0.403
log(Parent_positive_ratio)	2.95	1.058	2.79	0.008
Parent_negative_MLU	1.78	0.670	2.65	0.011
Parent_positive_MLU	-0.87	0.640	-1.35	0.183

Table 18

Estimating Production Ratio of Positive Counterparts for Epistemic Negation in Child Speech, when head verb is think

Predictor	B	SE	t	p
Intercept	29.18	2.103	13.87	<0.001
Age	0.01	0.002	5.03	<0.001
MLU	0.53	0.047	11.27	<0.001
log(Parent_negative_ratio)	-0.01	0.483	-0.01	0.989
log(Parent_positive_ratio)	2.43	0.520	4.66	<0.001
Parent_negative_MLU	-2.53	0.267	-9.48	<0.001
Parent_positive_MLU	-0.44	0.068	-6.53	<0.001

Possession.   The last function we explored is possession. 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)). We also included individual noun phrases with possessive
pronouns as heads and modified by negative morphemes (e.g. (16)). 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 66,783 (child: 19,097; parent:
47,686).

(15) *I don't have it*

(16) *not mine*

Given Figure 7, the developmental trajectory for possession in child speech appears to
have notable differences depending on what the negative morphemes are modifying. When
their syntactic head is *have*, the pattern is comparable to those of "rejection" and "labeling",
where children are increasing their combination of negative morphemes from 18 to 36
months. However, the production moving ratio for utterances headed by possessive pronouns
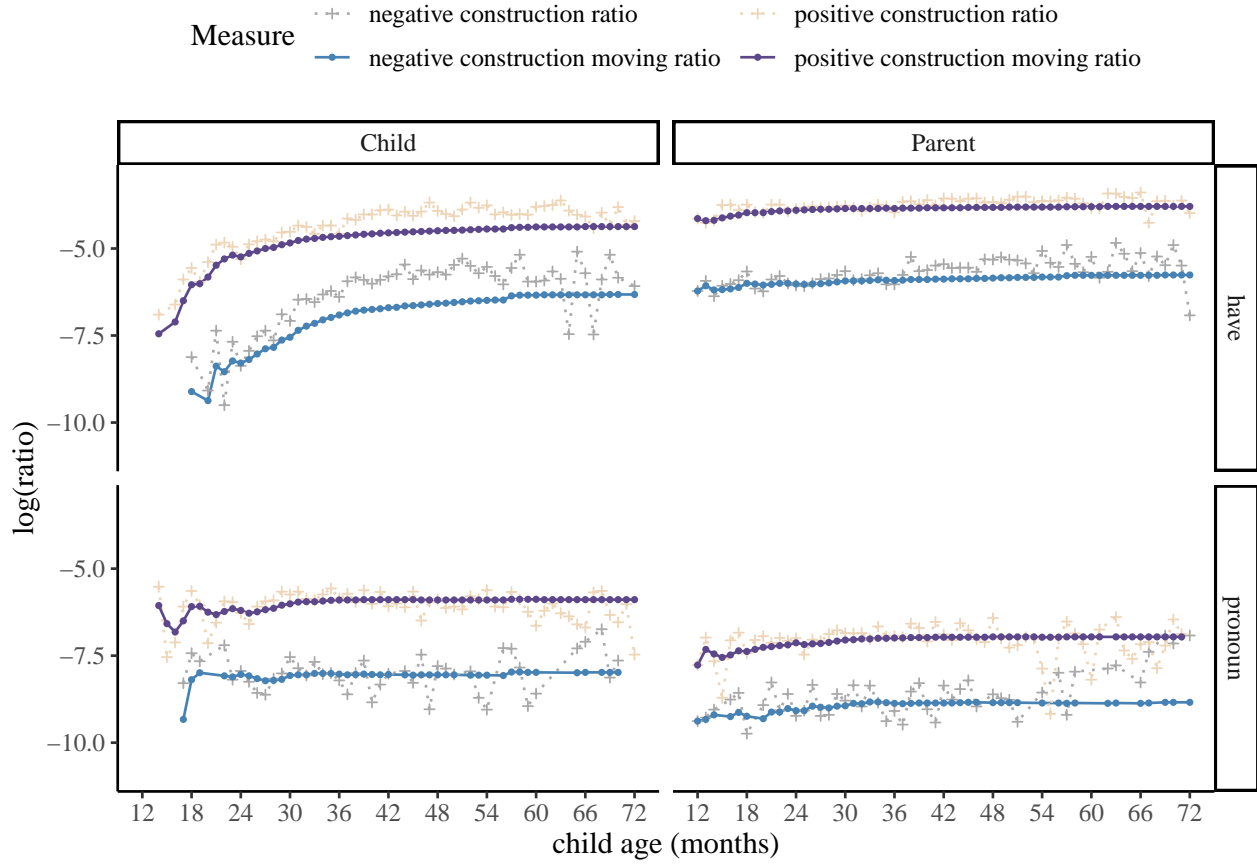seems to be relatively stable across different ages.

