Categorical Acquisition: Parameter Setting in Universal Grammar

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Abstract

Three models of parameter setting are compared: the Variational model proposed by Yang (2002; 2004), the Structured Acquisition model endorsed by Baker (2001; 2005), and the Very Early Parameter Setting model advanced by Wexler (1998). The Variational model supposes that children employ statistical learning mechanisms to decide among competing parameter values. The model anticipates delays in parameter setting when the critical input is sparse, but anticipates that all children in the same linguistic community should undergo a similar, albeit gradual course of development. The Structured Acquisition model also anticipates delays in development, but delays occur, on this model, because parameters form a hierarchy, with higher-level parameters set before lower-level parameters. Assuming that children freely choose the initial value, children are expected to sometimes misset parameters. When that happens, parameter resetting should trigger a precipitous rise in one parameter value and a corresponding decline in the other value. To adjudicate between these models, and the Very Early Parameter Setting model, we conducted a year-long longitudinal study of four children who ranged in age from 1;9 to 2;1 at the start of the study. The children were in the throes of setting two interlocking parameters, one governing inflection and one governing negation. Different children were found to follow different developmental patterns for each parameter, with only some children initially assigning the 'correct' adult value. For these children, there was no evidence that the other value was in competition, as expected on the Variational model. Moreover, when parameter resetting took place for the other children, they exhibited a precipitous rise in the 'correct' value, and corresponding decline in the other value, as anticipated by the Structured Acquisition model. Taken together, the findings are interpreted as support for the Structured Acquisition model.

1. Introduction

The last thirty years have seen remarkable advances in linguistic theory, and corresponding advances in our understanding of how children acquire language. Advances on both fronts have resulted in large part, in our view, because of a shift from the 1980s rule-based theories of grammar to the current Principles and Parameters approach (e.g., Chomsky 1981, 1995). The Principles and Parameters approach enabled researchers in language development to make many new and far-reaching predictions about the course of language acquisition. According to this framework, children were no longer expected to accrue individual rules for the local language being spoken around them, as in the earlier versions of linguistic theory. The initial state of the language faculty continued to embody universal principles that establish boundary conditions on children's linguistic hypotheses, and children were not expected to deviate from these principles in the course of language development (see, e.g., Atkinson 1992, Crain 1991, Guasti 2002). But in addition to linguistic universals, certain aspects of language variation took on a new look in the Principles and Parameters approach. Many differences across languages were taken to be encoded in the language faculty as innately specified parameters, where the parameters establish (typically binary) choices among linguistic properties of particular natural languages. The introduction of an innately specified system of parameters in Universal Grammar was motivated by the desire to ensure that language learning was less burdensome for the learner than it would be otherwise (Chomsky 2002). The new look learner is seen as navigating through an innately specified parameter space that is made available by Universal Grammar; learning is largely replaced by (or reduced to) parameter setting (cf. Clahsen 1990). This assisted the theory of Universal Grammar in meeting its overarching goal of 'explanatory adequacy,' i.e., to explain children's rapid mastery of the grammar of any natural language (Chomsky 1965; 1986).

In the theoretical literature, parameter setting was originally conceived to be executed by a linguistic mechanism that resided in the language acquisition device. Each time the mechanism was engaged, it had immediate and far-reaching consequences throughout a learner's grammar. A metaphor for this mechanism was that of a switch – where the learner simply flicked a switch to one setting or the other in response to some 'triggering' experience that was readily observable in the primary linguistic data. The switch metaphor suggested that, at some circumscribed period during the course of development, the setting of a parameter would be decisively triggered, with one value being adopted rather than the other (Fodor 1998, Gibson and Wexler 1994, Hyams 1986, Roeper 2000). To continue with the metaphor of setting a switch, if the switch was set one way, then the child's grammar took one form, and if the switch was set the other way, the child's grammar took another form. Parameter setting was seen to set in motion radical changes in children's grammars, for example from a grammar with null subjects to one with overt subjects, or from a grammar without Wh-movement to one with Wh-movement, and so on. It was suggested, moreover, that setting a single parameter might induce the introduction of a cluster of properties into children's emerging grammars. The paradigm case exemplifying this was the null subject parameter studied by Hyams (1986; 1987; 1989) (cf. Rizzi 1992). Other work, such as Snyder's (2001) work on acquisition of complex predicates and word-formation has followed in this tradition.

