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

80 instances from the corpora investigated, nor reflect all possible communicative functions that

81 could be played by negation more broadly, but it could provide at least a conservative

82 estimate of the age range during which negation is developed gradually in child production.

Related Work

84 Starting a century and a half ago, Darwin (1872) thought that negation has roots in

85 the expression of human emotions and desires. He hypothesized the earliest manifestation of

86 negation and affirmation in infants is when they refuse food from parents, by withdrawing

87 their heads laterally, or when they accept the food, by inclining their heads forward. He

88 suggested that head shaking and nodding as common gestures for negation and affirmation

89 pro developed from this early habit. Similarly, many researchers studying early functions of

90 negative morphemes like *no* proposed that children use them to "reject" or "refuse" (Bloom,

91 1970; Choi, 1988; Pea, 1978). For example, when they are asked "do you want juice?" they

92 may say "no," "not want it," or "don't like it." Pea (1978) proposed this negation function is

93 the first to emerge in children's early speech.

94 Bloom (1970) argued that the use of negation to expresses "non-existence" emerges

95 before rejection or refusal. For example, when an object that children expect to be present is

96 not present, children may say: "no window," "no fish in the bathroom," or "I do not pro

97 underpants." Two close concepts to non-existence are "disappearance" and "non-occurrence"

98 (Pea, 1978; Villiers & Villiers, 1979). Disappearance refers to situations where an object

99 disappears and children use negation to express it (e.g. "no food. all gone" or "no more

100 noise"). Non-occurrence refers to cases when an expected action or event does not occur as

101 in "not working" or "doggie not barking." Some researchers referred to these cases as

102 "failures" and included examples like "no fit in da box" or "it don't fit" (Cameron-Faulkner,

103 Lieven, & Theakston, 2007; Choi, 1988). Non-existence can also be expressed by negation of

104 locative prepositional phrases (e.g. "no in there" or "daddy was not on the phone"). While

105 rejection was hypothesized to interact with human emotions and desires, non-existence

106 (broadly construed to include "disappearance" and "non-occurrence") likely interacts with

107 human perception. Choi (1988) proposed that children's early linguistic negation is used to

108 express both rejection and non-existence.

109   Additionally, Choi (1988) introduced "prohibition" and suggested that it emerges as

110 early as rejection and non-existence. In cases of prohibition, children use negation to stop

111 others from performing actions; for example "don't go" or "do not spill milk." A special case

112 of prohibition is "self-prohibition." For example, a child may approach prohibited food but

113 immediately say "no, don't eat" to stop themselves. A function similar to prohibition is

114 "inability" (e.g. *I can't reach / I cannot zip it*), in that both involve conceptualizing actions

115 and negating them, possibly interacting with early development of motor control. Choi

116 (1988) suggested that expression of inability emerges after the first phase, namely

117 non-existence, rejection, and prohibition.

118   "Denial" is another function of negation that is argued to be late in development.

119 Bloom (1970) defined it as asserting that "an actual or supposed predication was not the

120 case," for example "It's not sharp." Later researchers formulated it as "truth-functional

121 negation" because it is used to negate the truth of a proposition (Cameron-Faulkner, Lieven,

122 & Theakston, 2007; Pea, 1978). However, this definition depends on the assumed logical

123 system and its assumptions on what type of propositions receive truth values. A particular

124 sub-function of denial is "labeling," which is realized as the negation of nominal or adjectival

125 predicates such as "this is not a bunny" or "not red." These utterances are often used to

126 introduce new linguistic labels by parents and in turn may facilitate word learning (Clark,

127 2010). Conversely, labeling and word learning may aid the development of abstract negation.

128   Despite considerable research on early functions of negation, their developmental

129 trajectories in children's productions pro remained unclear. Different studies pro claimed

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

131 looked at the speech of five children in the Providence corpus (Demuth, Culbertson, & Alter,

132 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.

<center>**Experiments**</center>

Data and preprocessing

For developmental production data of child speech in English, we turned to the CHILDES database (MacWhinney, 2000)[1] and focused on 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.

With our parsed data set, we consider seven communicative functions of negation shown in Table 1 and analyzed negative constructions that convey each of these functions at both the syntactic and discourse level. At the syntactic level (e.g. (1)), give each communicative function, we characterized the syntactic features of the negative utterances associated with the function, then selected cases based on these features in a rule-based fashion with the help of POS information and syntactic dependencies. In addition, to further investigate the developmental paths of negation within specific constructions (that are not necessarily negative), besides negative utterances, we also examined the production

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

157 trajectory of positive counterparts to the negative constructions; the positive utterances

158 share the same syntactic features (e.g. same head verb) with their negative counterparts

159 except with no negative morphemes. Note that the positive constructions evidently do not

160 express the communicative function as their negative counterparts do; our main purpose of

161 including the positive structures is to provide better control and direct contrast for analyses

162 of the negative constructions.

163   (1) Rejection at the syntactic level: negative: *I don't want to go*; positive counterpart: *We*

164   *want to try*

165   (2) Rejection at the discourse level: Parent: *Do you (not) want to go*; Child: *No I like here*

166   At the discourse level, on the other hand, we aim to analyze utterances where the

167 negative morphemes are discourse response variables instead. To do that and in order to

168 alleviate potential parsing errors, instances starting with any of the negative morphemes that

169 are discourse response variables with a dependency relation *discourse* were included

170 (e.g. (2)). In this case, utterances such as "no no I like it" were selected. Then for each

171 negative utterance identified this way, we extracted its previous utterances in the discourse

172 context based on the utterance order and transcript id provided by childes-db. In particular,

173 for child speech, we included interactions (contextual utterances + current negative

174 utterance) where the contextual utterances were produced by either the parents or the

175 children themselves; and for parent speech, we only included interactions where the

176 contextual utterances were produced by children. Then for every function, we applied the

177 same syntactic features for both negative and positive utterances at the syntactic level to the

178 contextual utterance within each discourse interaction. This means that the contextual

179 utterance does not have to be negative.

Measures

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We took the age of the children as the index of developmental stage[2]. Take negative

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constructions at the syntactic level as an illustration. For each communicative function, we

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used the following two metrics at each age as measures of the developmental trajectory in

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child speech. The first one is the *ratio* of negative utterances. For instance, the number of

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utterances produced by children at the age of 30 months (not just all negative constructions

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at this age) is 81,302 in total. Among these utterances, negative structures that have the

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function of rejection occur 391 times; the ratio for this communicative function at 30 months

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is then calculated as 391 / 81,302 = 0.005.

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Given the noisy nature of child production data in general, and the facts that there are

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different numbers of utterances and children at each age, another measure that we utilized is

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moving ratio, borrowed from the model of moving average in analyses of time series data

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(Wei, 2006). For a communicative function, the goal of the moving ratio is still to reflect the

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production of the negative utterances at the given age; meanwhile it takes into account the

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previous production of all negative constructions of the same function before the specified

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age. This would allow us to have a more balanced look at individual developmental stage

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(e.g. age) of a communicative function, in relation to its development patterns thus far.

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The computation of the moving ratio is as follows. For instance, given that the number

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of negative utterances that express rejection in child speech is 391 at the age of 30 months,

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we: (1) count the total number of negative constructions with the same function produced by

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children *at and before* 30 months old (2,166); (2) compute the total number of utterances

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(721,748) within the same age range; (3) divide the number of (1) by that of (2) (2,166 /

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721,748 = 0.003).

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At the syntactic level, besides the negative constructions, we also calculated the two

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[2] Utterance length was also applied as another index of developmental stage. For more details....

measures above for their positive counterparts, and extended the measures to discourse interactions at the discourse level.

While our focus is child production, we used parents' speech as comparative references. Therefore for every communicative function, the same measures were calculated for parent speech in a similar fashion. Our plots accordingly contrast the ratios / moving ratios of different 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 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 and their positive counterparts

Rejection.   For the function of rejection, at the sentence level, we examined cases where the lemma of the head verb of the phrase is either *like* or *want*. For negative constructions, the head verb is modified by one of the three negative morphemes, whereas cases including the same head verb but without negation were determined as the positive counterparts. Therefore the positive utterances do not necessarily have large lexical overlap with the negative structures. With negative utterances, other than expressions that the speakers used to describe their own desires with (e.g. (1)) or without (e.g. (2)) an auxiliary verb, we also included cases that express rhetorical inquiries of desires from one interlocutor addressed to another (e.g. (3)), and instances where the speaker is describing the desires of somebody else (e.g. (4)). This resulted in a total of 20,641 negative utterances (child: 9,398; parent: 11,243), and a total of 180,881 negative utterances (child: 63,427; parent: 117,454).

(1) negative: *I no like sea* ; positive: *she likes cheese*

(2) negative: *don't wanna go* ; positive: *I want it*

229   (3) negative: *don't you wanna try it* ; positive: *I wanna have that*

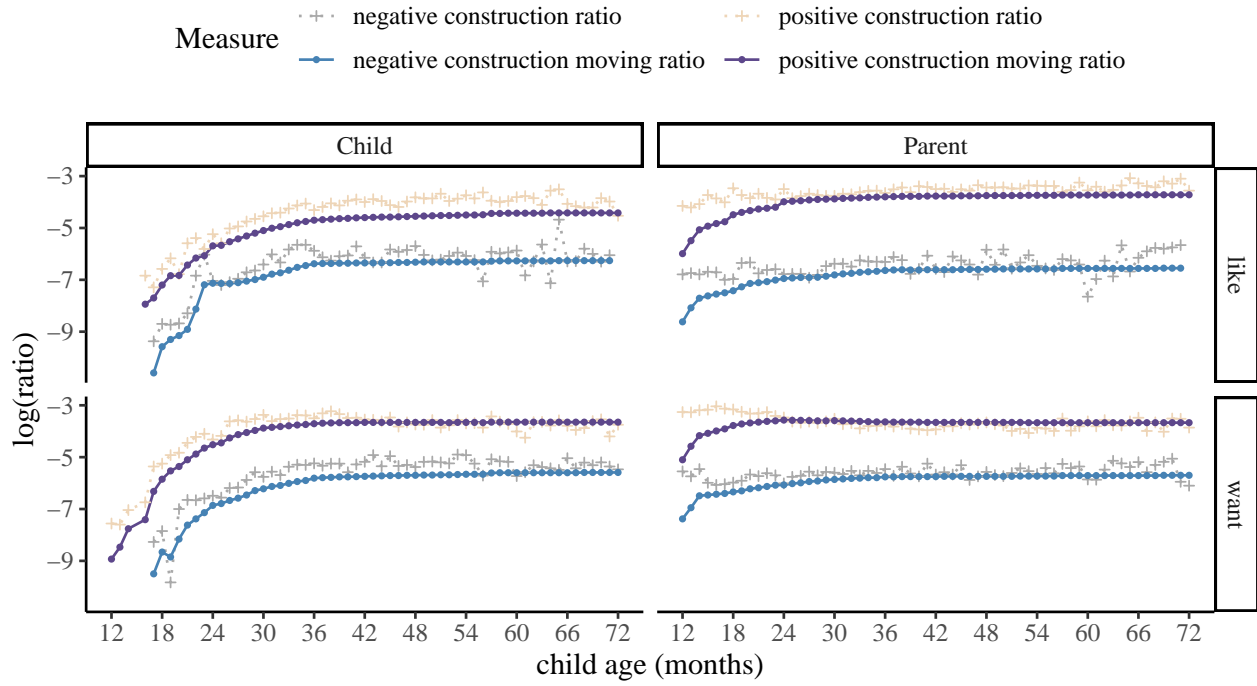230   (4) negative: *Sarah doesn't like that either* ; positive: *she likes this one*

