

TO LEARN OR NOT TO LEARN: CHILDREN'S ACQUISITION OF NEGATION

by  
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# Abstract

As any parent will attest, by the age of two, most toddlers are producing the words used to express negation (e.g. ‘no,’ ‘not,’ ‘don’t,’ ‘can’t’) quite extensively. However, it is unclear whether these early negative utterances reflect a true understanding of negation as a concept that reverses the truth value of a proposition. In two studies, using production and comprehension data respectively, I sought to help elucidate the path children take on the way to syntactically and semantically mature truth-functional negation.

The production study used corpus data of child and parent speech from CHILDES (MacWhinney 2000) to evaluate two open questions in the literature about children’s early non-adultlike negative utterances introduced by Klima and Bellugi (1966): First, whether children initially go through a stage during which their truth-functional negators are pronounced outside of their sentences, and second, whether children’s negative auxiliaries are initially analyzed as [aux + ‘nt’] or treated as unanalyzed wholes. The analysis of the corpus data did not support either claim, finding instead evidence for an anaphoric analysis of early sentence-external negators and for negative auxiliaries that are already a part of the auxiliary system once they are being used in sentences.

The comprehension study sought to elucidate the order in which children acquire various forms and functions of negation by developing a violation of expectation looking-time-based experimental method that eliminates some of the inhibition- and processing-related task demands present in previous studies. The comprehension study was interrupted due to COVID-19, but preliminary results support the feasibility and potential contribution of the study.

# 1 Introduction

Human beings are set apart from the rest of the Animal Kingdom by our ability to use abstract, combinatorial thought, which is most conspicuously realized in our unique ability to learn and speak language. It is clear that human language, consisting in itself of meaningful combinations of atomic elements, depends on the ability to use combinatorial thought. It is less clear, however, to what extent the use of combinatorial thought depends on language. Does language simply make use of an existing combinatorial system of thought? Or is the learning of language in some way necessary to the development of combinatorial thought (e.g. Davidson 1999)? There is likely not a single answer to this question; perhaps certain combinatorial concepts are innate to humans, while others must be learned through external input, linguistic or otherwise. Because of this possibility, the relationship between language and combinatorial concepts must be assessed on a case by case basis.

One interesting lens through which to view this issue is children's acquisition of negation— both negative concepts and the language used to describe them. Negation is a particularly useful case because the language we use to express negation is combinatorially diverse— the many different negative morphemes (no, not, -n't, un-, dis-, etc.) each occur in their own unique syntactic and morphological contexts— but all negative morphemes ultimately map onto logical concepts that are closely related. These features provide us with a unique window into how specific forms and contexts of language contribute to the development of novel concepts.

It will be useful to first clearly define what is meant by 'negation.' Negation has been defined in many ways, but for our purposes a simple propositional definition, proposed first by Frege (1919), will be largely sufficient: negation is a conceptual operator that reverses (or denies) the truth value of a proposition. For example, if the proposition 'the ball is red' is true, then applying the linguistic negator 'not' will

create a false proposition: ‘the ball is not red.’ The negator ‘nt’ will do the same, though it is not permitted to stand alone; it requires an auxiliary verb (e.g. ‘is,’ ‘do,’ etc.) to attach to: ‘the ball isn’t red.’ The final negator that we will concern ourselves with, the word ‘no,’ behaves slightly differently. It cannot be directly embedded into a sentence in order to reverse the truth value (e.g. \*‘the ball no is red’). However, it can be used to deny the truth of a statement; for example, in response to the claim ‘the ball is red,’ one might say ‘no!’ and in doing so assert that the proposition ‘the ball is red’ is false.

It is in the sense of reversing propositional truth values that I will refer to negation as a ‘truth-functional conceptual operator.’ I will use the word ‘negator’ to reference the specific language (i.e. ‘no,’ ‘not,’ ‘nt’) used to express the abstract conceptual negative operator, which I will refer to as ‘negation.’ These definitions in place, we can now return to the question at hand.

Broadly speaking, there are two possibilities for how children come to have adult conceptual and linguistic negation. First, children might be endowed with an innate abstract negative concept, in which case the learning problem is solely an issue of **mapping** that concept onto the relevant words. This is in and of itself a complicated task— even if a negative concept is already available to children in thought, the negative input that children receive is sufficiently complex that it may not be immediately clear how this concept is mapped onto language. Second, there may be no such innate negative concept. In this case the learning problem entails the **construction** of a novel concept. This is not a trivial task (Fodor et al. 1980). A valid argument for this alternative must include a description of a learning mechanism that is capable of constructing a negative concept through interactions with the outside world, possibly with the assistance of language. Thus, understanding the role of language in learning negation will be an essential element to answering the innateness question.

It is important to note that to say a concept is innate is not to say that it does not develop. Rather, it is a question of the *cause* of development. For example, children develop the ability to walk many months after birth, yet those developments are innately driven. Thus, evidence that there is an age at which very young children do not have access to conceptual negation (e.g. Mody, Feiman, and Carey (under review)) is not evidence against the existence of an innate negative concept. If children do have an innate negative operator, then at some point in development they will gain access to it. At this moment, we might expect a sudden explosion in linguistic comprehension across various forms and functions of negation, corresponding with the sudden explosion in conceptual competency. If, however, children must use external stimuli, including linguistic input to create the concept of negation, or if they do have an innate concept but there is an additional syntactic bottleneck, then we might expect a longer, more piecemeal acquisition process. In this case, we might expect children to acquire specific negators at different ages, and perhaps to at first map simpler, more domain-specific negative concepts, such as non-existence or rejection, onto the negators.

Language acquisition encompasses the development of two distinct capacities: production and comprehension. Children's naturally produced speech can provide valuable insight into the combinatorial power of children's syntax. It cannot tell us, however, whether the meanings children are attempting to express with their early utterances are the same as the meanings that we as adults ascribe to them. In the case of negation, for example, what do young children really mean when they say 'no?' Is it the abstract, combinatorial, truth-functional negation described above? Or could they be expressing some other, potentially less complex, concept? In order to disambiguate between these two options, we must ask not only what children can produce, but what they can *comprehend*. While production data speaks to the combinatorial power of children's negators, comprehension data can help us to

understand the specific meanings that underlie those negators. In this thesis, I will address the question of negation acquisition through the lenses of both production and comprehension. I will now briefly discuss each of these issues, and then I will lay out a roadmap for the rest of the thesis.

With regards to children's production of negation, the broad question to be answered is how combinatorially productive children's use of each of the negators is. The answer to this question can help us to understand the combinatorial complexity of the concepts that underlie these negators. I will be focusing on two claims that have been made in the literature (Klima and Bellugi 1966): first, that children go through a stage of development during which their negators are pronounced externally to the sentences being negated (e.g. 'no the sun shining' to mean 'the sun is not shining'), and second, the claim that children's negative auxiliaries (e.g. 'can't,' 'don't') are initially treated as unanalyzed whole negators, akin to 'no' or 'not,' and thus that 'nt' does not combine productively with auxiliaries. Both of these claims have existed for many years in the literature, but were made on the basis of evidence from very few children. Thus, in the production study I bring all of the English language data in the CHILDES corpus of child and parent speech (MacWhinney 2000) to bear on these two issues (before exclusions, 1,337,478 utterances from 747 children, as well as 1,667,576 parent utterances).

In the comprehension study, I sought to assess more directly which specific concepts and functions of negation children's early negators represent by testing young children's comprehension of these negators in various syntactic and functional contexts. The results of such comparisons could inform our understanding of the specific conceptual trajectory of children's negators, and thus bear on the central question of whether this acquisition results from a mapping or a constructing mechanism. It was the aim of the comprehension study to perform comparisons across forms and functions of children's early negation, which might be able



disambiguate between these two possibilities.

In sum, this thesis includes three studies: two corpus studies on negation production, and one experimental study on negation comprehension. Because the two corpus studies use much of the same data filtering process, I will first discuss the general methods used to process and tag the production data that apply to both studies in Section 2. The following three sections discuss each of the three studies individually, and each contains a review of the literature relevant to the question at hand. Section 3 discusses the question of a sentence-external negative stage, Section 4 addresses the claims that negative auxiliaries are initially unanalyzed, and Section 5 provides the preliminary results of the comprehension study<sup>1</sup>. Finally, Section 6 discusses my findings with respect to the theoretical questions mentioned above.

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<sup>1</sup>Unfortunately, due to the COVID-19 pandemic I was prevented from running the in-person comprehension study as originally planned. However, even as I pivoted to the corpus work described above, I also immediately began working to create comprehension methods and stimuli that would work online over Zoom, and I have recently begun piloting the online study. Because of this interruption, I was not able to complete this study, but I do report some preliminary data from a few pilot participants that supports the feasibility and potential contribution of this study.