Figure 7. Possession and its positive counterparts

Table 19

Estimating Production Ratio of Posession in Child Speech, when head verb is have

Predictor	B	SE	t	p
Intercept	38.51	18.126	2.12	0.039
Age	0.00	0.005	0.69	0.496
MLU	-0.15	0.066	-2.26	0.029
log(Parent_negative_ratio)	5.42	1.358	3.99	<0.001
log(Parent_positive_ratio)	0.62	5.332	0.12	0.907
Parent_negative_MLU	-2.35	0.305	-7.70	<0.001
Parent_positive_MLU	1.53	0.470	3.26	0.002

Table 20

Estimating Production Ratio of Positive Counterparts for Posession in Child Speech, when head verb is have

Predictor	B	SE	t	p
Intercept	55.54	5.195	10.69	<0.001
Age	0.00	0.002	-0.94	0.351
MLU	0.13	0.060	2.24	0.030
log(Parent_negative_ratio)	-1.10	0.576	-1.90	0.063
log(Parent_positive_ratio)	14.14	1.014	13.94	<0.001
Parent_negative_MLU	-1.02	0.151	-6.76	<0.001
Parent_positive_MLU	-0.35	0.126	-2.77	0.008

Table 21

Estimating Production Ratio of Posession in Child Speech, when syntactic head is pronoun

Predictor	B	SE	t	p
Intercept	-29.61	4.201	-7.05	<0.001
Age	0.00	0.002	-1.33	0.194
MLU	0.34	0.113	2.98	0.006
log(Parent_negative_ratio)	-0.66	0.503	-1.32	0.197
log(Parent_positive_ratio)	-2.29	0.818	-2.80	0.009
Parent_negative_MLU	-1.42	0.208	-6.85	<0.001
Parent_positive_MLU	1.51	0.196	7.69	<0.001

Table 22

Estimating Production Ratio of Positive Counterparts for Posession in Child Speech, when syntactic head is pronoun

Predictor	B	SE	t	p
Intercept	-15.69	6.861	-2.29	0.028
Age	0.00	0.002	-1.77	0.085
MLU	0.98	0.309	3.16	0.003
log(Parent_negative_ratio)	-0.40	0.385	-1.05	0.301
log(Parent_positive_ratio)	-0.62	0.844	-0.73	0.468
Parent_negative_MLU	-0.20	0.213	-0.93	0.359
Parent_positive_MLU	-0.11	0.200	-0.54	0.593

297 **An overall look.**

298 <div align="center">**Discussion**</div>

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

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

317 Lastly, our experiments have concentrated on larger syntactic structures at the
318 utterance level, hence cases where negation is used as discourse markers to respond to
319 previous utterance(s) were excluded. However, these instances also have important semantic
320 and conceptual roles in the communication between children and parents (e.g. parent: *do*

321 *you want some bread?*; child: *no no no*). Thus inclusions of negative structures at a more

322 comprehensive level would be able to paint a more clear picture about the development of

323 negation.

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Function	Linguistic Composition	Examples
Rejection	with *like* or *want*	*I not like it, not want it*
Non-existence	expletives	*there is no soup*
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 23

Communicative functions of negation in early child language of English.