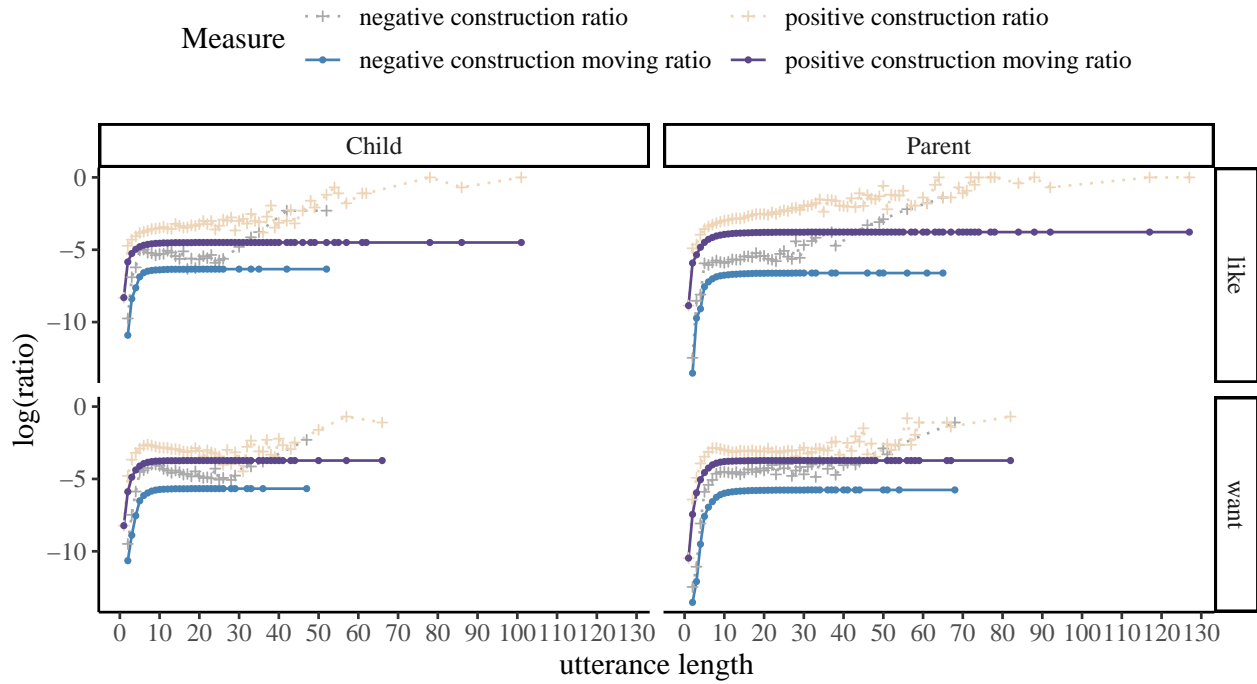*Figure 1*. Rejection and its positive counterparts.

Figure 2. Rejection and its positive counterparts, indexed by utterance length.

231   As presented in Figure 1, at the sentence level the overall pattern for children's usage

232 of negative morphemes for rejection is comparable regardless of the particular head verb.

233 Comparing child and parent speech, it seems that children's production of rejection is

234 gradually increasing between the age of 18 to 36 months. And the production moving ratio

235 in child speech appears to be more comparable to that of parent speech after 28-30 months.

236 Across the age range the production ratio for negative utterances is consistently lower than

237 that for their positive counterparts.

238   On the discourse level, we investigated discourse interactions (contextual utterance +

239 current negative utterance) in which the contextual utterances have a head verb of *like* or

240 *want*, yet the head verb does not have to be modified by negative morphemes (e.g.). This

241 resulted in a total of 1,957 utterances (child: 994; parent: 963).

242   As shown in Figure 2, children's production of negation as discourse response variables

243 increases regularly from the age of 24 - 36 months[3]. Overall negative morphemes are applied

244 at the discourse level more frequently in child speech compared to that in parent speech.

245   (6) Parent: *I want you to try it*; Child: *no no no*

246   (7) Parent: *would you like to go*; Child: *no no*

247   (8) Child: *I don't like that*; Parent: *no honey you have to try it*

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[3] 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 final
analyses
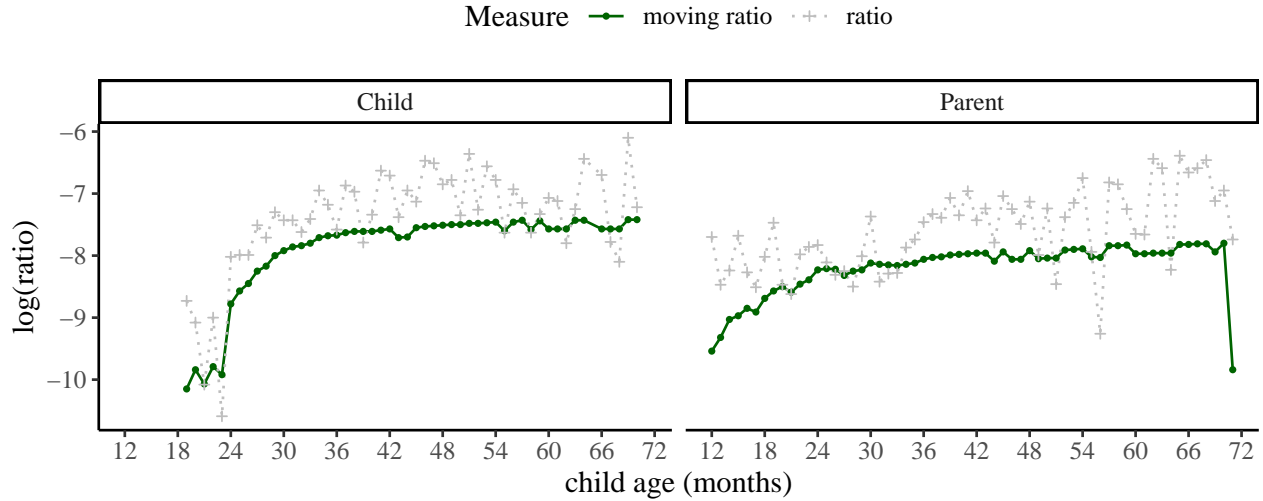
Figure 3. Discourse-level Rejection.

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

249   have expletives marked by *there* in which the predicate is a nominal phrase (headed by either

250   nouns or pronouns). Cases where the predicate is modified by negation were considered

251   negative utterances, and the rest were analyzed as positive constructions. This led to a total

252   of 1,987 negative utterances (child: 498; parent: 1,489), and a total of 35,390 positive

253   utterances (child: 8,398; parent: 26,992).

254   (5) negative: *there's no (more) water* ; positive: *there are books*

255   (6) negative: *there isn't it* ; positive: *there is it*

256   In child speech, the production of negative constructions to express non-existence at

257   the syntactic level is consistently less frequent than their positive counterparts. The moving

258   ratio of negation for this function is gradually increasing from 25 to 36 months (Figure),

259   which is by contrast later than that for the communicative function of rejection presented in

260   Figure 1. This observation does not seem to align with Bloom (1970), which initially

261   proposed that the development of non-existence is earlier than that of rejection. On the

262   other hand, children's production moving ratios tend to be consistently lower than that for

263   parent speech at the corresponding ages of the children.

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

265   25 months regarding child production. A closer inspection of the data reveals that within

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

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

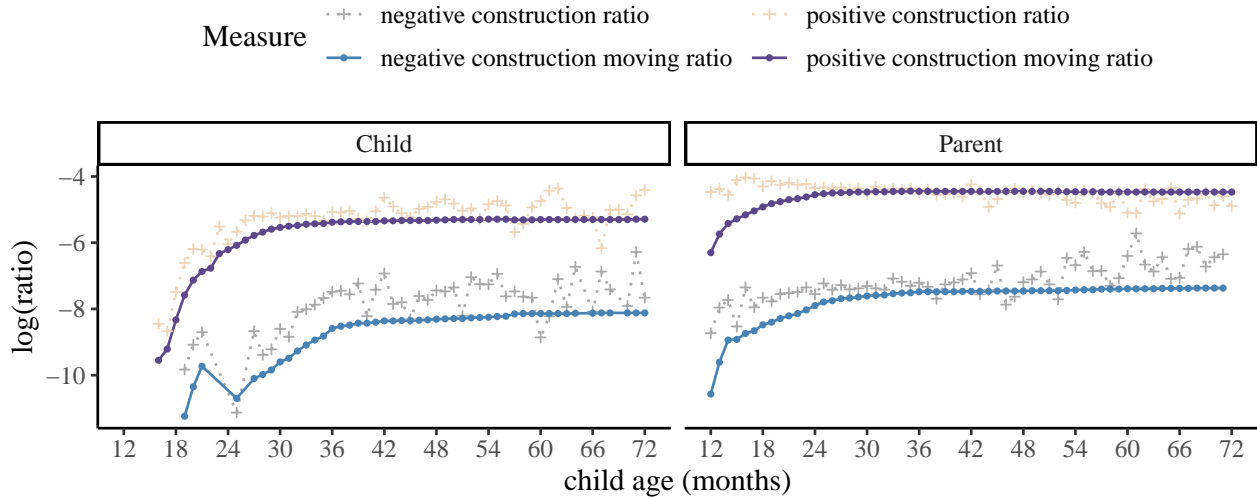268   the moving ratio for negative utterances actually decreases.