## 2 Production Study: Methods

The aim of this study was to bring larger data sets to bear on several existing claims in the literature on children’s acquisition of negation. In order to do so, I analyzed data from the English-North America and English-UK collections of corpora from CHILDES (MacWhinney 2000). I used the R programming package *childesr* (Sanchez et al. 2019) to run an utterance-based analysis of child and parent speech. The initial dataset contained 1,337,478 utterances from 747 children, as well as 1,667,576 parent utterances. Untranscribed utterances and utterances missing part of speech tagging were excluded ( $N = 246,485$  for children,  $71,166$  for parents), and unintelligible words were removed. Additionally, utterances whose number of word tokens did not match the number of part of speech tags were excluded ( $N = 57,552$  for children,  $78,331$  for parents). This was necessary in order to ensure that each word uttered was mapped onto the correct part of speech.

Each utterance was binned by child age in months and tagged for number of tokens in the utterance, the speaker role (parent vs. child), and polarity (positive vs. negative). Negative utterances were further coded for the presence of ‘no,’ ‘not,’ and ‘nt,’ as well as for syntactic position of the negator. There were 101,786 negative child utterances in the data, and 190,293 negative parent utterances. Repeated instances of ‘no’ were condensed to a single instance. Single-word negative utterances were removed, as well as utterances in which the negative was combined repetitively with extra-syntactic particles (e.g. “ah no,” “no oh oh”) ( $N = 53,969$  for children,  $32,966$  for parents). After all processing, the dataset contained 47,817 negative utterances from 462 children, and 157,327 negative parent utterances. All data and analyses are available in the study’s online repository<sup>2</sup>.

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<sup>2</sup>You can access the repository at [https://github.com/annikamh406/child\\_negation\\_acquisition\\_thesis](https://github.com/annikamh406/child_negation_acquisition_thesis)

### 3 Sentence-External Stage

The first question the production study addressed was whether children go through a stage in their linguistic development during which their negative utterances consist of a positive sentence nucleus composed with and an external negator, as in ‘no the sun shining.’

#### 3.1 Literature Review

The possibility for a stage during which children produce negative words externally to the negated proposition was first proposed by Klima and Bellugi (1966). Specifically, Klima and Bellugi (1966) claimed that during this stage, children’s negative utterances were of the form [{‘no’/‘not’} + Nucleus] or [Nucleus + ‘no’], where ‘Nucleus’ referred simply to the phrase or fragment being negated. Crucially in this stage, the only negative morphemes in children’s lexicons were ‘no’ and ‘not’; negative auxiliaries were hypothesized to arise only in later stages.

The evidence that Klima and Bellugi (1966) provided for their sentence-external stage included utterances such as ‘no the sun shining’ and ‘wear mitten no’ in which the Nucleus consisted of a subject and a predicate, as well as less complete utterances of the form ‘not fit’ and ‘no play that.’ However, as de Villiers and de Villiers (1979) pointed out, because children often drop the subjects of their utterances, it is impossible to determine whether an utterance like ‘not fit’ is a manifestation of sentence-external negation (i.e. ‘not it fit’), or sentence-internal negation (i.e. ‘it not fit’). Thus, only utterances with an overt subject present (ie. [{‘no’/‘not’} + S], where S = [subject + predicate]), can be taken as strong evidence for utterance-external negation.

The debate surrounding sentence-external negation was further complicated by

Bloom (1970)’s finding that, while utterances of the form [‘no’ + S] do occur, the vast majority of these are in fact anaphoric in nature— that is to say, instead of negating the truth value of the following sentence S, the ‘no’ is negating some previous utterance or event. For example, a parent might ask ‘Do you want juice?’ and a child might answer ‘No, I want milk.’ In this case, it is clear that the child’s use of ‘no’ is intended to negate the proposition previously uttered by the parent, ‘you want juice,’ not the following statement that ‘I want milk.’

Wode (1977) drew on this anaphoric account in his analysis of German-speaking children, claiming that children go through an initial stage of anaphoric negation, but then move into a second stage in which truth-functional pre-sentential negation ([‘no’ + S]) arises as an overgeneralization of earlier anaphoric utterances. de Villiers and de Villiers (1979) agreed that pre-sentential negation occurs in child speech, but claimed that it does not constitute a stage, and instead is an occasional overgeneralization of parental anaphoric negation.

Drozd (1995) contested these claims, and converged with Bloom (1970) in finding that all but about 10% of children’s utterances of the form [‘no’ + S] were anaphoric. Furthermore, Drozd claimed that the remaining 10% of utterances were not truth-functional pre-sentential negation, but were in fact instances of metalinguistic negation: ‘no + X’ was akin to saying ‘Don’t say “X!”’ Drozd came to this conclusion on the basis that children’s pre-sentential negative utterances that were not anaphoric tended to echo previous utterances and were compatible with the paraphrase ‘Don’t say X’ in context. Under this account, children’s apparently ungrammatical uses of pre-sentential negative utterances would actually be simple over-generalizations of the use of the word ‘no’ to otherwise grammatical metalinguistic negation.

Despite the several alternatives discussed above, the concept of a sentence-external stage of development is still pervasive in the field. Park (1979)

claimed that an anaphoric pre-sentential use of ‘no’ develops out of an earlier truth-functional sentence-external stage, and Déprez and Pierce (1993) took the occurrence of a sentence-external stage for granted, and Thornton and Tesan (2013) treated the possibility of a sentence-external stage as an open question in the field. Thus, the literature appears to remain undecided on the issue of sentence-external negation, both in terms of its existence, and in terms of its nature and causes.

### 3.2 Methods

In order to assess the occurrence of a sentence-external negative stage, I used CHILDES part of speech tags to divide the syntactic positions of children’s negators into several categories. Cases where ‘no’ or ‘not’ combined externally with a sentence (by definition containing an NP and a VP) were marked as [NEG + S] and [S + NEG]. Utterances where ‘no’ or ‘not’ occurred either before or after an utterance not satisfying the definition of ‘sentence’ above were marked as [NEG + X] and [X + NEG]. Finally sentence-internal negatives were split into a simple [NP + NEG + VP] category and a category for all other internal negatives. Figure 1 shows the syntactic distribution of children’s multi-word utterances of ‘not’ across these categories between 18 and 36 months. There were very few to no multi-word negative utterances in any age bin younger than 18 months.

### 3.3 Results and Discussion

If we limit our criteria to strict sentence-external negation, defining a sentence exclusively as an overt subject NP + VP, then the case of ‘not’ utterances is clear-cut: children produce almost no instances of strict sentence-external ‘not’ ([not + S] or [S + not]) at any age (Figure 1). If we expand our definition of ‘external’ to include utterances of the form [not + X] or [X + not], where X is some expression that does

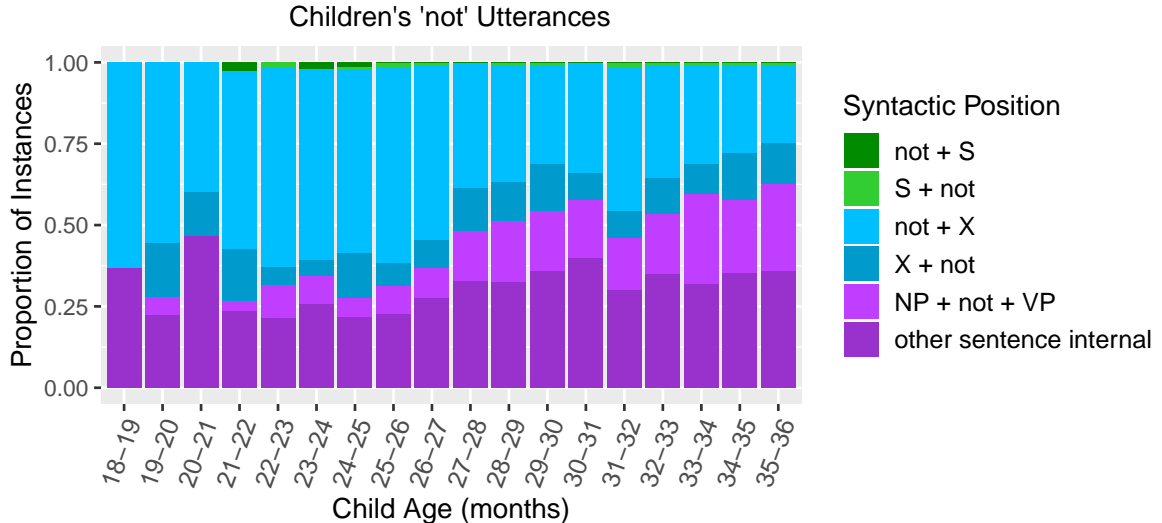


Figure 1: Syntactic analysis of children’s ‘not’ utterances between 1 and 3 years of age.

not fit our strict definition of a sentence, the story becomes more complicated.