Although parameters were, admittedly, fixed on the basis of input, it was generally assumed that the ambient input sufficed for 'early parameter setting' (see, e.g., Borer and Wexler 1987, Wexler 1998). Nothing in the theory itself prevented parameters from being set early, so if it turned out that they were not set early, then something outside the theory must be responsible for late parameter setting. Therefore, it was the 'null hypothesis' that parameters were set early. Finally, researchers working within the parameter-setting framework assumed that children were initially free to pick one or the other setting, unless a subset problem would arise if one particular setting were adopted, rather than the other. The possibility of 'default' settings was available, in principle, but there was no reason to suppose *a priori* that there were default settings. Another view, advanced by Lebeaux (1988), was that children begin with both parameter values being operative, with one of them taking priority in response to input from the local language (cf. Yang 2002; see below).

The observation that children could set parameters to either value immediately raised the expectation that children could initially 'misset' parameters. That is, the learner could initially adopt a value that was inconsistent with the local language. The mismatch would presumably be easily detected, and soon set straight. Still, it could take a child some amount of time to reset a parameter, and during the period of parameter resetting, the child would be speaking a fragment of a 'foreign' language. Therefore, the investigation of children's early productions promised, potentially, to offer empirical support for the parameter-setting approach. On other approaches, the learner was seen to be attempting to match the input, by accruing rules or constructions on the basis of positive examples.

The earliest empirical support for the Principles and Parameters approach was one such case of apparent parameter missetting, reported in Hyams (1986). This was a study of young English-speaking children, who were found to spontaneously produce sentences that lacked overt subjects. The interpretation by Hyams of children's subject omissions was that children had misset the 'pro-drop' parameter. The pro-drop parameter distinguishes languages that require overt subjects, such as English, from languages that also tolerate covert subjects as well as overt ones, such as Italian. So, child speakers of English who had misset the parameter were seen to be speaking a 'foreign' language, at least in part. Over the years, there have been a number of other reports of misset parameters, where children were found to be projecting parameter values, rather than being directly guided by the input in language development. Empirical data along this line can be found in Armon-Lotem, Crain and Varlokosta (2006), Becker (2000), Hyams (1987; 1989). Of course, children eventually converge on a grammar that is equivalent to that of adult speakers of the local language, so parameter resetting must be responsive to the input.

Assuming that the input consists solely of 'positive' data, and lacks negative evidence, it is likely that the values of some parameters must be set in a particular order, to ensure that children can always reset parameters, if need be, using positive data. This is the familiar subset condition. The subset condition is that part of the language acquisition device that prevents learners from succumbing to subset problems. A subset problem would arise if the language generated by one setting of the parameter, call it setting A, is a superset of the language generated by the alternative setting, call it setting B. In this case, if the child chose setting A, and it turns out that setting B was correct for the target language, then positive data would not suffice to inform the child of the error, and the child would not converge on the adult grammar. Since children do, in fact, converge on the same grammar as adults, the solution to this problem is to initially set the parameter to setting B. If B is correct for the local language, then B is maintained. If A is the correct setting, then the input will contain linguistic expression that are generated only on setting A, and the child can use these expressions to reset the parameter to the new value. We will assume that all parameters whose values fall in a subset/superset relation are initially set to the default, subset value (see e.g., Berwick and Weinberg 1984; Crain, Ni and Conway 1994, Roeper and Williams 1987). Setting subset problems aside, the picture of language development that emerged in the early days of the principles and parameters approach was one in which children could freely choose any parameter value, and would quickly be confronted with relevant input if the value they had adopted was incorrect for the local language.