Figure 4. Non-existence and its positive counterparts.
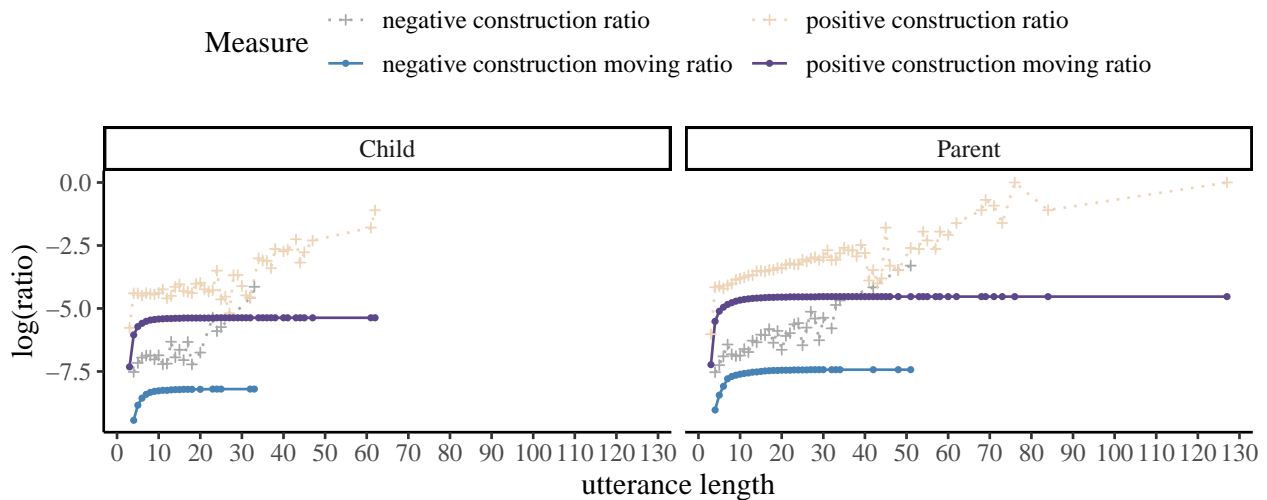
Figure 5. Non-existence and its positive counterparts, indexed by utterance length.

269   For non-existence at the discourse level, we applied similar utterance selection criteria

270 and extracted interactions where the contextual utterance is an expletive structure (e.g.).

271 This led to a total of 221 utterances (child: 91; parent: 130). Given Figure , the

272 developmental pattern for this communicative function at the discourse level bares

273 similarities to that at the syntactic level. The production of negation as discourse response

274 variables also increases regularly from 24 to 36 months, meanwhile gradually approaching the

275 moving ratio of parent speech around 34-36 months.

276 () Parent: *Is there a bunny*; Child: *no no bunny*
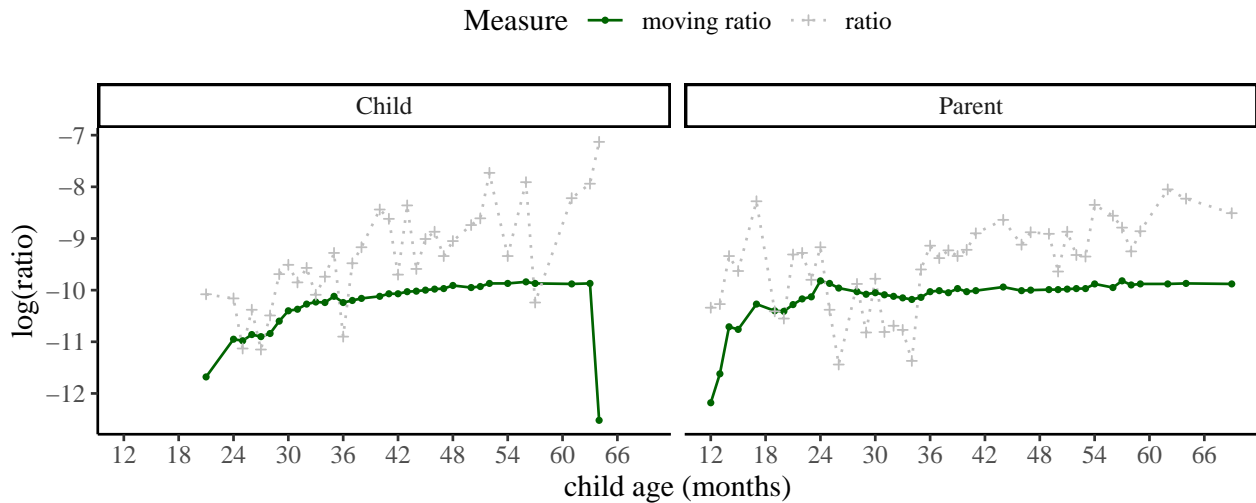
Figure 6. Discourse-level Non-existence.

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

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

279 In particular, we selected instances where the head verbs do not take any subjects. Cases

280 without negative morphemes are considered as positive structures. For negative

281 constructions, we chose structures where the negative morphemes are combined with the

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

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

284 below), our search excluded utterances where the head verb has any of the following lemma

285 forms: *like*, *want*, *know*, *think*, *remember*, *have.* This resulted in a total of 1,069 negative

²⁸⁶ utterances (child: 309; parent: 760), and a total of 25,542 negative utterances (child: 8,659;

²⁸⁷ parent: 16,883).

²⁸⁸   Based on Figure 3, in both child and parent speech, the production of negative

²⁸⁹ constructions for prohibition at the syntactic level is consistently lower than their positive

²⁹⁰ counterparts. Children are combining negative morphemes for this function more and more

²⁹¹ regularly between 24-36 months, which is comparable to that of the function of non-existence,

²⁹² but slightly later than that of rejection. In comparison, the production moving ratio in

²⁹³ parent speech gradually decreases when the children are within 15 - 36 months; yet child

²⁹⁴ production is still consistently lower than that in parent speech at any age of the children.

²⁹⁵   (7) negative: *don't blame Charlotte* ; positive: *cook it*
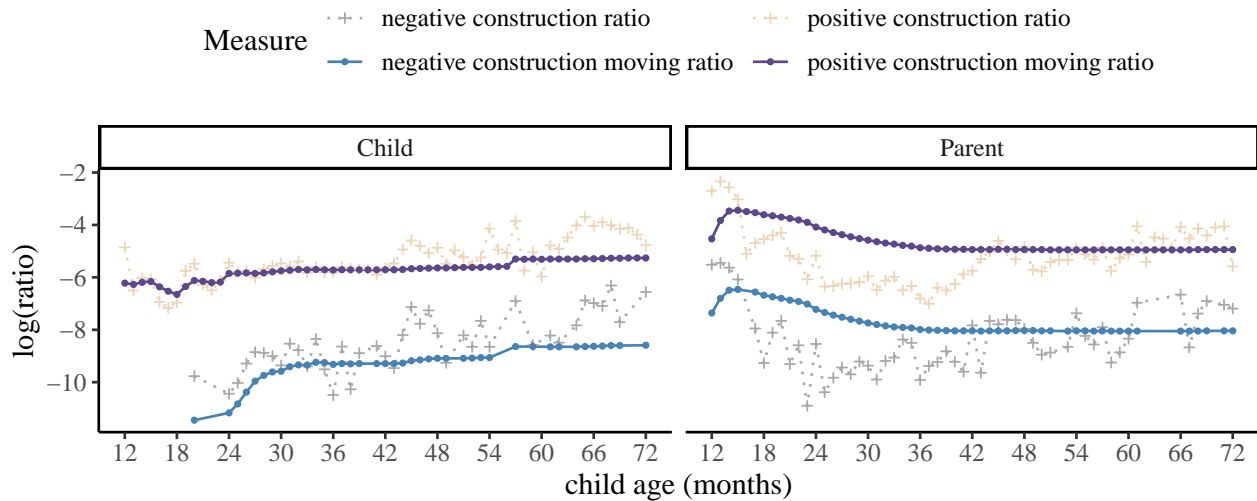
Figure 7. Prohibition and its positive counterparts.
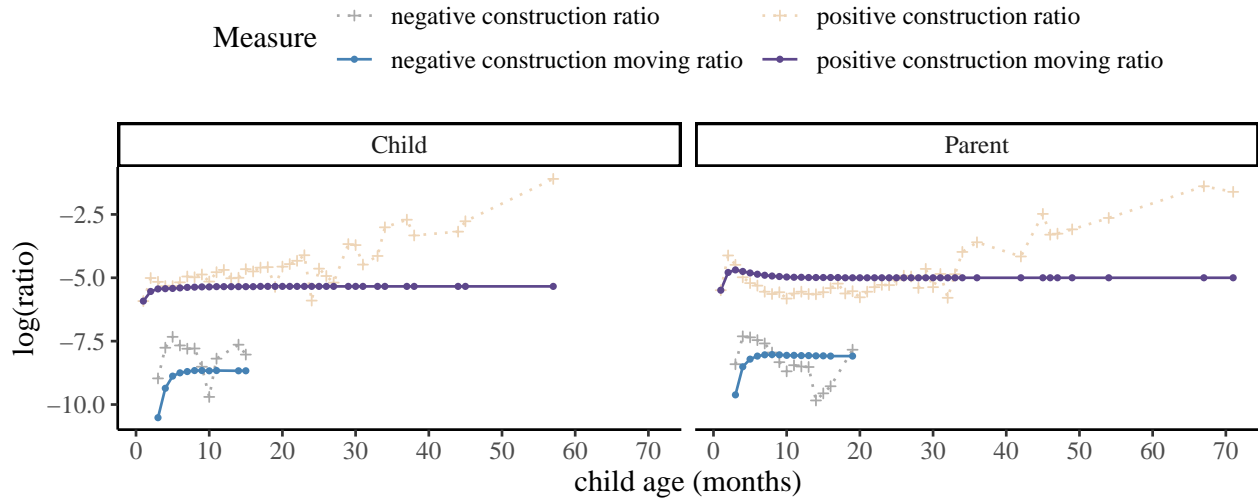
Figure 8. Prohibition and its positive counterparts, indexed by utterance length.

When it comes to the discourse level, we took discourse interactions where the contextual utterances are also subjectless imperatives headed by a verb, of which the lemma form is not *like*, *want*, *know*, *think*, *remember*, nor *have*. This resulted in a total of 238 utterances (child: 8,968; parent: 17,643).

As shown in Figure , children's usage of negation as response variables to express prohibition is comparable to that at the sentence level: the production in child speech increases within the age range of 24 to 36 months. and parent production decreases when the children are between 15 to 36 months.