Instances of this utterance-external ‘not’ account for more than half of all multi-word ‘not’ utterances in several younger age bins. However, as discussed above and in previous literature, counting such [not + X] utterances (which include subject-drop sentences) as sentence-external requires the additional stipulation that there is a covert subject between the negator and the rest of the utterance (and crucially not before the negator). It is not clear if such stipulation is warranted, and corpus data may not be able to adjudicate this matter. It is worth noting that many utterances of the form [X + not] are grammatical in adult speech (e.g. “why not,” “no it’s not”). Furthermore, even with the stipulation of covert subjects, it is still the case that as soon as children begin to use ‘not’ in multi-word utterances, they are already also using it sentence-internally, making an initial stage of sentence-external ‘not’ appear much less likely given the available corpus data.

Turning now to children’s early uses of ‘no,’ Figures 2 and 3 illustrate the syntactic distribution respectively of children’s and parents’ multi-word ‘no’ utterances between 18 and 36 months. Again, due to potential elisions, utterances

where ‘no’ combines with a full sentence [NP+VP] are most convincing. The number of [S + no] utterances is relatively small at all ages for children and adults.

Utterances of the form [no + S] do occur with considerable frequency, but as pointed out by previous literature (Bloom 1970; Wode 1977; Drozd 1995), pre-sentential ‘no’s can be anaphoric and not truly sentence-external as intended by Klima and Bellugi (1966). My large-scale analyses provide two types of evidence suggesting that such utterances do not constitute strong evidence for a pre-sentential stage.

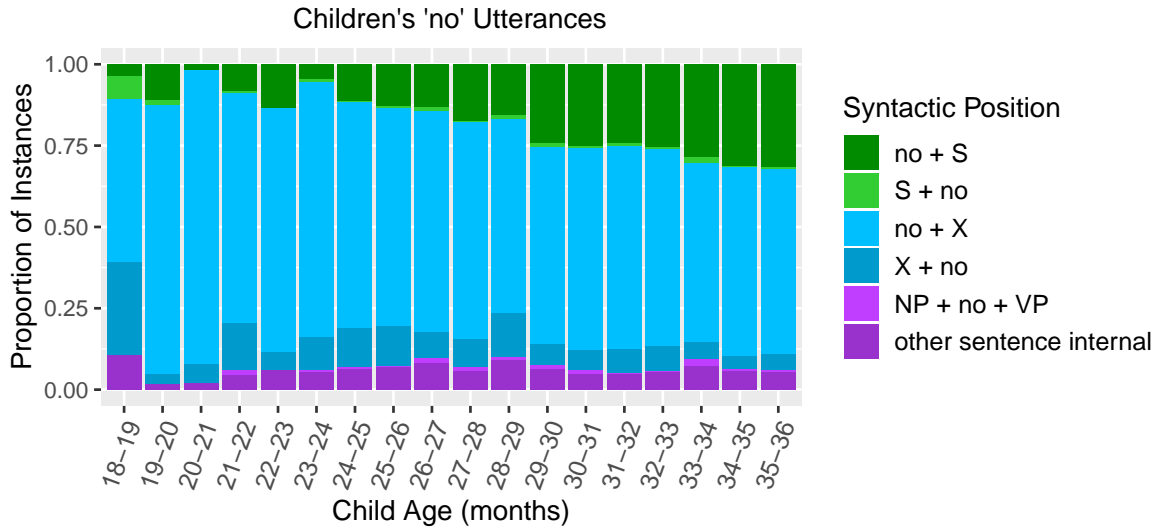


Figure 2: Syntactic analysis of children’s ‘no’ utterances between 1 and 3 years of age.

First, [no + S] utterances account for between a quarter and a half of all parental multi-word ‘no’ utterances as well. Since it is safe to assume that parents do not produce ungrammatical ‘no’-external utterances, we can expect this rate in parental speech to reflect grammatical anaphoric cases of ‘no.’

As Figure 2 shows, children start with low proportions of [no + S] utterances and the proportions increase gradually until they reach the adult level. This pattern is the opposite of what a non-adult-like pre-sentential stage predicts, namely initial prevalence of non-adult-like pre-sentential utterances and their gradual decrease. The observed pattern is more consistent with children learning to follow anaphoric negators with longer and more complex utterances until they reach adult level

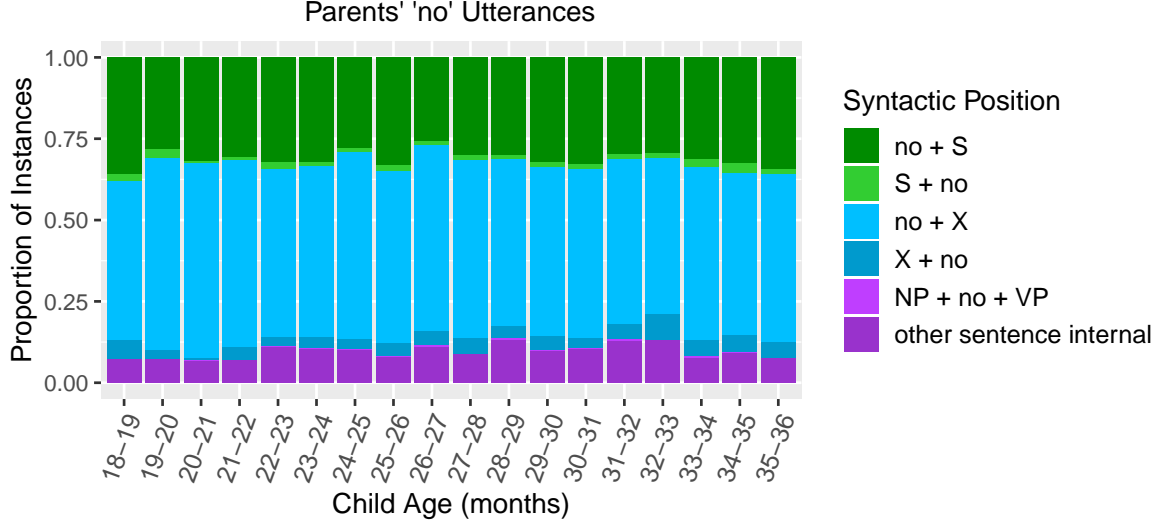


Figure 3: Syntactic analysis of parents’ ‘no’ utterances to children between 1 and 3 years of age.

production.

Second, Figure 4 shows the breakdown of presentential utterances by children and their parents into cases where the sentence composed with the negator is itself negative in polarity (e.g. ‘no I didn’t’; coded as [no + S\_NEG]), and cases where the internal sentence has positive polarity (e.g. ‘no I run’; coded as [no + S\_POS]). An utterance of the form [no + S\_NEG] is not compatible with the pre-sentential negation hypothesis, as the S\_NEG itself exhibits already sentence-internal negation. Ultimately, the only way to know for sure whether cases of [no + S\_POS] are anaphoric or not is through careful examination of the context and annotation of instances. As discussed in Section 3.1, Drozd (1995) looked at a subset of such cases and found less than 7% of these cases plausibly pre-sentential and non-anaphoric.

### 3.4 Conclusions

The first question asked in the production study was whether children go through a stage during which their negators are realized externally to their utterances. I found



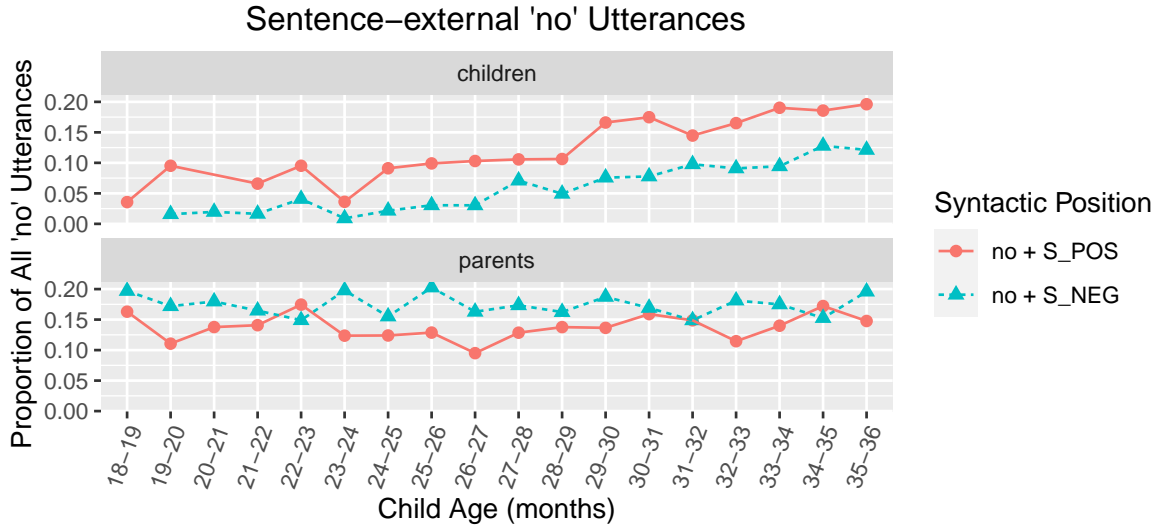


Figure 4: Parents' and Children's ['no' + S] utterances.

that, while children do produce a number of apparently sentence-external negatives, the vast majority of these utterances use 'no' instead of 'not,' and specifically are of the form [no + S]. Instances of this form do not swell early and then dissipate, as would be expected of an early stage of production, but rather are initially infrequent and slowly climb to adult levels. Furthermore, many of the propositions following these apparently pre-sentential 'no's are in fact negative themselves, making a truth-functional pre-sentential reading much less likely. I claim that these findings provide no evidence to support a sentence-external stage of negation development, and join Bloom (1970), Wode (1977), Drozd (1995), and others in proposing that my observations are more consistent with an analysis of [no + S] utterances as largely anaphoric, with the negator negating some previous event or statement.