Although nothing in the theory Universal Grammar specifies precisely how parameter setting might unfold in real time, the 'null hypothesis' was that parameter setting (and even parameter resetting) would take place early in the course of language development, triggering immediate and far-reaching changes from one kind of grammar to another. However, the empirical data have not unequivocally supported the null hypothesis. There are several ways to explain the lack of 'fit' between theory and data. One way for triggering models to explain the recalcitrant data is to invoke performance factors to account for children's unexpected behavior. Another response is to invoke maturation for late-developing grammatical properties (Borer and Wexler 1987; 1992, Wexler 1994; 1998). Another kind of response to the recalcitrant data is to bring statistical learning mechanisms into play, in addition to the principles and parameters of Universal Grammar. We will scrutinize this last approach, focusing on one important model of parameter setting augmented by statistical learning, advanced first in Yang (2002).

Yang (2002) contends that the conception of parameter setting as 'triggering' is simply wrong. Although Yang is a staunch advocate of Universal Grammar, he argues that parameters are set on the basis of statistical information contained in the input. Yang proposes what he calls the Variational model of parameter setting. On this model, different parameters values amount to different grammars, which compete with each other. The value that survives is the one that is better instantiated in the input. There is abundant input for some parameters of course, and the learner is expected to rapidly decide on the value of such parameters. Where the input is less abundant, however, a gradual learning curve should be witnessed. Yang points to evidence of late parameter setting in support of the Variational model.

It is premature, however, to cast out the triggering model of parameter setting in favor of a model that postulates a statistical learning mechanism in addition to Universal Grammar, even in cases of parameters for which the input is impoverished. The empirical data that have been invoked in support of statistical learning have generally been from children's naturalistic productions, frequently averaged over groups of children and across extended time periods, often months and even years. As a result, these data may not be fine-grained enough to reveal abrupt changes that may occur in the grammars of individual children. To provide richer data sets for individual children, the present study reports longitudinal data that were obtained for four children, using elicited production techniques in addition to recordings of naturalistic data. The elicited production studies produced relatively dense data sets for each child subject. These data sets enabled us to accurately track rapid changes in the grammars of the four children whose linguistic progress is studied in this paper. Analysis of the data allow us to draw a picture of grammar formation with sharp contours rather than gradual climbs, as anticipated by a triggering model of parameter setting, and not as expected on the Variational model.

The paper is structured as follows. In section 2 we introduce three models of parameter setting, and establish a set of criteria by which these models can be distinguished. Sections 3 and 4 discuss the learning trajectory anticipated by triggering models and by the Variational model. A second distinguishing feature of the models, called conformity, is the focus in section 5. In section 6, the models are related to previous literature on children's acquisition of morphosyntactic properties. Two functional parameters from children's developing morphosyntax are introduced in section 7, and the learnability of these parameters is discussed in section 8. Section 9 presents the details of the study, and section 10 presents the findings of our empirical investigations of the two parameters, and discusses how well the three models stand up against the child language data. Finally, conclusions are presented in section 11.

2. Criteria for evaluating models of parameter setting

We will evaluate three theoretical models of parameter setting, comparing the predictions of these models against findings from detailed investigations of the acquisition of inflection and negation. Universal Grammar assumes a dominant role in all three of the models. However, the models differ in several important respects. They differ in predictions about (a) the time course of parameter setting, (b) the need for statistical learning mechanisms in parameter setting, (c) how parameter values are engaged, i.e., whether children start with a single parameter value, or with both values operative, (d) the behavioral patterns that should be observed in parameter setting, i.e., whether behavior should take the shape of a gradual curve or a steep climb, and (e) whether or not the behavior patterns in parameter setting should assume the same form for all children. Our joint goals are, first, to spell out the ways in which the three models differ and, then, to see how well each model stands up to empirical findings from longitudinal production studies focusing on the acquisition of morpho-syntax in four English-speaking children.