() Parent: *put away your toys*; Child: *no mommy I like these*
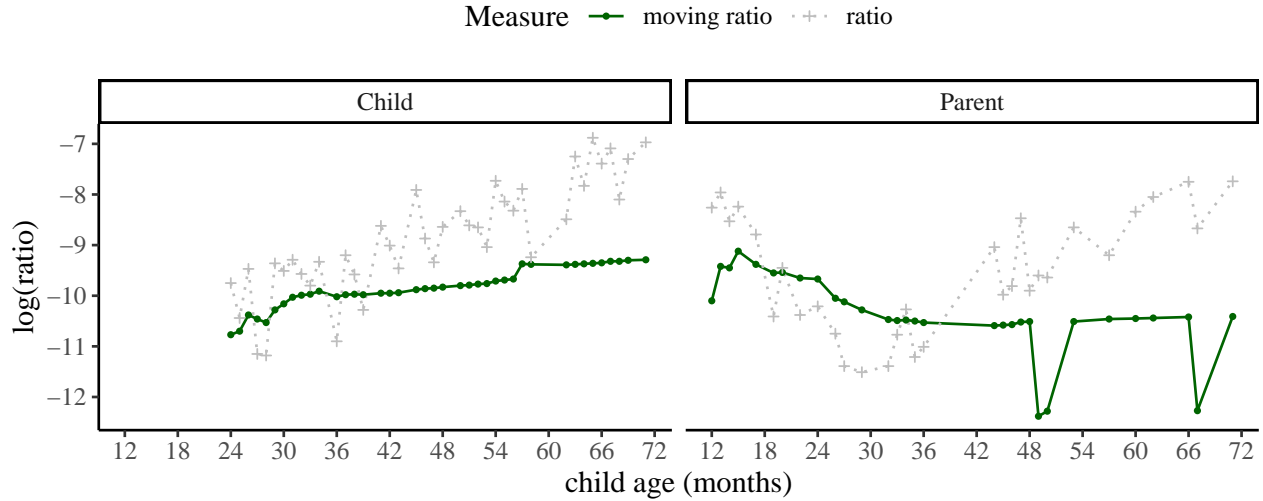
Figure 9. Discourse-level Prohibition.

305   **Inability.**   For the function of inability, at the syntactic level, we analyzed instances

306 with head verbs that are modified by the auxiliary *can* (*can* and *could*; e.g. ()). Structures in

307 which the head verbs are also modified by negative morphemes are determined as negative

308 while the others are considered positive. Cases without a subject (e.g. "can't play") or where

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

310 looking at a larger discourse context; they could be a rhetorical question or also express the

311 concept of prohibition. Therefore to potentially avoid less ambiguity, we restricted our

312 analyses only to cases with a subject *I*. This led to 7,115 negative utterances (child: 3,917;

313 parent: 3,198), and 14,433 positive utterances (child: 7,589; parent: 6,844).

314 (8) negative: *I can't see* ; positive: *You could do it*

315   As shown in Figure , the developmental trajectory of inability at the sentence level is

316 similar to that of rejection. Negation is applied more and more regularly between 18-36

317 months. By contrast, it is different from those of non-existence and prohibition. It seems

318 that the production trajectories of the latter two are both becoming more regular at a later

319 age (25 and 24 months, respectively). Overall the production of negative structures is less

320 frequent than their positive counterparts in both child and parent speech.
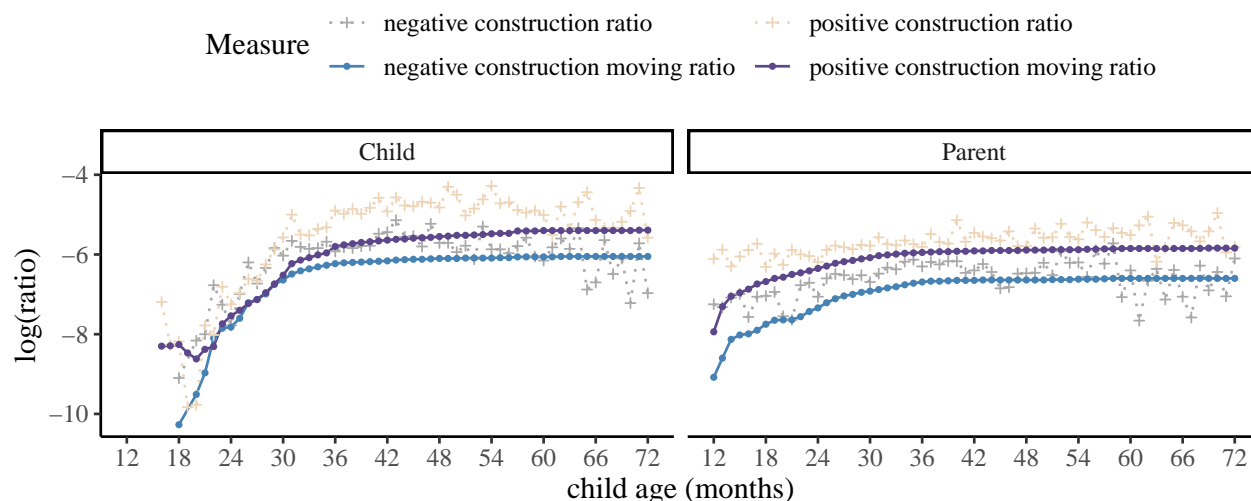
Figure 10. Inability and its positive counterparts.

321   For inability at the discourse level, we analyzed interactions where negation is applied

322   to respond to contextual utterances in which the head verbs take the auxiliary *can* or *could*

323   along with the subject *I*. This yielded a total of 313 negative utterances (child: 11,506;

324   parent: 10,042).

325   Looking at Figure , children's production of inability at the discourse level gradually

326   increases from 24 to 36 months. By contrast parents' production decreases from the age of

327   15 to 36 months, which is similar to parent production of prohibition at the discourse level.
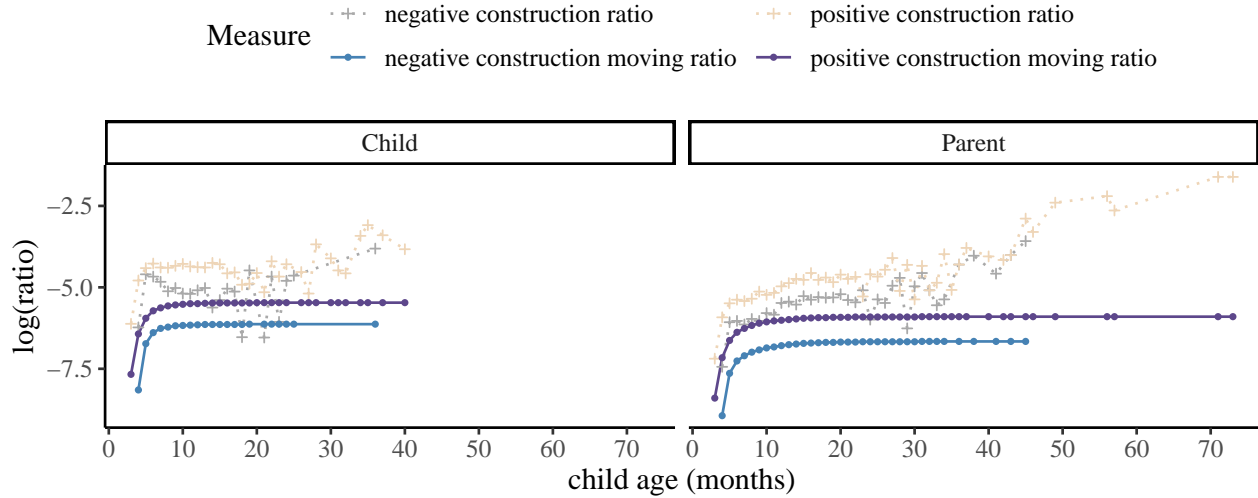
Figure 11. Inability and its positive counterparts, indexed by utterance length.
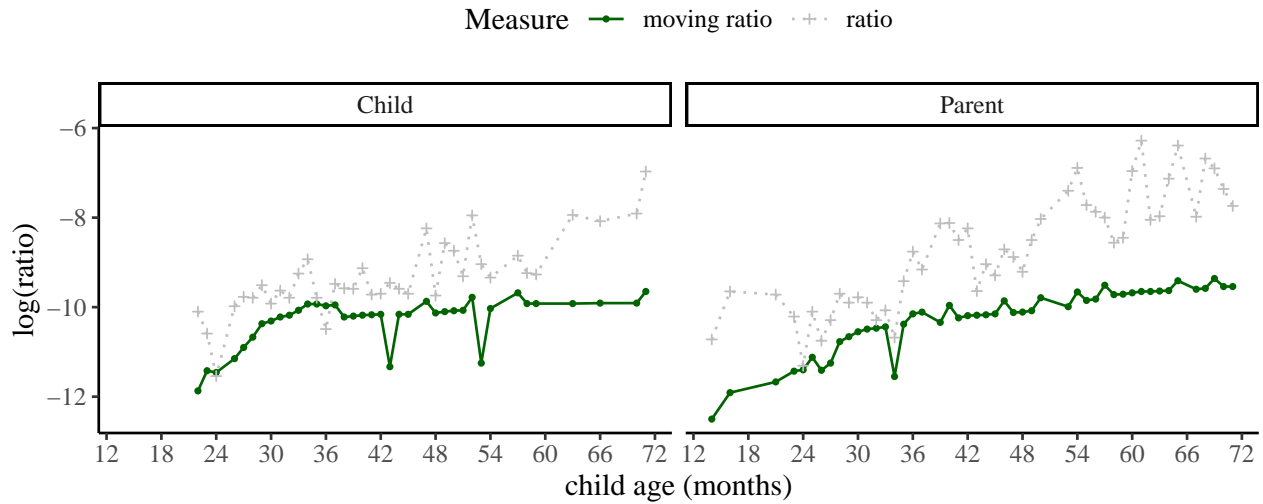
Figure 12. Discourse-level Inability.

Labeling. To capture the function of labeling at the sentence level, we concentrated on copula structures in which the predicate is a nominal or an adjectival phrase. Specifically, the nominal predicates exclude possessive pronouns in order to not be confused with cases for the communicative function of possession (see below). Instances where the predicate is modified by negative morphemes are deemed negative, and the others are positive structures. None of the utterances contained expletives (e.g. "there is no book") to distinguish from non-existence. This resulted in a total of 36,410 negative utterances (Child: 6,193; Parent:

335   30,217), and 484,679 positive utterances (Child: 121,107; Parent: 363,572).