## 4 Unanalyzed Negative Auxiliaries

A second issue addressed in the production study was the claim that children initially treat negative auxiliary verbs (e.g. ‘don’t’ and ‘can’t’) as single, monomorphemic negators, not as auxiliary verbs combined with ‘nt,’ as they are coded in the adult lexicon. In this section, I will bring new data to bear on two claims in the literature that pertain to this issue.

### 4.1 Literature Review

The unanalyzed auxiliary proposal was initially supported by the claim that the negative auxiliaries ‘don’t’ and ‘can’t’ appear in children’s speech before their positive counterparts ‘do’ and ‘can,’ and furthermore that ‘don’t’ and ‘can’t’ are present in children’s speech long before other negative auxiliaries (e.g. aren’t, shouldn’t, etc.), indicating that initially ‘nt’ is not combinatorially productive Jasbi et al. (In press).

As a plausible explanation for unanalyzed auxiliaries, Thornton and Tesan (2013) proposed that children learning English initially hypothesize that all negation is adverbial— i.e. the negative appears as an adverbial adjunct on the predicate— and that children only later learn to add a negation phrasal head to their syntax. The authors proposed that this early adverbial stage explained Klima and Bellugi’s unanalyzed auxiliary stage. This claim depended on the assumption that English ‘not’ is an adverbial negator, but that English ‘nt’ is a negative head. The argument was that if children only had access to adverbial negation, they would be forced to coerce negative auxiliaries into an adverbial system, and adverbs in English do not vary under tense or person. Thus, the use within the adverbial system of words that adults analyze as negative auxiliaries would result in failure to mark these words for tense and agreement. As evidence for an initial adverbial stage of negation, Thornton and

Tesan (2013) cited a sharp transition in children’s third person utterances from ‘not’ to [aux + ‘nt’], hypothesizing that this was the moment of transition to head negation.

Schütze (2010), however, disputed the conclusion that ‘don’t’ is unanalyzed, citing the asymmetry of errors in children’s productions of ‘don’t’ and ‘doesn’t,’ as well as the absence of predicted mistakes such as ‘he’s don’t singing,’ as evidence that children are already at this stage differentiating between ‘don’t,’ ‘doesn’t,’ and ‘not.’ Schütze concluded from these data that children are in fact analyzing ‘don’t’ and ‘doesn’t’ as [auxiliary + nt], and that any errors are caused by underspecification for inflection in the child’s lexicon.

## 4.2 Methods

I designed my experiment to assess the twin claims that children initially hypothesize that all negation is adverbial, and that in early children’s speech, the negators ‘don’t and doesn’t’ act as unanalyzed monomorphemic negators. In order to do this, I created two subsets from the CHILDES dataset of negative child utterances. First, I filtered the CHILDES dataset for only utterances in which the negator was preceded by either a third-singular pronoun or a proper noun, and followed by a lexical verb (e.g. ‘Mama not eat’;  $N = 2,350$ ). Proper nouns ending in ‘s’ and open class nouns were not included because the CHILDES part of speech tags did not include a marker for number, so my code was unable to accurately classify these nouns as plural or singular. The limitation to third-singular nominals was made in order to emulate Thornton and Tesan (2013)’s conditions as closely as possible.

Second, in order to more directly evaluate the question of negative auxiliaries, I filtered the CHILDES dataset for only utterances containing ‘don’t’ or ‘doesn’t’ following a pronoun (e.g. ‘I don’t like,’  $N = 8,095$ ). I then did the same for utterances

containing the corresponding positive ‘do’ or ‘does’ following a pronoun (e.g. ‘He do go’;  $N = 4,514$ ) These limitations were necessary because, in order to test for subject-auxiliary agreement, both the subject and the auxiliary must be marked in some way for person and number. ‘Does(n’t)’ is exclusively correct in third-singular contexts, so it serves as a good test for accurate person and number agreement. In English, third person singular pronouns (‘he,’ ‘she,’ ‘it’) are morphologically distinct from all other pronouns, so it is always possible to determine automatically whether a pronoun followed by ‘do(n’t)’ or ‘does(n’t)’ is in correct agreement. Once the data were filtered, I tagged children’s utterances as either third-singular or not third singular, and for the use of ‘don’t,’ ‘doesn’t,’ ‘do,’ or ‘does.’

### 4.3 Results and Discussion

I first examined the claim that children learning English initially hypothesize that all negation is adverbial, and only later learn to add a negation head to their syntax (Thornton and Tesan 2013). The motivation that the authors provided for this theory was evidence that children transition sharply from using ‘not’ to using negative auxiliaries in third singular negative utterances. They hypothesized that this moment of transition was the moment that a negation head was added to the lexicon. My findings are presented in Figure 5. Instead of a transition, I found constant, relatively high levels of negative auxiliary use in third singular contexts, and constant, relatively low levels of ‘no and ‘not.’ These results failed to confirm Thornton and Tesan (2013)’s findings. While my results are not strictly inconsistent with a shift from adverbial to head negation, they do provide a point against that account, as the distribution of children’s third person negators remains virtually constant throughout the acquisition period, and does not show any sudden transitions or changes that might be indicative of a paradigm shift.

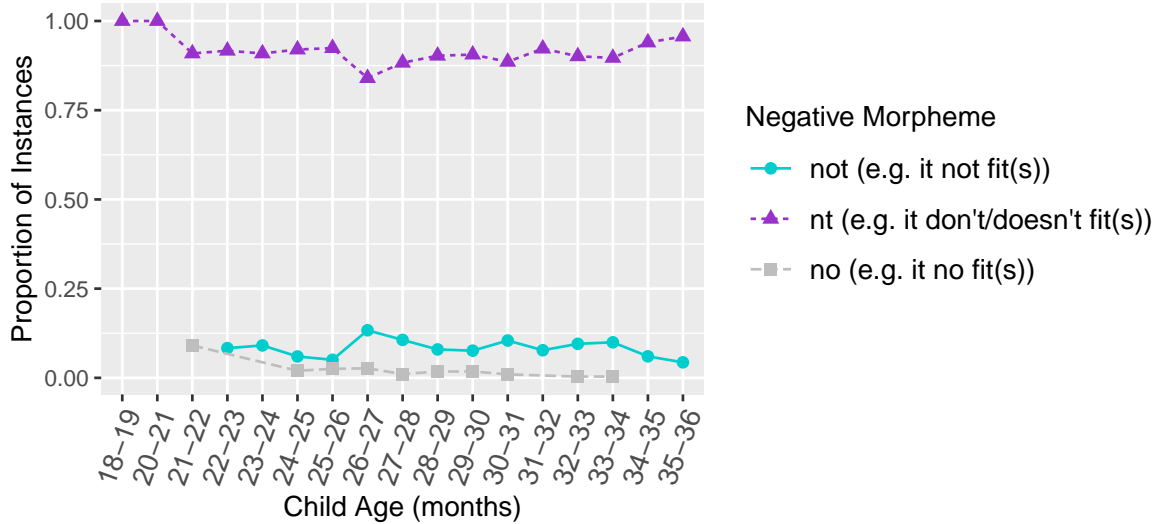


Figure 5: Breakdown of children's negative utterances after a third singular subject (and composed with a lexical verb) between 1 and 3 years of age.

Second, I addressed the prediction that, if children's negative auxiliaries are initially unanalyzed, they ought to be distributed without reference to person or number (Schütze 2010). For this purpose, I used the case study of the distribution of 'don't' and 'doesn't' across third-singular and non-third-singular contexts. If negative auxiliaries were truly untensed, we would expect to see symmetrical use of 'don't' and 'doesn't' across both syntactic contexts. However, what we find instead is a clear asymmetry in the pattern of errors (Figure 6). Children's uses of 'don't' are distributed across both third-singular and non-third singular contexts, but 'doesn't' appears almost exclusively in the third-singular context, where it is grammatically correct in adult speech. This asymmetry indicates that at least 'doesn't' is analyzed as an element that agrees for person and number with pronouns.