The three parameter-setting models are (a) the Very Early Parameter Setting model (Wexler 1994; 1998), (henceforth the VEPS model) (b) the Structured Acquisition model (Baker 2001; 2005), and (c) the Variational model (Yang 2002; 2004). The first two models are similar in character. Both of these models assume that parameter setting is straightforward for learners, and does not require specialized statistical learning mechanisms. However, the Structured Acquisition model introduces an ingredient beyond that of the Very Early Parameter Setting model, namely parameter ordering. Parameter ordering leads to far-reaching empirical predictions that distinguish the Structured Acquisition model from of the Very Early Parameter Setting model. The third model, the Variational model, introduces statistical learning into parameter setting. The assumption that statistical mechanisms play a critical role in development has taken a strong hold in the field, so it is instructive to explore the proposal that statistical mechanisms are engaged by learners in parameter setting. To frame discussion of the alternative parameter-setting models, we list a number of criteria by which the predictions of the models will be evaluated using data from child language.

2.1. **Continuity**: The continuity hypothesis maintains that each value of a parameter is fully specified by UG, and that each value corresponds to a fragment of a possible human language (cf.; Baker 2002, Crain 1991, Crain and Pietroski 2002, Pinker 1994). According to this hypothesis, at any stage of acquisition children are speaking well-formed structures from a possible human language, but perhaps not all and only structures exhibited in the local language. The Structured Acquisition model and the Variational model assume continuity. By contrast, the Very Early Parameter Setting model (VEPS) allows that certain linguistic principles are biologically timed to become operative later than others in the course of development; before these linguistic operations mature, child grammars may lack certain linguistic properties that characterize adult grammars (cf. Borer and Wexler, 1987).

2.2. Uniformity: Uniformity is the supposition that all children in the same linguistic community encounter a similar distribution of relevant exemplars (linguistic expressions or structures) for setting parameters. This means that, in the long run, the relative frequencies of the input corresponding to each parameter value are roughly the same for every child. All three models under consideration assume uniformity.

2.3. Ordering: Parameter setting models either postulate that (a) parameters are set in a particular order, or (b) that parameters can be set in any order. On the Structured Acquisition model, parameters are hierarchically organized (but see also early work on parameter ordering by Nishigauchi and Roeper 1987, Roeper and de Villiers 1991). An ordering of the parameter space could also be imposed by maturation, with certain parameters being biologically time to become operative at a later point in development than others. Unordered parameters are said to be ‘independent.’ If parameters are independent, then acquisition is like a scavenger hunt, where items (values) may be acquired in any order. This can be contrasted with a treasure hunt, in which items must be acquired in a particular sequence. The Structured Acquisition model views parameter setting as a treasure hunt; the Variational model and the VEPS models view it as a scavenger hunt. Without additional assumptions, the scavenger hunt models predict more rapid acquisition (i.e., the completion of parameter setting) than does a treasure hunt model.

2.4. Starting point: This refers to the number of values that are in play when the learner first engages in setting a parameter. According to the Variational model, the learner entertains multiple values simultaneously (cf. Lebeaux 1988, Valian 1991). On the Very Early Parameter

Setting model and the Structured Acquisition model, the learner initially adopts a single value of a parameter.

2.4.1. Initial value: If a single value is selected, there may be a default value or learners may opt for either parameter value, unless this gives rise to subset problems. Default or unmarked values are essential for parameters whose values stand in a subset/superset relation, on both the VEPS model and in the Structured Acquisition model. Both models assume that, in all other cases, learners are free to select either value as their initial guess.

2.5. Requisite Input: One possibility is that the primary linguistic data that suffices to set any parameter is available in sufficient quantity to ensure its 'easy' acquisition. This is the position taken by VEPS and the Structured Acquisition model. The Variational model assumes that the learner needs to accumulate a certain amount of data as a prerequisite to setting any parameter, and the model contends that the requisite data is not uniformly available for all parameters. On this model, it is more difficult to establish the 'correct' value of parameters with sparse relevant input, as compared to parameters that have abundant relevant input.

2.6. Trajectory: This refers to the pattern of development that learners manifest in selecting the value of a parameter in response to relevant input. If parameters are set using minimal input, or if input is abundant for all parameters, then no special record keeping is required for parameter setting. This is the view of VEPS and the Structured Acquisition model. In cases of parameter resetting, the ('idealized') developmental pattern that is expected is a step function, or rapid incline in one value of the parameter, and a corresponding, and equally rapid decline in the alternative value. Alternatively, record keeping may be required for parameters for which there is not abundant input. This is the perspective of the Variational model.