336   (9) negative: *that's not a farmer* ; positive: *this is a book*

337   (10) negative: *I'm not a heavy baby Mum* ; positive: *it's a nice bowl*

338   (11) negative: *It's no good* ; positive: *she's pretty*

339   Based on Figure 5, the developmental pattern for labeling at the sentence level is

340   comparable to rejection; children are increasing their use of the negative morphemes around

341   the age range of of 18-36 months. In both child and parent production, the frequency of

342   positive counterparts is consistently higher than that of the negative structures. Overall,

343   parent's production of negation for labeling is also comparatively higher than that in child's

344   production across the different ages of the children.
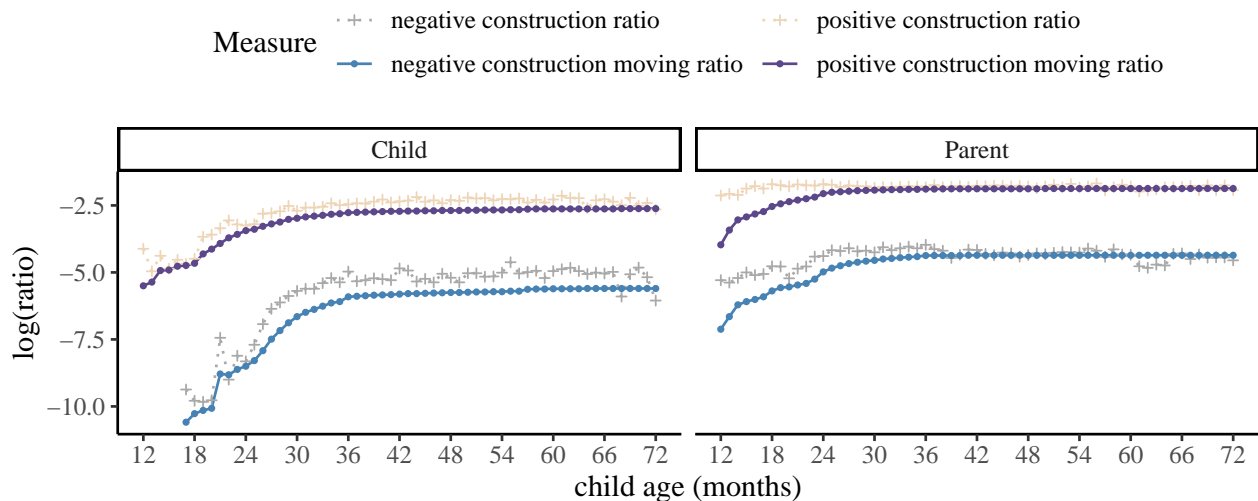
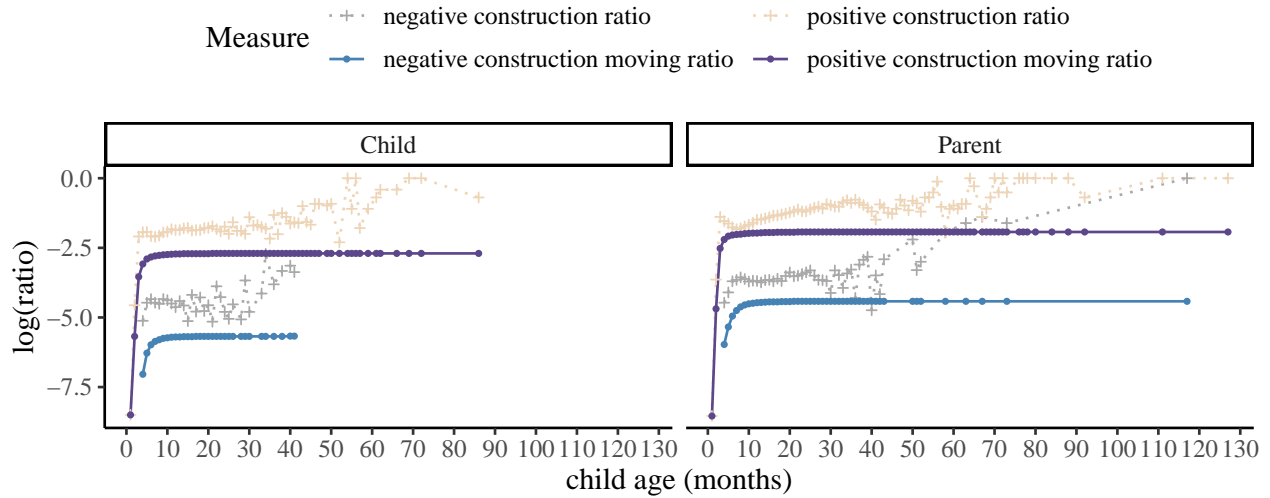*Figure 13*. Labeling and its positive counterparts.

Figure 14. Labeling and its positive counterparts, indexed by utterance length.

345   On the discourse level, we examined interactions where the contextual utterances are

346   copula structures with a nominal or an adjectival predicate. This resulted in 4,079

347   utterances (Child: 2,234; Parent: 1,845). Based on patterns from Figure , it seems that

348   children more regularly use negation as response variables to express labeling between 18 to

349   36 months; child's production frequency gradually approaches that in parent speech around

350   the age of 30 - 32 months.

351   () Child: *that's the one*; Parent: *no it's the green one*
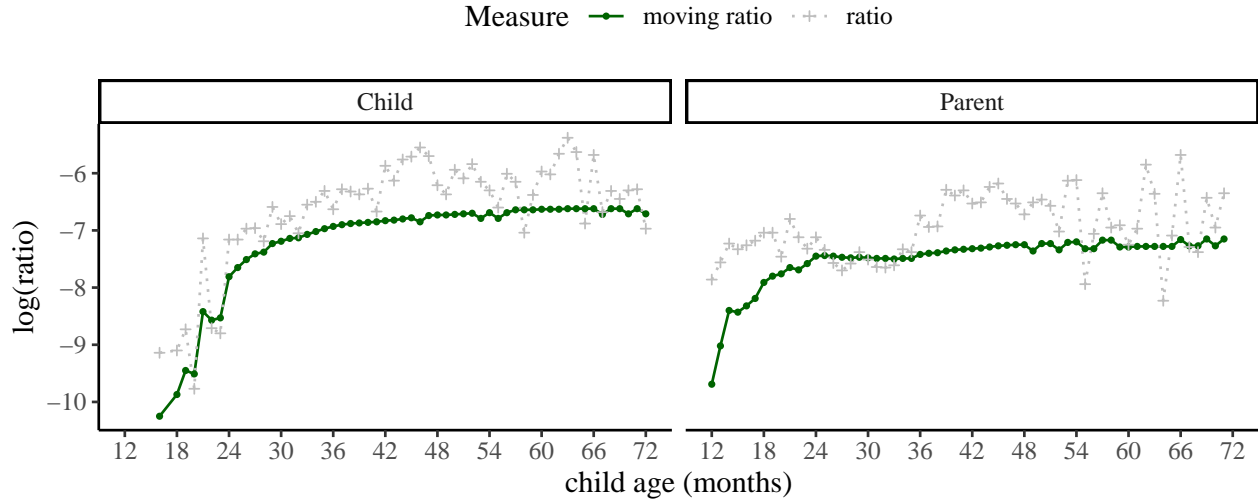
Figure 15. Discourse-level Labeling.

Epistemic Negation.   Previous studies have reported instances where negative morphemes are combined with mental/epistemic state verbs such as *know*, *think*, and *remember* in child speech to express epistemic negation. Here we focused on these three verbs as well. For the sentence level, we analyzed negative utterances that articulate the concept of not knowing (e.g. (12)) or uncertainty (e.g. (13)). The verbs in these cases are modified by the negative morphemes directly or by the combination of negation with auxiliaries. Instances where the speaker asks about or describes the negative epistemic state of another speaker (e.g. (14)) were also selected, 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 are not modified by negation. This resulted in a total of 95,679 negative utterances in total (child: 16,322; parent: 79,357).

(12) negative: *I not know / I didn't remember*; positive: *I knows*

(13) negative: *I don't think so*; positive: *I think this one is good*

(14) negative: *don't you remember / She doesn't know this*; positive: *She knows about this*

Based on the data analyzed here (Figure), for epistemic negation at the syntactic level, the production of negative utterances headed by *know* is comparatively the highest, and is

368 becoming more regular at an earlier age (17-18 months) compared to that of *remember* (~19

369 months) or *think* (~20 months). Overall the production moving ratio of negative utterances

370 is relatively lower than that of the positive structures. Across the three head verbs, it

371 appears that child's production with *know* and *remember* gradually approaches that in

372 parent production around 34 - 36 months, whereas cases with the head verb *think* tend to be