At first glance, the fact that children use 'don't' in both correct non-third singular and incorrect third singular contexts might appear to support the claim that 'don't' is not correctly analyzed at this stage. However, precisely the same pattern reveals itself in children's positive utterances containing 'do' and 'does' – children again produce 'does' almost exclusively in correct third-singular contexts, but

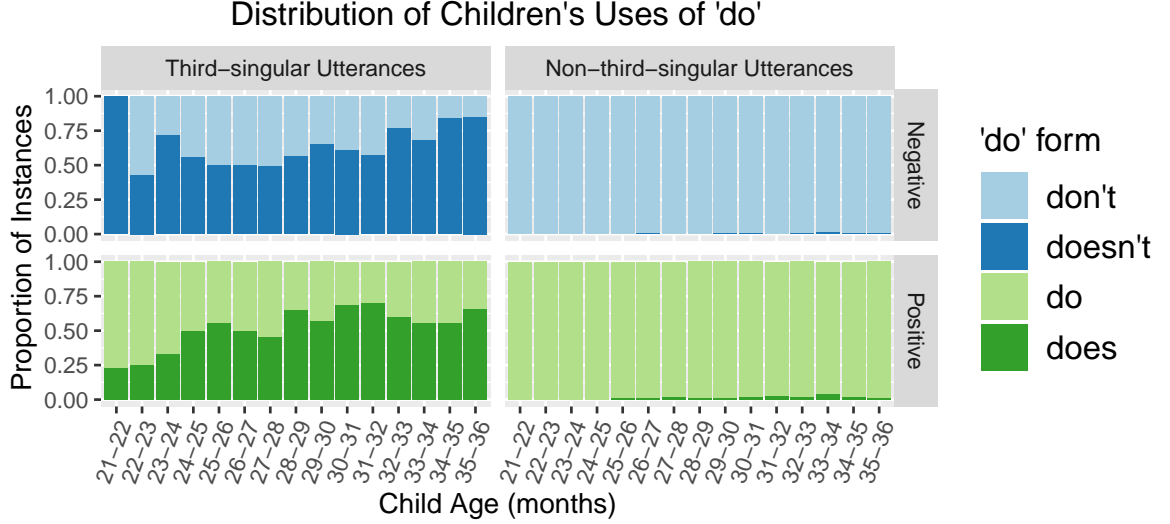


Figure 6: Children’s positive and negative utterances of *do(n’t)* and *does(n’t)* before 3 years of age.

produce ‘do’ in both correct and incorrect contexts (Figure 6). Thus, the incorrect ‘don’t’ utterances that we observe are in fact expected under the hypothesis that children are already at this age parsing ‘don’t’ as consisting of an auxiliary attached to the clitic ‘nt,’ and their mistakes can be simply explained as mistakes in agreement for the auxiliary ‘do.’ These results converge with the findings of Schütze (2010).

#### 4.4 Conclusions

In this section, I examined the claim that children initially treat negative auxiliaries as irreducible units (Klima and Bellugi 1966). I found that children discriminate their uses of the words ‘don’t’ and ‘doesn’t’ by the person and number of the subject from their earliest multi-word uses, and in fact that the distribution of children’s ‘don’t’ and ‘doesn’t’ utterances matches that of their positive ‘do’ and ‘does’ utterances. Furthermore, I failed to replicate the findings by Thornton and Tesan (2013) that children shift from using ‘not’ to using negative auxiliaries in their third person utterances. Instead, I found relatively constant proportions of each negator throughout the age period below 36 months, making a sudden paradigm shift in

children's understanding of negation, such as a shift from adverbial to head negation, appear much less likely. Both of these findings add to the evidence against an initial stage during which negative auxiliaries are treated as unanalyzed whole negators.

## 5 Comprehension Study

The overarching goal of the comprehension study was to perform comparisons of children’s comprehension of various negators used in various functional contexts in order to better understand the versatility of children’s negative concepts. In order to do this, I developed a novel looking time experiment, modeled after a word-learning study by De Carvalho et al. (2021). The new paradigm avoided demands on inhibition by using surprise (measured through looking time) as the dependent measure instead of children’s choices, and removed the complications of word-learning present in De Carvalho et al. (2021)’s study. As a proof of concept, the study is being initially tested on 27 month olds, who have been shown robustly to understand negation (Feiman et al. 2017; Austin et al. 2014). If successful, the paradigm will be expanded to younger children in order to conceptually replicate De Carvalho et al. (2021)’s finding of a comprehension age around 18 months. Then, the study will be extended to test other forms and functions of negation, allowing for controlled comparisons across the different negators in various functional contexts. As I was unable to run the original in-person version of this study due to the COVID-19 pandemic, I instead pivoted to develop an on-line methodology that works over Zoom, and I present preliminary piloting data of that new version here.

### 5.1 Literature Review

In addition to learning the syntactic contexts for the various negators, children must also learn their semantic values. This has the potential to be a difficult conceptual task. It is still an open question whether or not there exists something like an innate negative operator; if there does not, then we must ask ourselves how children eventually come to understand the abstract concept of negation as a reversal of truth



values. One proposal on this front is that children first learn simpler, more domain-specific negative functions like rejection and non-existence, which have emotional and perceptual bases, and thus do not rely on the ability to represent the truth value of a proposition. Under this model, children must then learn to generalize these functions into the adult concept of negation.<sup>3</sup> Much work has been done to classify children’s early negative utterances, and to characterize the role of language in the formulation of early negative functions.

Bloom (1970) was the first to propose the classification of children’s early negative utterances into functional categories, and the categories she discussed were non-existence (e.g. ‘there’s no juice’), rejection (e.g. ‘don’t want juice’), and denial, which she described as the assertion that an actual or supposed predication was not the case (ie. what I have been referring to as ‘adult’ or truth-functional negation). With these categories in place, Bloom went on to propose an order of acquisition—non-existence, rejection, then denial—and to analyze the form and syntax of children’s negative utterances with respect to these functions. Bloom found that, in some children, functional negative categories were differentiated from each other by the form of the negator (e.g. ‘no more’ for non-existence, ‘don’t’ for rejection). Notably, in Bloom’s data, it was not true that all children attached the same form to the same function; rather, it was just the case that (for some of the children) some form mapped onto each function—though other children did not formally differentiate the functions at all.

Subsequent researchers have objected to Bloom’s taxonomy of negative utterances. de Villiers and de Villiers (1979) proposed to divide Bloom’s

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<sup>3</sup>I acknowledge that I am assuming here that there is such a thing in the adult semantics as abstract, truth-functional negation, and that this concept underlies every (or most) adult use of ‘no,’ ‘not,’ and ‘nt.’ This is not a necessary assumption; it is possible that what I refer to as adult negation is in fact itself composed of several similar but specialized functions. I know of no conclusive evidence adjudicating this issue, so for the purpose of the present argument I will assume that the words ‘no’ and ‘not,’ and the clitic ‘nt’ are all capable of representing the inversion of the truth value of a proposition.

non-existence function into non-existence, disappearance, nonoccurrence and cessation, while Choi (1988) left non-existence intact, but added categories for prohibition, failure, inability, epistemic negation, normative negation, and inferential negation. Many more recent researchers have taken some or all of these modifications for granted, but there is no consensus on which, if any, functional categories are relevant or useful. Moreover, very little evidence has been provided for the existence of such functional categories in children's (or adults') cognitive representations of language. Bloom provided little motivation for her original proposal of categories beyond personal intuition, and many later researchers took the existence of functional categories for granted, disputing only which categories should be posited.

There have been several different theories since Bloom (1970) for how the forms of children's negative utterances interact with the functions that they express. de Villiers and de Villiers (1979) agreed that each new function was learned with a specific form, but added that the choice of that form depended on the frequency of the form in the input of that function. Choi (1988) complicated the picture, finding that some functions were at first formally identical, and then later came to be differentiated by the addition of new negative forms into the child's speech. These new negative forms also appeared to introduce new functions of negation, leading Choi to conclude that the learning of negative language contributed to the conceptual development of negation. It is important to note that, while semantic functions are ideally defined by their contexts, often limited available context data forces researchers to rely on the form of the utterance to define the function, trivializing the relationship between form and function.

One piece of evidence for the salience of categories for at least non-existence and desire/rejection is found in Japanese children's acquisition of negation (McNeill and McNeill 1968). Japanese has four different lexical negators, among which are *nai* (adj), which negates existence, and *iya*, which negates internal desire. The two other

negators are both versions of denial negation, one of which facilitates entailment of an alternative truth. These facts about Japanese, along with McNeil and McNeil's finding that children first learn to differentiate the features separating non-existence and desire negations, have been cited as evidence for the existence of these categories in English, although there is no clear lexical distinction delineating them in English.

More recently, Cameron-Faulkner, Lieven, and Theakston (2007) presented a very different picture of the form-function relationship. Instead of defining the form of negation as standard combinations of words with negators (e.g. 'no more,' 'don't want') as Bloom did, Cameron-Faulkner et al. focused simply on the form of the negator itself (e.g. 'no,' 'not,' 'nt') as it appeared in the neg + verb construction, only including negators in their analysis that met their productivity criterion of combining with at least three different lexical items. This is a significant departure from Bloom's approach, as an utterance like 'no more' could easily be an unanalyzed chunk, and thus has no bearing on the general productivity of the negator 'no.'