2.7. Conformity: According to this feature of development, either all learners navigate the same course through the parameter space, or children may chart different courses. Clearly, if parameters are unordered and the input is abundant and uniform for all parameters, then individual differences are not expected. If parameters are ordered, then individual differences will arise, even with uniform and abundant input, as long as children are permitted to adopt different initial values (starting points). Some children will immediately advance through the hierarchical parameter space, others will make just a few missteps, and some children will make many missteps, and will take more time than other children do to complete the process of parameter setting.

2.8. Summary

With these evaluation criteria at the ready, let us briefly summarize the main characteristics of the three models. First, the Very Early Parameter Setting model (VEPS) (Wexler 1994; 1998) postulates: (a) parameters are independent (*ordering*), (b) children initially begin with a single parameter value, but may adopt either value, unless this would lead to subset problems (*starting point, initial value*), (c) grammar formation is characterized by abrupt changes in grammars (*trajectory*), (d) differences in the primary linguistic data have little impact on the observed course of parameter setting (*requisite input*), so no special (e.g., statistical) learning mechanisms are needed to assist in parameter setting, and (e) since parameter setting is completed early, little individual variation will be observed (*conformity*). The VEPS model has little room to maneuver in response to apparent delays in parameter setting. Maturation is one possibility. Late emergence could also be interpreted as evidence that some phenomenon does not properly count as a parameter. This is the approach taken by the VEPS model for the so-called optional infinitive (OI) stage of language development. We return to the OI stage in section 6.

The second model is the Variational model (Legate and Yang 2005, Yang 2002; 2004). On this model: (a) parameters are independent of each other (*ordering*), (b) children initially begin with competition among parameter values (*starting point*), (c) grammar formation is characterized by gradual changes in grammar (*trajectory*), (d) differences in the primary linguistic data determine the observed course of parameter setting (*requisite input*), because stochastic learning mechanisms determine the course of parameter setting, and (e) since input is assumed to be uniform across children, individual differences are not anticipated (*conformity*). In contrast to VEPS, the Variational model sees the optional infinitive stage of development as falling within its purview. In fact, optionality in children's behavior is probably the principle motivation for the assumption that parameter values initially compete against each other (*starting point*).

The third model is the Structured Acquisition model, based largely on the "implicational universals" proposed in Baker (2001; 2005). On this model parameters are ordered in a hierarchy, with large-scale parameters at the top of the hierarchy, including the polysynthesis parameter and the head directionality parameter. These parameters are presumably set early and have significant impact on the overall form of the language that is acquired. Smaller-scale parameters reside lower in the hierarchy, and they are not set early because they must await the decisions about parameters that are more dominant in the hierarchy. On the Structured Acquisition model: (a) parameters are interlocked (*ordering*), (b) children initially begin with a single parameter value, though either value may be selected (*starting point, initial value*), (c) grammar formation is characterized by abrupt changes in grammars (*trajectory*), (d) differences in the primary linguistic data have little impact on the observed course of parameter setting (*requisite input*), so no special (e.g., statistical) learning mechanisms are invoked in parameter setting, and (e) setting some parameters can only occur once others have been set, and since children may adopt different starting values, different children may set the same parameters at different times (*conformity*), giving rise to individual variation.

The criteria we have elaborated for evaluating the alternative models of parameter setting should make it straightforward to adjudicate between them, once we turn to the empirical data from child language. For example, all three models anticipate that (at least) some parameters will be set early, but the models differ in expectations about precisely which parameters will be set early. VEPS maintains that all of them will be. Parameters are set early, on the Structured Acquisition model, if they make the broadest cuts across natural languages, so early parameters include the polysynthesis parameter, the head directionality parameter, the wh-movement parameter, and so on. The Variational model contends that parameters that are associated with the most robust input will be set early. Other criteria will prove valuable in comparing the models, including trajectory, to which we turn next.