373 produced less frequently in child speech.
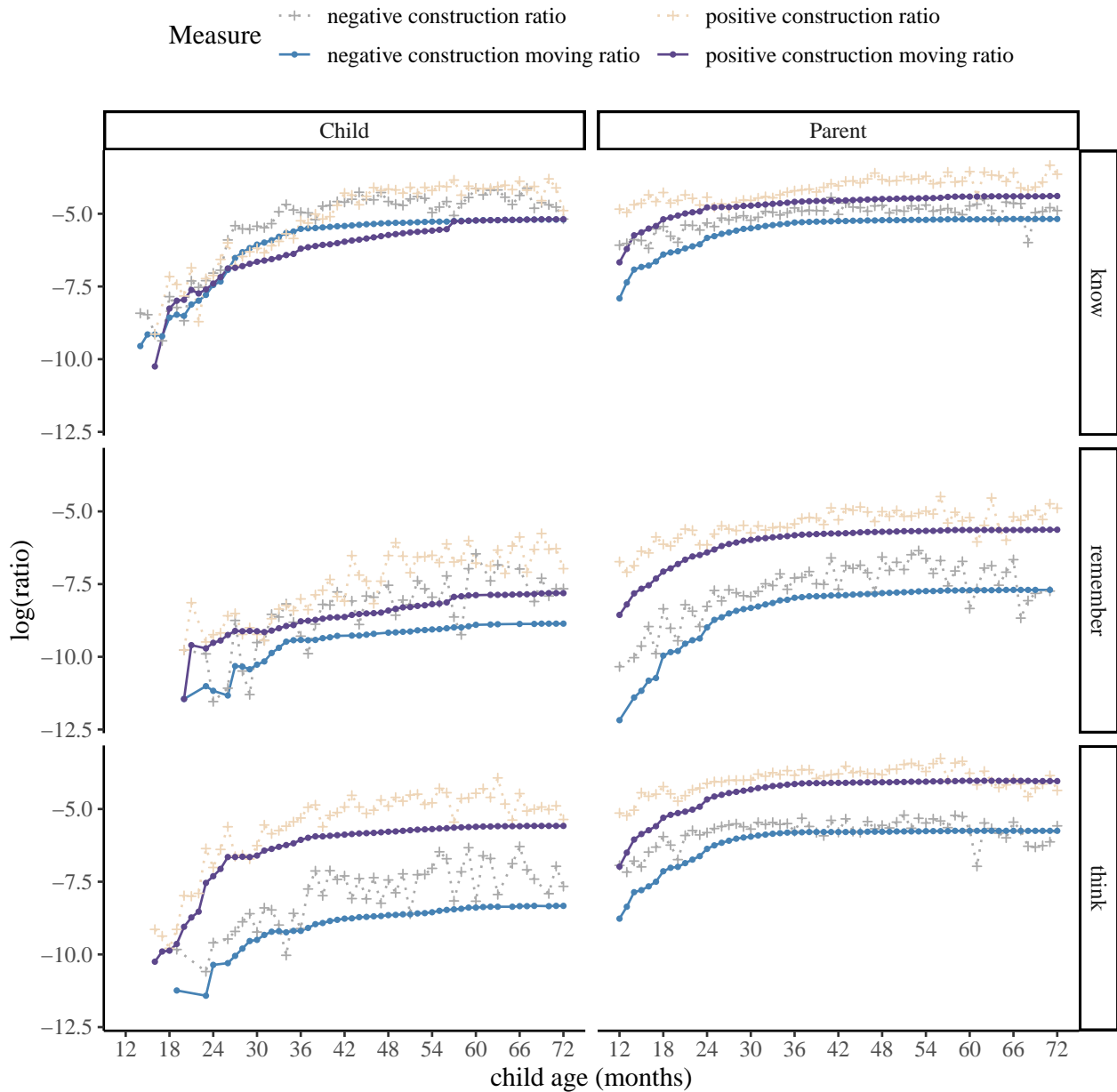
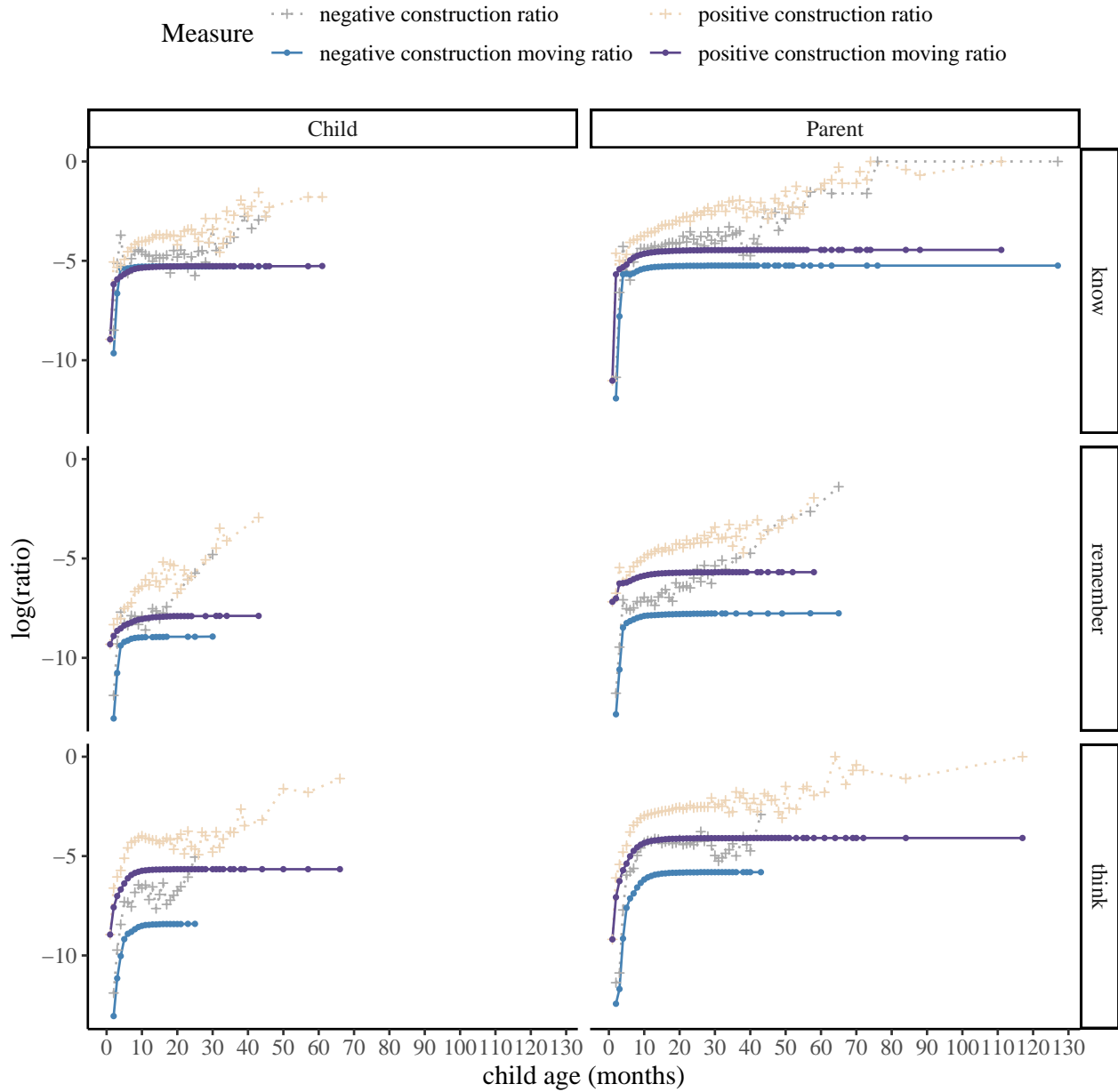*Figure 16*. Epistemic negation and its positive counterparts.

Figure 17. Epistemic negation and its positive counterparts, indexed by utterance length.

374   For epistemic negation at the discourse level, we examined interactions in which the

375   contextual utterances take any of the three head verbs, *know*, *remember* and *think*, leading

376   to a total of 985 utterances in total (child: 26,174; parent: 101,201). The developmental

377   trajectory of child speech from Figure demonstrates a gradual increase of production moving
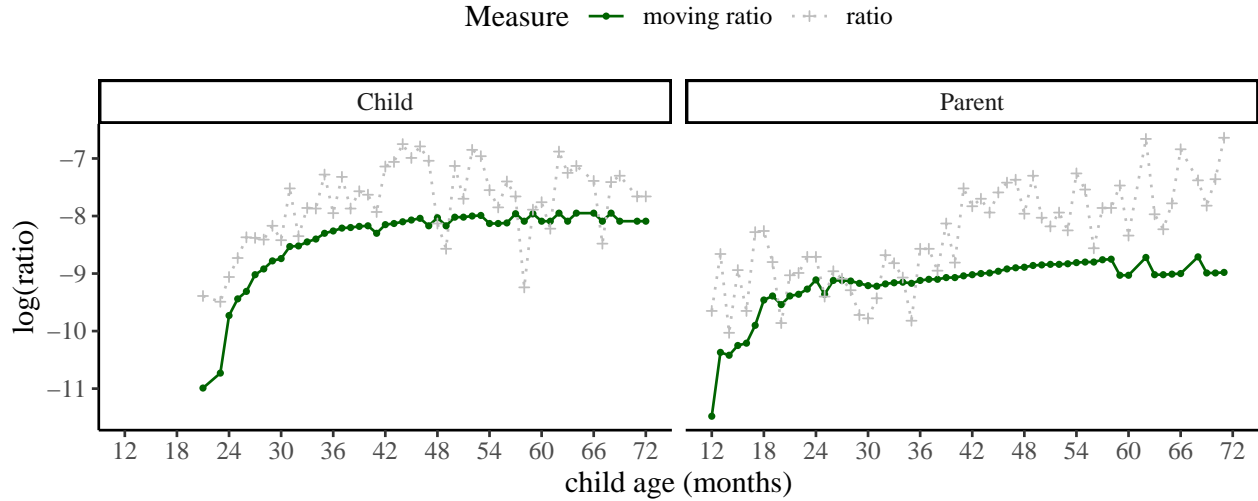
378   ratio from 24 to 36 months.

Figure 18. Discourse-level Epistemic Negation.

³⁷⁹   **Possession.**   The last function we explored is possession. At the syntactic level, for

³⁸⁰ negative structures we selected cases where the negative morphemes are combined with

³⁸¹ auxiliary verbs to modify a head verb with the lemma form *have* and a POS tag of VERB

³⁸² (e.g. (15)). We also included individual noun phrases with possessive pronouns as heads and

³⁸³ modified by negative morphemes (e.g. (16)). Cases in which the syntactic head of the

³⁸⁴ negative morphemes is a predicate of a copula verb (e.g. "this is not mine") were excluded to

³⁸⁵ separate them from the function "labeling." The number of negative utterances that were

³⁸⁶ subjected to analysis for this function is 9,025 (child: 2,852; parent: 6,173). Again the

³⁸⁷ positive counterparts share similar structures except with no negation, leading to a total of

³⁸⁸ 8,230 (child: 6,062; parent: 2,168). One thing to note here is that for the positive structures

³⁸⁹ with the head verb *have*, we restricted to cases where the verb takes a direct object (with the

³⁹⁰ dependency relation *obj*). This is to avoid potential parsing errors of instances such as *I*

³⁹¹ *have*, where the verb could ambiguously be an auxiliary.