Cameron-Faulkner et al. studied the developmental trajectory of a single child, finding that he learned 'no' productively first, then 'not,' then 'nt.' Furthermore, this trajectory remained stable within specific functions, and the rate at which he learned each morpheme was related to the quantity of input in that particular function. As this study was of a single child, there are few generalizations that can be made, but it does provide some evidence for a usage-based model of negation acquisition.

The above study, as well as the work of Bloom, Choi, and others, has been taken as evidence for the existence and relevance of semantic functions of negation in children's minds. However, even taking the existence of these functions for granted, it is clear that the literature on children's natural production of negation has not come to a consensus on which negative functions exist in a cognitively meaningful way, nor on the order in which these functions are acquired by children. Laboratory experiments can provide a useful supplement to the above corpus work because they

allow researchers to control for more variables and tune in to finer-grained distinctions, but they bring with them complications of their own.

When negative utterances arise in natural speech, they are made pragmatically felicitous by their physical and conversational context. For example, it would be unnatural to say ‘the ball is not red’ unless there were some a priori reason to have believed that the ball was red. One challenge in designing an effective laboratory experiment to test comprehension of negation is to manufacture a context where the negative utterance is not out of place. Underscoring this fact, Wason (1965) showed that adults process negation more quickly in a context where the negated feature has been made salient. Participants were shown an array of dots, one of which was a different color from the rest. They were then asked to complete sentences of the type ‘[this circle] is not...’ with a color word for both the outlier circle and one of the other matching circles. Adults’ reaction times were significantly faster for the outlier circle, whose difference from the norm was salient, than for the matching circles. For example, a participant might have been shown an array of blue dots with one red dot. The red dot violates the pattern of the rest of the array, so it is pragmatically relevant to assert that it is not blue; in contrast, there is no expectation established for any of the blue dots to be red, so it is unnatural to assert that one of the blue dots is not red.

De Villiers and Flusberg (1975) extended this result to children, using a similar experimental method with a single outlier in a uniform group (e.g. a row of cars and a single bottle). They found that 2 to 4 year old children responded more slowly and made more errors when asked to complete an infelicitous negative sentence about a member of the uniform group than with a felicitous one about the outlier. They further found that 2 year olds performed badly overall on negative sentences of all types. These findings emphasize the necessity of developing pragmatically natural experimental tasks, especially for young children, who can be easily overwhelmed by increased processing demands.

There have been several studies testing comprehension of negation using paradigms with children's actions in response to stimulus as the dependent measure. Feldman (1972) tested children on their ability to apply negated predicates to set membership by presenting children with sets of wooden blocks that varied along axes of color (red, black, green) and shape (square, circle, star). Children were asked to 'give me the things that are not X (e.g. red),' and a child was coded as having responded correctly if they gave the experimenter all of the blocks that belong to the relevant set. Feldman (1972) found that even by age 6, children were performing significantly worse on negative trials (<70% correct) than on positive trials (>90% correct). This result is initially surprising, but a further testing found improved performance with smaller set sizes, implicating difficulty keeping track of large sets of blocks as the limiting factor in children's success, not comprehension of negation *per se*.

Austin et al. (2014) and Feiman et al. (2017) both also used children's actions in response to stimulus as a measure of comprehension. Both research teams independently converged on a method in which a child is given some clues and then asked to search for a toy in one of two locations. In Austin et al. (2014)'s study, one experimenter hid a block in either a house or a bucket, and then another experimenter asked 'is it in the X?' In the one-word condition, the first experimenter answered 'yes' or 'no,' and in the proposition condition, the first experimenter answered 'it is in the X' or 'it's not in the X.' The child was then allowed to search for the block. Austin et al. (2014) found that children failed in both negative conditions at age 1;8 - 1;10, but succeeded in both conditions at age 2;0 - 2;2. A surprising result in Austin et al.'s data was that children succeeded in negative tasks before they succeeded in affirmative ones.

Feiman et al. (2017), however, did not replicate this finding. Feiman et al. used a nearly identical paradigm, with two verbal conditions. In the first condition, the

child was told by the experimenter who had hidden the toy either ‘it’s in the X’ or ‘it’s not in the X.’ In the second condition, the child’s parent was instructed to ask ‘is it in the X?’ and the experimenter responded with either ‘yes’ or ‘no.’ Feiman et al. diverged from Austin et al. (2014) in finding that children at all ages in both conditions were able to successfully interpret affirmatives. In negative trials for the first condition (‘it’s not in the X’), Feiman et al. found success only at 27 months, with 20 month olds treating negatives like affirmatives. However, when trials were blocked so that children saw affirmatives before negatives, performance improved, with marginal success in 24 month olds. In their second condition (‘is it in the X?’; ‘no’), Feiman et al. found similar ages of success, but no effect of trial order.

Crucially, Feiman et al. also tested children in a non-verbal condition, where they were shown visually that one of the two hiding places was empty. In this condition, even 20 month olds succeeded, implying that the failure of 20 and 24 month olds in the above study was a linguistic limitation, not a limitation on inhibition or logic. Taken together, these two studies paint a picture in which negation comprehension arises early in the second year, although they disagree in many of the details. They also illustrate the importance of task demands to children’s success, finding evidence of an effect of trial order, which indicates that children had an easier time processing the negative sentences when they had already had a chance to familiarize themselves with the paradigm.

There have been several studies which used children’s eye movements as the dependent measure instead of their actions. Nordmeyer and Frank (2014) used a preferential looking task in which children were presented with cartoons of two boys, one holding apples, and one empty handed. Children were told to ‘look at the boy with no apples.’ Nordmeyer and Frank (2014) tested 2, 3, and 4 year olds, but only 4 year olds looked to the target boy significantly more than chance, and 2-year olds treated negatives like affirmatives, just as 20-month olds did in Feiman et al. (2017).

However, when the target boy was modified to be holding two gifts instead of being empty handed, 3-year olds succeeded as well, and 2-year olds were at chance. The authors' explanation for this shift was that the empty-handed boy was uninteresting, and thus that there was less incentive to inhibit glances to the boy with the apples.

Reuter, Feiman, and Snedeker (2018) used a very similar preferential looking procedure to test children's comprehension of the past tense auxiliary negator 'didn't.' The negator composed with transitive verbs like 'break' and 'close' in sentences like "DW didn't break one of the plates" (experiment 1) or "show me the one DW didn't break" (experiment 2). Participants (2 and 3 year olds) were shown a cartoon character and two objects, one of which exhibited a state change due to the verb (e.g. one intact plate and one broken plate), and the dependent measures included both time looking at the target object and correctly pointing to the target object. 3 year olds succeeded at both looking and pointing in both experiments. In experiment 1, 2 year olds were marginally successful in looks, but at chance in points. In experiment 2, affirmative and negative trials were blocked, and 2 year olds succeeded in both metrics when affirmative trials occurred first, as in the Feiman et al. (2017) study. Notable in this study is the fact that in experiment 1, 2 year olds performed better in the looking time measure than the pointing measure, implying that implicit reactions such as looking time may be earlier indicators of negation comprehension than deliberate responses.

Overall, the above studies seem to imply an earliest age of comprehension around 2 or 3 years old, although some studies have found difficulty with negation even as late as 6 or 7 years old (Feldman (1972), Slobin (1966)). However, De Carvalho et al. (2021) found evidence of comprehension of 'not' at 18 months using a violation of expectation looking time paradigm. Many of the previously mentioned studies required children to choose, explicitly or implicitly, between two alternative choices. This task is known to be difficult for young children with limited executive

functioning capacity, and De Carvalho et al. (2021)'s study avoided this issue by using looking time as a simple measure of surprise without presenting two alternative options. They first taught French speaking children two novel words: 'bamoule,' a noun describing a penguin cartoon character on the screen, and 'pirdaling,' a verb describing either a cartwheeling or spinning motion. In the test trial, children were presented with the same character performing the opposite action from the familiarization trials: for example, if a participant had seen the penguin spinning in the familiarization trials, they saw the same penguin cartwheeling in the test trial. Children in the noun-switch condition were then presented with the false sentence 'Oh look! It's not a bamoule!' while children in the verb-switch condition were presented with the true sentence 'Oh look! It's not pirdaling!' De Carvalho et al. (2021) found that 18 and 24 month old children looked significantly longer at the screen in the false noun-switch condition than in the true verb-switch condition, implying that they were surprised by the statement rendered false by the negator.

This finding is a shift from earlier studies, where the youngest comprehension of negation was found around 24 months, and it warrants further exploration. The present comprehension study aims to conceptually replicate De Carvalho et al. (2021)'s results, and extend the findings to English speaking children. The study the aims to expand the paradigm described in Section 5.2 to other forms and functions of negation in order to better understand how negative language contributes to and interacts with early negative concepts.