3. Trajectory: Triggering Models

The trajectory of acquisition data was first used to distinguish competing accounts of grammatical development in the early literature on parameter setting. The earliest use of trajectory concerned the 'pro-drop' parameter. The pro-drop parameter is probably the most thoroughly investigated of all parameters[1]. Given that it governs the use of subjects, and all sentences have subjects, there should be no shortage of data available to establish the time course in setting the parameter, based on children's spontaneous speech. Early research concluded that children learning English initially adopted the [+pro drop] value of the parameter, even in languages in which the adult setting was the [-pro drop] value. This conclusion was based on children's notable omissions of subjects in their spontaneous speech (Guilfoyle (1984), Hyams 1986; 1987, Jaeggli and Hyams 1988, Lebeaux (1987), Lillo-Martin (1986), Pierce (1992), and others). This particular source of evidence for parameter setting was challenged, however, on two fronts. One challenge attempted to explain children's omissions of subjects as performance errors, rather than as revealing children's emerging linguistic competence. This position was taken by Paul Bloom (1990) among others (e.g., L. Bloom 1970, Pinker 1984, Valian 1991).

Bloom (1990) proposed that the proportions of null subjects in children's productions could be accounted for by a model of language processing, rather than a parameter setting model. Using the transcripts of Adam, Eve and Sarah in the CHILDES database, Bloom (1990) showed that children produced higher proportions of null subjects in sentences with longer VPs than in sentences with medium-length or short VPs. His observation was that in sentences with short VPs children tended to produce more lexical NP subjects, and pronominal subjects tended to appear more often than null subjects in sentences with medium-length VPs.

In response to Bloom's performance account, Hyams and Wexler (1993) provided a number of arguments in favor of an account based on children's linguistic competence. Our discussion is limited to one of their arguments, which rests on the assumption that a competence-based account would be supported by abrupt changes in child language: its trajectory. On the particular version of the parameter-setting theory advanced by Hyams and Wexler (1993), English-speaking children who were omitting subjects were speaking a topic-drop language; thus they had misset a parameter. On Hyams and Wexler's analysis, children were expected to use few overt pronominal subjects, because the null pronoun option would be available to them. To such children, null subjects should be the favored option. However, once the parameter was reset to the adult English value, null pronouns should no longer be licensed in children's grammars. Therefore, these researchers predicted a sharp increase in the proportion of overt pronominal subjects once the parameter was reset. But, since null subjects would be replaced by pronominal subjects, no significant change in the proportion of lexical subjects was expected as the parameter was reset; the proportion of lexical subjects should remain constant. The performance model advanced by Bloom (1990) made no predictions about changes in the proportions of null subjects versus pronominal subjects in children's developing grammars; it simply predicted that lexical subjects would tend to be 'replaced' by pronouns, or omitted, as processing demands increased, such as in sentences with longer verb phrases.

In assessing the fit of the data to the grammatical model, Hyams and Wexler (1993) turned to the Brown corpus, and investigated eight 2- hour transcripts from the corpora of Adam and of Eve. To measure the overall shift in the proportions of covert subjects versus overt pronouns, they calculated the proportion of lexical subjects and pronominal subjects produced by Adam and Eve in the first and last of the eight transcripts, as well as in a later 9th transcript (cf. table 4, p. 443). These data are summarized in Table 1. It can be seen that while the use of lexical subjects remained stable over time for the two children, the use of overt pronouns increased by 56% for Adam and by 53% for Eve.

	Adam (2;5-3;5) Transcripts 06-30		Eve (1;6-2;3) Transcripts 02-20	
	Pronouns	Lexical Subjects	Pronouns	Lexical Subjects
First transcript	11 %	33%	29%	11%
Last transcript	67%	30%	82%	11%
	56% increase	3% drop	53% increase	No change

Table 1: Proportions of pronouns and lexical subjects in the transcripts of Adam and Eve across 8 transcripts