³⁹² (15) negative: *I don't have it*; positive: *you have that*

³⁹³ (16) negative *not mine*; positive: *hers.*

³⁹⁴   Given Figure 7, at the sentence level, the developmental trajectory for possession in

³⁹⁵ child speech appears to have notable differences depending on what the negative morphemes

³⁹⁶ are modifying. When their syntactic head is *have*, the pattern is comparable to those of

³⁹⁷ "rejection" and "labeling," where children are increasing their combination of negative

³⁹⁸ morphemes from 18 to 36 months. However, the production moving ratio for utterances

³⁹⁹ headed by possessive pronouns seems to be relatively stable across different ages.
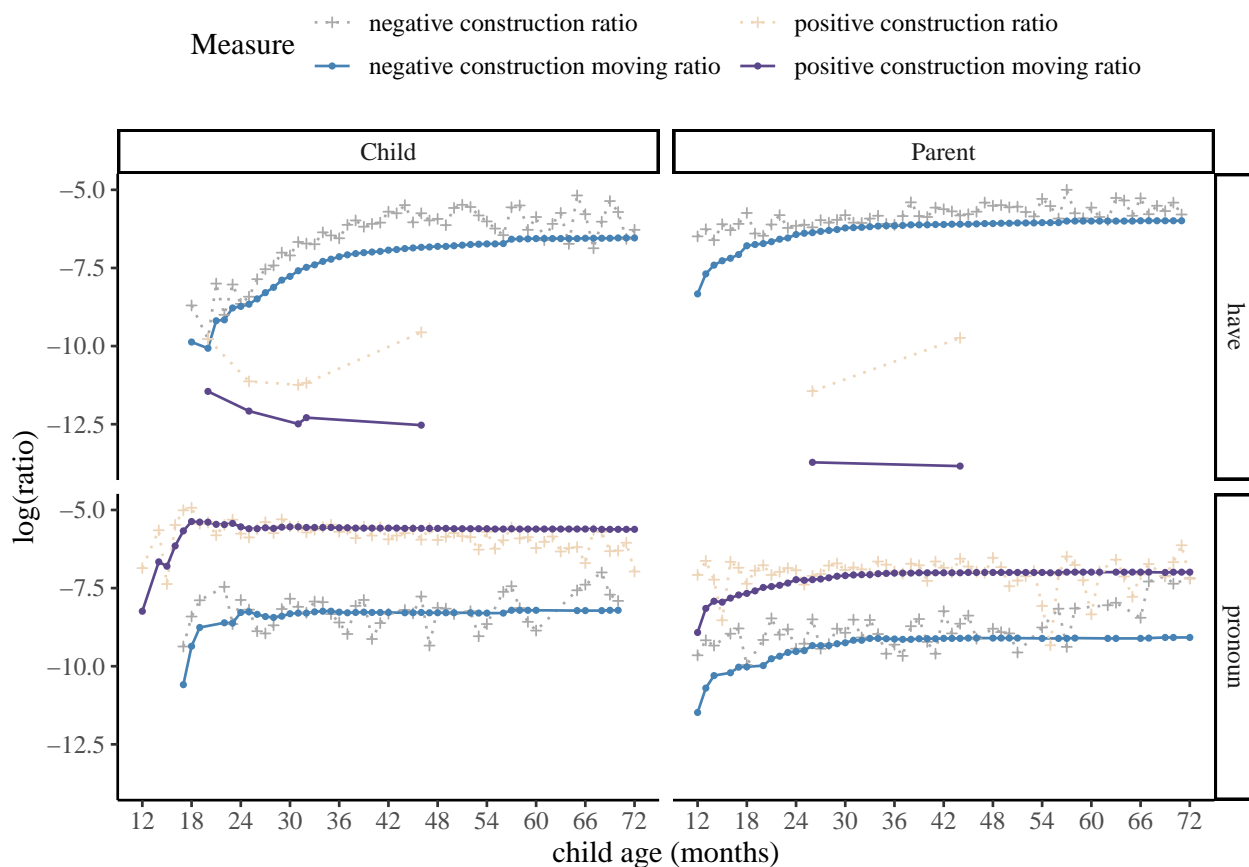

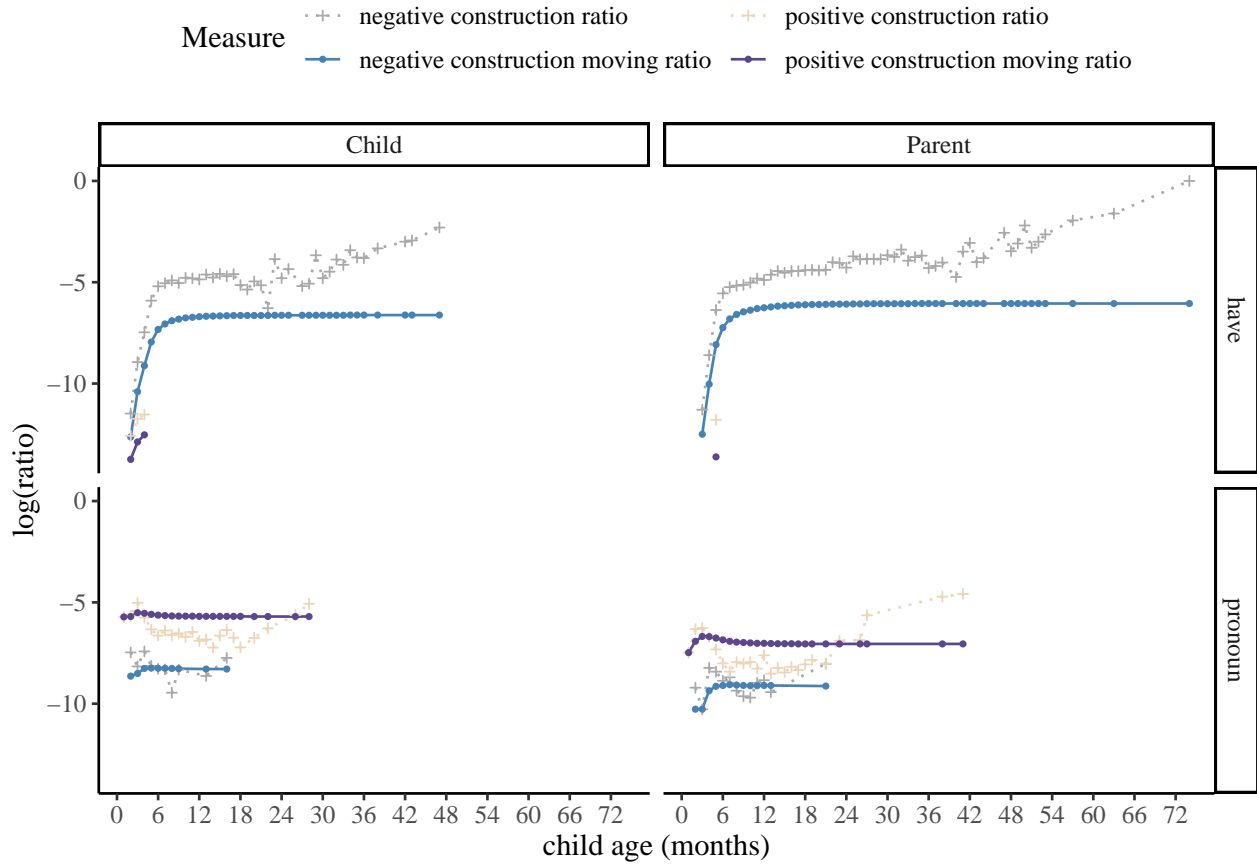*Figure 19*. Possession and its positive counterparts.

Figure 20. Possession and its positive counterparts, indexed by utterance length.

400   For the discourse level, we selected interactions in which the contextual utterances have

401 similar structural features to both the negative and the positive constructions at the

402 syntactic leve.

403   () Parent: *I don't have the book*; Child: *no no mommy please read it to me* () Parent:

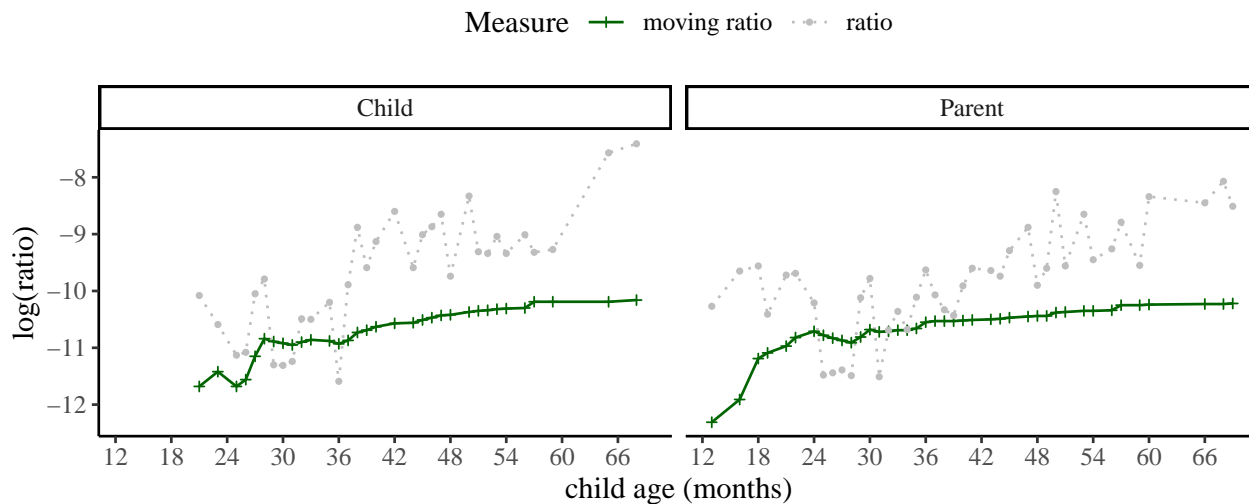404 *not yours*; Child: *no it's mine mine*
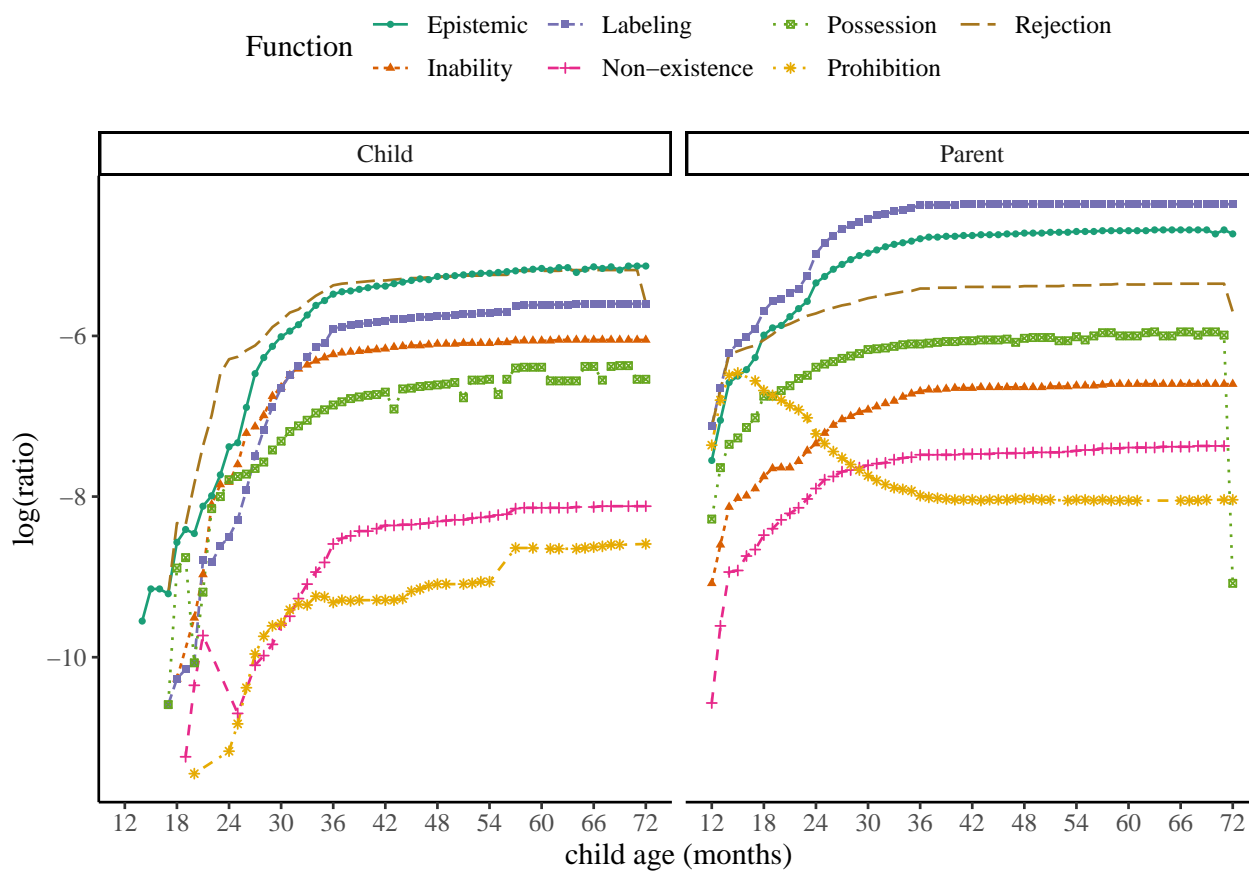
Figure 21. Discourse-level Possession.