## 5.2 Methods

This study was designed to test children's ability to understand the word 'not' applied to identity predicates. Children were shown several images one by one on a computer screen in conjunction with a recording of a sentence describing each picture.



Children were familiarized to positive, truth-preserving adverbs like ‘really’ as in ‘this is really a ball,’ and then tested on either the similar truth-preserving adverb ‘now,’ or the negative adverb ‘not.’ I predicted that if toddlers are sensitive to the functional role of negation in altering the truth conditions of statements, they will exhibit surprise (evidenced by longer looking times) in the false ‘not’ condition as compared to the true ‘now’ condition.

### 5.2.1 Participants & Materials

7 toddlers in the age range of 26 to 33 months have been tested so far in initial piloting. Participants were recruited from an online database largely centered in the area of Cambridge, MA, and families received a certificate and a \$5 Amazon gift card for participating.



Figure 7: Images of a ball, duck, and shoe presented to children during the study.

The experiment used three images: a beach ball, rubber duck, and a shoe (Figure 7). Images were selected from a free online repository. The images were selected to correspond with words that the children being tested are familiar with; according to MB-CDI data available through Wordbank (Frank et al. 2016), half of toddlers produce the nouns (‘ball,’ ‘duck,’ and ‘shoe’) by 18 months and almost all toddlers produce them by age 24 months (Figure 8). The positive adverbs used were selected from the set {‘really,’ ‘just,’ ‘only,’ ‘now’}, and ‘not’ was used as the negative adverb. 15 linguistic stimuli were recorded corresponding to the 15 combinations of the 5 adverbs used with the 3 nouns. Recordings are available in the study’s online

repository.

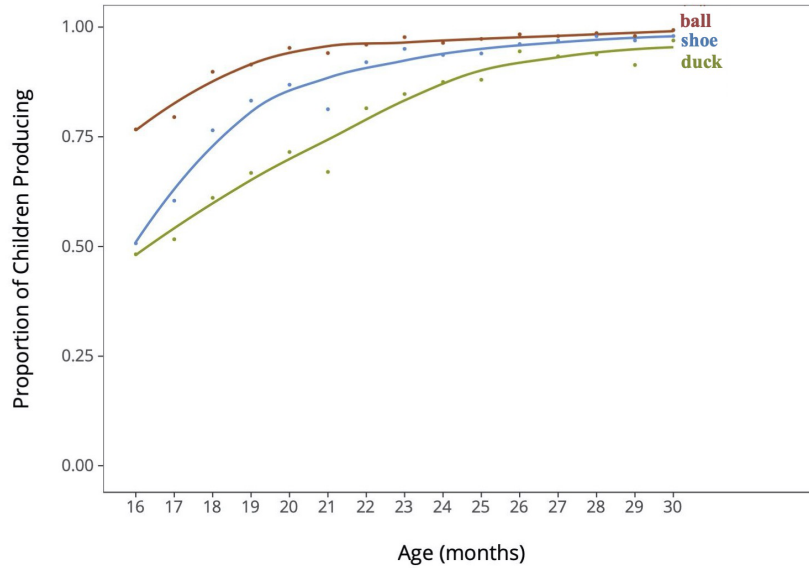


Figure 8: Item trajectories for the three nouns used in this study (Frank et al. 2016).

### 5.2.2 Procedure

The study consisted of two phases: familiarization and test. In familiarization trials, toddlers saw a picture and heard positive sentences of the general form “this is [adverb] a [noun],” where the noun spoken always matched the picture shown on the screen (e.g. a picture of a ball and the sentence ‘this is really a ball’). Positive adverbs were selected from the set {‘really,’ ‘just,’ ‘only’}, and paired with the nouns ‘ball,’ ‘duck,’ and ‘shoe.’ Children saw 6 randomly selected familiarization trials, chosen such that each adverb and noun was heard twice before moving on to the test trials. In each trial, first an attention getter appeared in the middle of the screen along with a short jingle. When toddlers looked at the screen, the object appeared and the audio of the sentence was played once, followed by a 4 second pause, and then the sentence audio again. The trial was not gaze-contingent until after the sentence had been played once through, and after that the trial ended when toddlers looked away from the screen for more than 2 seconds. Gaze coding occurred in real

time over Zoom using PyHab (Kominsky 2019), a PsychoPy-based stimulus presentation software (Peirce 2007). All sentences in the familiarization phase were true—the nouns matched the pictures shown, and the adverbs did not alter the truth condition of the sentence.

The test phase had two between-participant conditions: positive (control) and negative. The positive condition used the adverb ‘now’ and was similar to the habituation phase in that the adverb was positive and did not alter the truth conditions of the statement. The negative condition used the adverb ‘not,’ which reversed the truth conditions of the statement (e.g. a picture of a shoe and the sentence ‘this is not a shoe’). There were three test trials in each condition, one for each noun. Only in negative trials was the statement false with respect to the image on the screen. I predicted that if toddlers are sensitive to the truth conditional contributions of the adverb ‘not,’ they will exhibit more surprise in the negative condition relative to the positive (control) condition, as measured by a greater increase in looking time from the familiarization trials.

### 5.3 Preliminary Results

Interruptions due to the COVID-19 pandemic prevented the collection of a full sample, but some preliminary results are presented in Figure 9. Some qualitative observations can also be reported. One of the concerns with running a looking time study on 2 year olds was that they would bore quickly and would be unwilling to sit through the entire study. However, none of the piloted children seemed to get bored or needed to end the study early due to fussing. Additionally, although the study does not yet have the statistical power to draw any conclusions from looking times, the children tested in the negative condition exhibited clear subjective signs of comprehension, such as laughter in response to the unexpected false statement, and assertions that ‘it

*is a ball!*' Given this behavior and previous results showing comprehension by 27 months (Feiman et al. 2017; Austin et al. 2014), if the present study fails to find evidence for comprehension using the looking time metric, it will be taken as a failure of the methods used, not an inability of the children to comprehend negation.

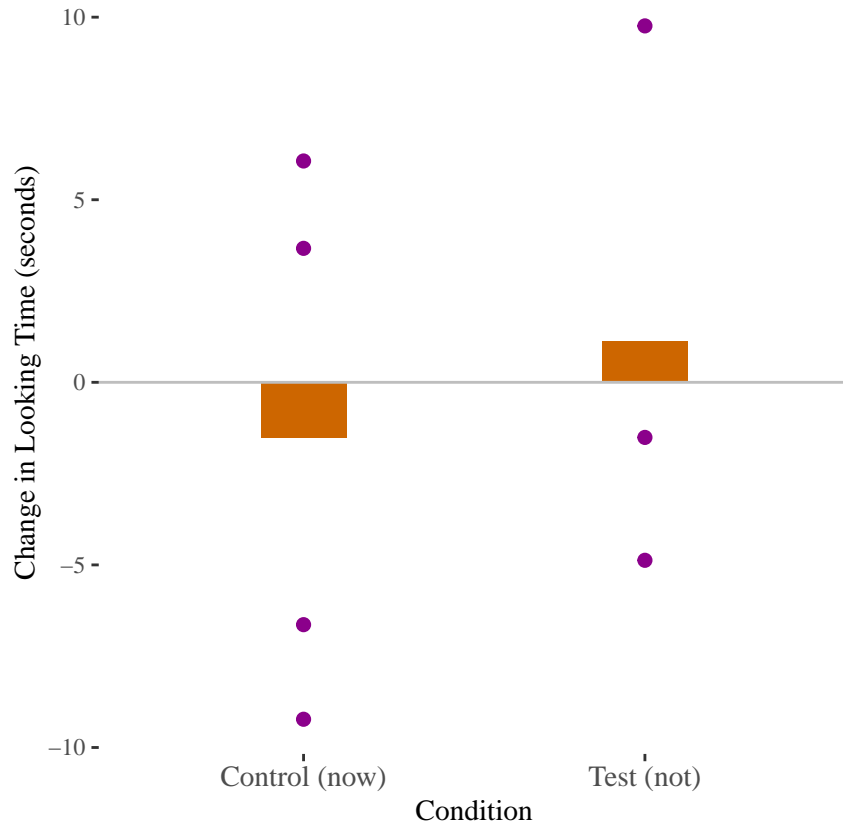


Figure 9: Preliminary Results: Looking time change in seconds between familiarization and test trials. Purple dots represent individual participants and orange bars represent mean looking times.

Evidence for successful comprehension in this study would be significantly longer looking times at the false negative condition (using ‘not’) than at the true positive condition (using ‘now’), relative to the final three familiarization trials. I will run a linear regression to test for significance, with the dependent variable being the difference in looking times between the familiarization and the test condition, and the independent variable being an indicator variable for participation in the negative test condition. If the present study does show evidence for comprehension, it will be

necessary to also test children in true negative (e.g. a picture of a ball with ‘this is not a duck’) and false positive (e.g. a picture of a shoe and ‘this is now a ball’) conditions. Success in the present study will be taken as a proof of concept, but these additional controls are necessary in order to ensure that the prosody of the recorded test sentences or unexpectedness of the specific test adverbs did not unduly influence the results.