As Hyams and Wexler remark

> "From the first to the last transcript the proportions of lexical subjects are about the same, and this is true for both Adam (.33 to .30) and Eve (.11 to .11). The proportions of pronouns, however, show a dramatic shift, for both Adam (.11 to .67) and Eve (.29 to .82). Thus, the overall pattern of change from the null subject to the non-null subject stage is a dramatic increase in the number of pronominal subjects with a (roughly) steady number of lexical subjects. This is exactly what we would expect under the grammatical model, since null subjects trade off with pronouns under this theory." (p.444)

The "dramatic increase" that Hyams and Wexler noted in Adam and Eve's grammars is impressive, but the figures summarize changes that took place in over a year for Adam, and over 9 months for Eve. These periods may even be long enough to be accounted for by models of gradual change, such as the Variational model. However, closer examination of the data from Hyams and Wexler's data (see Table 4, p.443) shows that the dramatic increase in pronominal subjects actually took place within a much shorter time period. To show this, we present graphs of the transcript-by-transcript data for each child. The data in Figures 1 and 2 show the proportion of lexical subjects and overt pronominal subjects produced by each child in each session. The proportion of null subjects is calculated by adding the overt pronouns and lexical subjects together and then subtracting the sum from 100. Because lexical subjects remain stable over time, as null subjects decrease, there is a corresponding increase in pronominal subjects. Figure 1 shows the graph of Adam's data. A dramatic change takes place between transcripts 14 and 20 (ages 2;9.18 and 3;0.11). At transcript 14, null subjects are produced 70% of the time; by transcript 20, they have dropped to 12%, a change of 58%. At transcript 14, overt pronominal subjects appear only 15% of the time; at transcript 20, they comprise 77% of Adam's subjects, an increase of 62%. Thus the dramatic change in use of pronominal subjects takes place within 3 months.

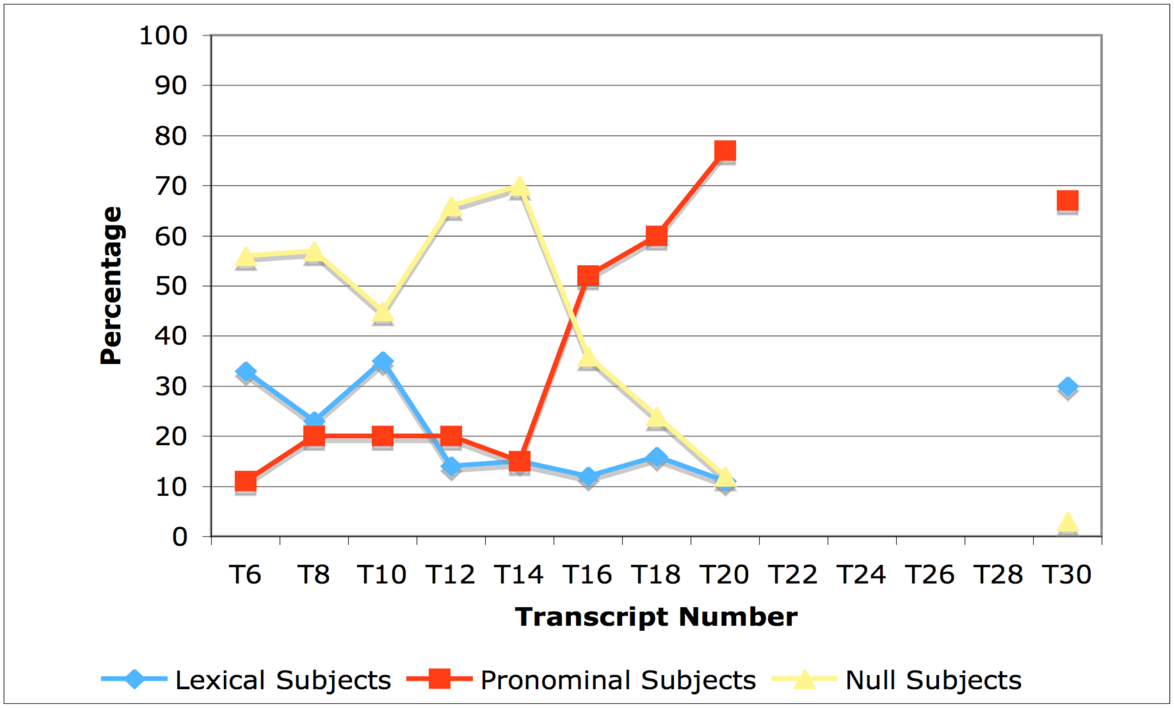

Figure 1: Adam's subjects from Transcript 06 to Transcript 20, and 30. Ages 2;5.12 to 3;0.11 and age 3;5.1