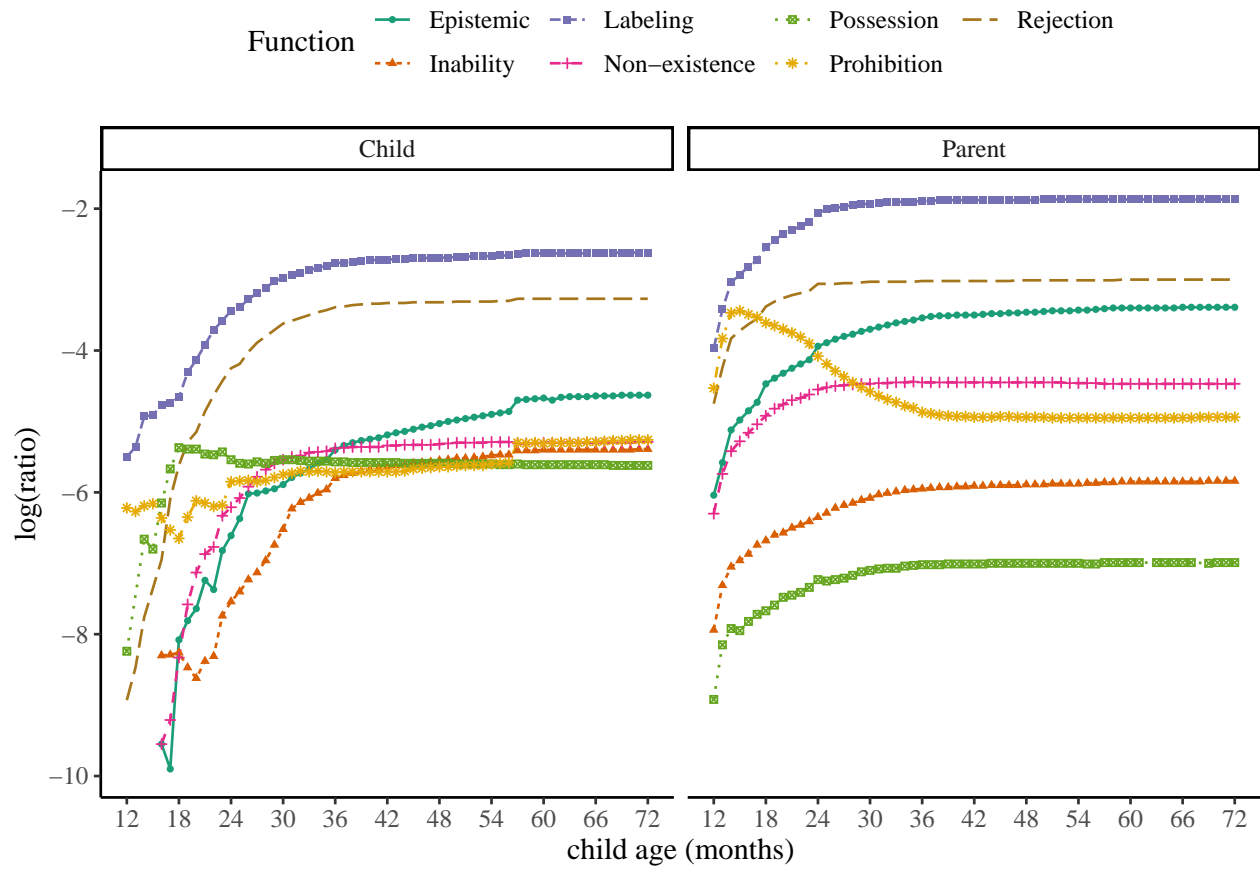*Figure 22*. All negative constructions at the syntactic level.

Figure 23. Positive counpterparts of all negative constructions at the syntactic level.
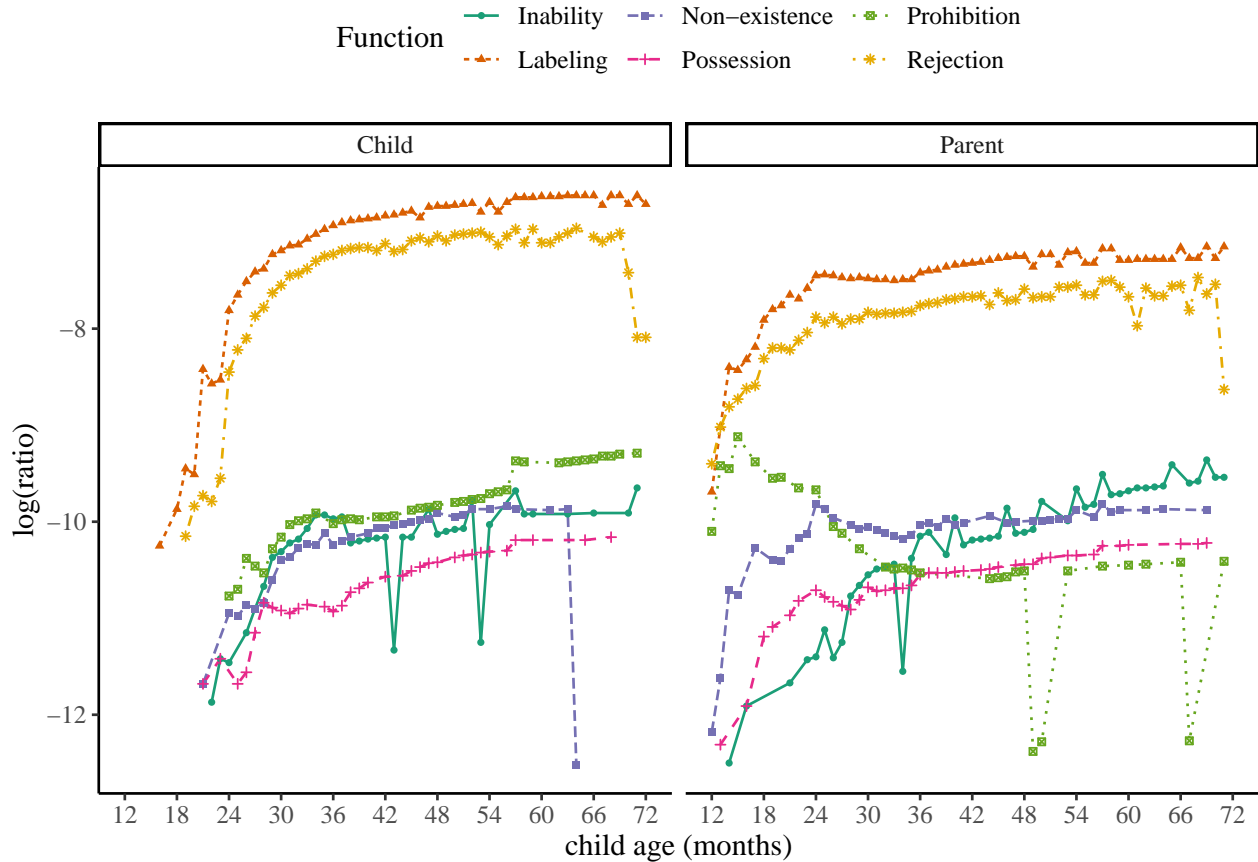
Figure 24. All functions at the discourse level.

₄₀₅ **An overall look.**

₄₀₆ **Discussion**

₄₀₇ Using automatic annotations of large-scale corpora of child-parent interactions, we

₄₀₈ presented production trajectories for seven negative constructions that tend to express

₄₀₉ rejection, non-existence, prohibition, inability, labeling, epistemic states, and possession

₄₁₀ (Table 1). The results suggest that the production of almost all these negative constructions

₄₁₁ (except for prohibition) emerges and gradually increases within the 18-36 months age range

₄₁₂ (Figure 8). Their production frequencies remain stable and regular after 36 months and

₄₁₃ relatively close to parents' levels of production. It is important to note that similar to prior

₄₁₄ studies, our conclusions are limited to negation in children's production. Systematic

415 experiments testing children's comprehension of negative utterances with different

416 communicative functions are necessary to better understand the origins and developmental

417 trajectory of negation.

418   For future work, we would like to explore several directions. First, to more thoroughly

419 examine and potentially model the developmental trajectories of negation in child production,

420 certain production-specific factors (e.g. length of utterance, ease of pronunciation) should be

421 taken into account as well. In addition, we aim to investigate the production trajectory of

422 positive counterparts to our negative structures (e.g. "I know" for "I don't know").

423 Comparisons of negative utterances in relation to their positive counterparts would allow us

424 to further analyze the developmental paths of negation within specific constructions.

425   Lastly, our experiments have concentrated on larger syntactic structures at the

426 utterance level, hence cases where negation is used as discourse markers to respond to

427 previous utterance(s) were excluded. However, these instances also have important semantic

428 and conceptual roles in the communication between children and parents (e.g. parent: *do

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

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

431 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/think/remember* *I*
Possession	with *have*; or possesive pronouns	*not have the toy*; *not mine*

Table 1

Communicative functions of negation in early child language of English.