## 5.4 Conclusions

The comprehension study had two professed goals: to confirm De Carvalho et al. (2021)’s finding of comprehension of negation at 18 months in a violation of expectation looking time task, and to provide a proof of concept for a method that can be used to compare across different forms and functions of negation. If the paradigm is successful, it will be expanded to test younger children, and to include different forms (e.g. ‘not,’ ‘nt’) and functions (e.g. non-existence, rejection) of negation.

These comparisons will allow us to paint a much clearer picture of the process of negation acquisition by helping us to understand whether there is a set order in which children learn the words that express negation, and whether those words first occur in specific functional contexts. These have in the past been questions asked largely in the negation production literature, but with a consistent means of comparison they can be asked in the comprehension domain as well.

## 6 General Discussion

### Production Studies

In the two production studies, I tested two claims that have existed for decades in the literature on children’s negation, but that were made on the basis of data from very few children. The first was the claim that children go through a stage during which their negators are pronounced externally to the utterances that they negate (e.g. ‘no the sun shining’ to mean ‘the sun is not shining’) (Klima and Bellugi 1966). I found that children’s negative productions in the CHILDES corpus did not exhibit a pattern consistent with a sentence-external stage, and furthermore that the distribution of children’s negative utterances was more consistent with an anaphoric explanation for many apparent sentence-external negators (Drozd 1995; Bloom 1970).

The second claim addressed was that children’s negative auxiliaries (e.g. ‘don’t,’ ‘can’t’) are initially treated as unanalyzed whole negators, and not as part of the auxiliary system (Klima and Bellugi 1966). I converged with Schütze (2010) in finding that the distribution of children’s sentence-internal utterances of ‘don’t’ and ‘doesn’t’ is dependent on the person and number of the subject. Furthermore, I found that the types of errors children make in the use of ‘don’t’ and ‘doesn’t’ track closely with the errors that they make in the use of the corresponding positive ‘do’ and ‘does.’ These results imply that children understand that ‘don’t’ and ‘doesn’t’ are sensitive to the features of the subject, and are not simply treated as unanalyzed adverbial chunks. Additionally, I failed to confirm Thornton and Tesan (2013)’s finding that children transition sharply between use of ‘not’ and use of negative auxiliaries (‘nt’) in their sentence-internal negatives. Instead, I found fairly constant levels of each negator at all ages, without any inflection point that might have been indicative of a shift from an adverbial analysis to an auxiliary analysis. Taken together, these results provide

evidence that, at least by the time children are producing negative auxiliaries within their sentences, they are already analyzing them as part of the auxiliary system.

Just as it was necessary to ask how generalizable the results of previous production studies are, it is now reasonable to ask the same question about the current production study. Recall that the objection to the early production studies [e.g. Klima and Bellugi (1966); Bloom (1970); Wode (1977); de Villiers and de Villiers (1979); etc.] was that they used (albeit fairly dense) data from relatively few children, and thus that any conclusions drawn from those data may be unique to the developmental trajectories of those specific children, and not necessarily generalizable to all children.

The present study could arguably be subject to the reverse objection: while the study included 47,817 negative utterances from 462 children, the density of data within many individual children was relatively low. Additionally, comparison across age bins often also entailed comparison between different sets of children, as many children did not have longitudinal data available. This distribution of data has the potential to obscure developmental stages, because different children go through developmental stages at different (and potentially non-overlapping) ages. However, if a true developmental stage existed, statistically we would still expect to see a peak of the relevant construction in some age range, and then a subsequent dissipation as children begin to mature out of the stage. It was this pattern that I was searching for in the production study, and it was the lack thereof that led to the conclusion that my data are inconsistent with stages of pre-sentential and adverbial negation.

The findings in the two production studies imply that children's early productions of negation are more combinatorially diverse than has previously been thought. Children's early negative utterances do not appear to be explicable by some single, general negative construction— such as a proposition-level operator or a

simple adverb— but rather are more productive and syntactically varied than previously assumed. If children are able to use negators productively in a wide variety of contexts, it is clear that they are not simply memorizing large immutable chunks of words to use for prescribed goals. This syntactic diversity and productivity in children’s early negators could be indicative of a similarly high combinatorial capacity of the concepts that underlie them, and thus of a fairly abstract concept of negation, at least by the age ranges studied. It is worth noting that the analyses in the production studies depend on children’s ability to produce at minimum full intransitive sentences, so any conclusions drawn can only be generalized to children with sufficient combinatorial ability to construct these sentences. Younger children’s conceptual knowledge of negation may be easier accessible through other means, including studies of comprehension.

### **Comprehension Study**

The local aim of the comprehension study was to replicate De Carvalho et al. (2021)’s finding of comprehension of negation at 18 months using a violation of expectation looking time paradigm. The longer-term goal of the study was to directly compare children’s understanding of various negators in different functional contexts. I presented some preliminary pilot data that supported the feasibility of the methods described.

Comparisons across negative forms and functions are theoretically significant because they speak to the question of whether or not children first map negative morphemes onto local, domain-specific negative functions, such as rejection or non-existence, before they are able to use or understand full, truth-functional negation. This question first arose in the literature on children’s production of negation, as first Bloom (1970) and then others [de Villiers and de Villiers (1979);



Choi (1988); etc.] proposed taxonomies of children’s early utterances that divided them into these local functional categories. However, the question of early negative functions cannot be adjudicated by production studies alone. It is entirely possible that utterances coded as rejection (eg. ‘no want juice’) are actually instances of truth-functional negation, and that early functions only seem salient because young children often find themselves in the position to be rejecting offers or complaining about non-existence (e.g. of food) (Feiman et al. 2017).

Work testing children’s comprehension of negation is not subject to the same contextual limitations as production work, so it has the potential to disambiguate this question. While in natural production studies we are limited to analysis of those speech events that naturally occur throughout the course of the recording, in comprehension studies we are able to manipulate the speech context such that we can test in a controlled way for comprehension of less frequent functions or constructions.

Looking ahead to possible outcomes of the comprehension study, one plausible finding is that children only understand negative morphemes in service of specific semantic functions, but not in more abstract, truth-functional contexts. This finding would be a strong point in favor of the cognitive relevance of these early negative functions. For example, we might find that young children are able to understand the word ‘not’ in contexts where something is being rejected (e.g. ‘not want’), but aren’t able to understand it in other contexts that can’t be mapped onto lower-level perceptual or emotional concepts (e.g. ‘not running’). In this case it could be argued that children have mapped ‘not’ (or perhaps the whole chunk ‘not want’) onto the concept of rejection, without generalizing it to an operator over truth values.

It is worth noting that such a finding would not preclude the possibility of an innate truth-functional negative conceptual operator. Rather, it would simply indicate that during the process of mapping meanings onto negative morphemes,

children *first* map the negators onto more local, low-level meanings. An early functional account is compatible with both the theory that children must construct abstract, truth-functional negation on the basis of external input, and that children do have an innate negative operator, but only learn to map it onto the negative morphemes after initially mapping simpler concepts onto them.

A second plausible finding of the comprehension study is that children begin to understand each negator in both lower-level and truth-functional contexts at the same time. This finding would imply that children do not go through a phase during which they understand the negators to mean simpler functions— as soon as children ascribe any meaning to negative morphemes, they ascribe the truth-functional meaning of negation to them. If this were the case, it would support the position that there is an innate truth-functional negative concept. It would be difficult to argue that a concept as abstract as reversing truth-values is a child's first hypothesis for the meaning of the morphemes 'no,' 'not,' and 'nt' without also postulating that that concept was innate. This is especially true given that the linguistic input contains many negative utterances that do fit into simpler functional categories like rejection or non-existence, so without some a priori predisposition, those simpler functions would make more natural initial mappings for the meanings of the negative morphemes.

In sum, these pilot data support the possibility of this comprehension study providing evidence for the order of acquisition of various forms and functions of negation. If further data exhibit the second pattern (i.e. that all functional meanings arise together), the production data and the comprehension data would converge. The production data suggested that children's conception of negation is abstract and combinatorially productive, and the comprehension data would in this case imply that that abstract concept is innate.

## 7 Conclusion

The human ability to acquire language is extraordinary, especially given the limited input that is present during acquisition. Even more extraordinary is children's ability to accomplish this feat as quickly and correctly as they do. Negation provides a compelling case study for this acquisition process, because the concept of negation as a reverser of truth values is highly abstract, and the language used to express negation is syntactically and morphologically complex. The three studies presented in this thesis investigate the processes by which children learn the syntactic intricacies of the linguistic negators and the abstract negative concepts that underlie them.

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