The data for Eve are illustrated in Figure 2. Eve's null subjects are replaced by pronominal subjects during the period from transcript 2 (at age 1;6.1), where null subjects comprise 60% to transcript 12 where null subjects comprise only 11% of the total. At that point, Eve is 1;11. Thus, in 5 months null subjects have decreased by 49%, and pronominal subjects have increased by 39%.

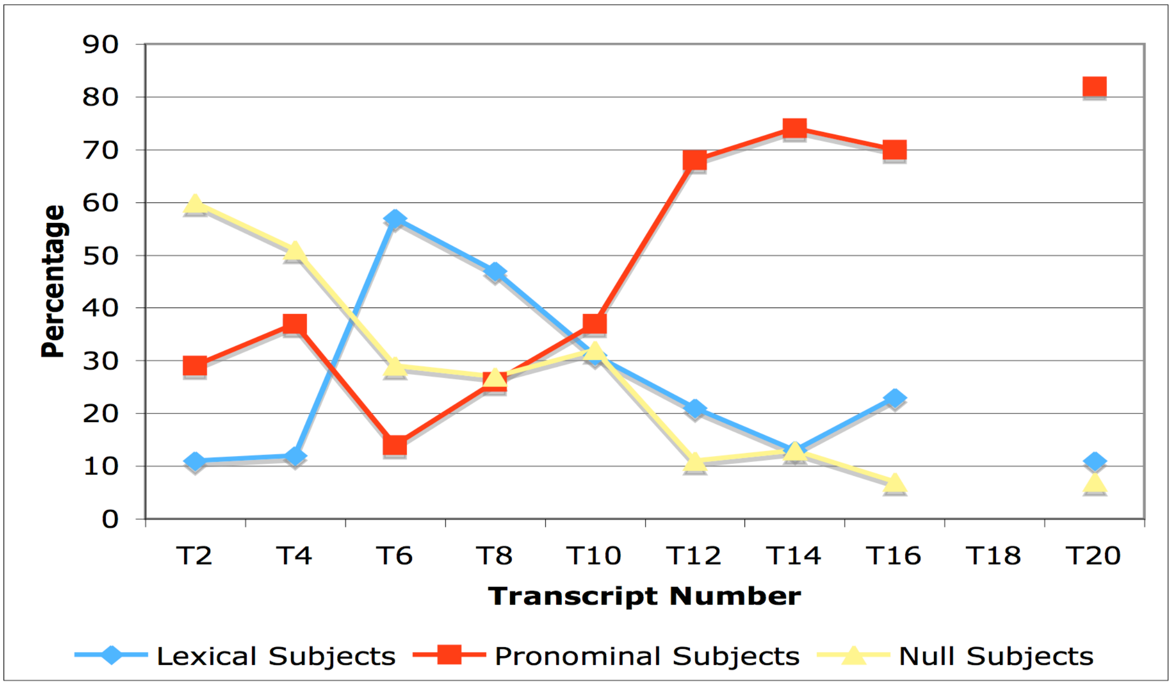

Figure 2: Eve's subjects from Transcript 02 to Transcript 16, and then 20. Ages 1;6. to 2;1 and 2;3

The shifts that take place from T14 to T20 for Adam, and from T2 to T12 for Eve, resemble the patterns of responses that appear in studies of 'categorical perception.' Apparently, one type of structure (roughly, one category) is completely replaced by another as some perceptual feature (here, time), is manipulated. An idealized depiction of what we will call 'categorical acquisition' appears in Figure 3. This is the trajectory pattern that is expected on 'triggering' models such as the VEPS model and the Structured Acquisition model.

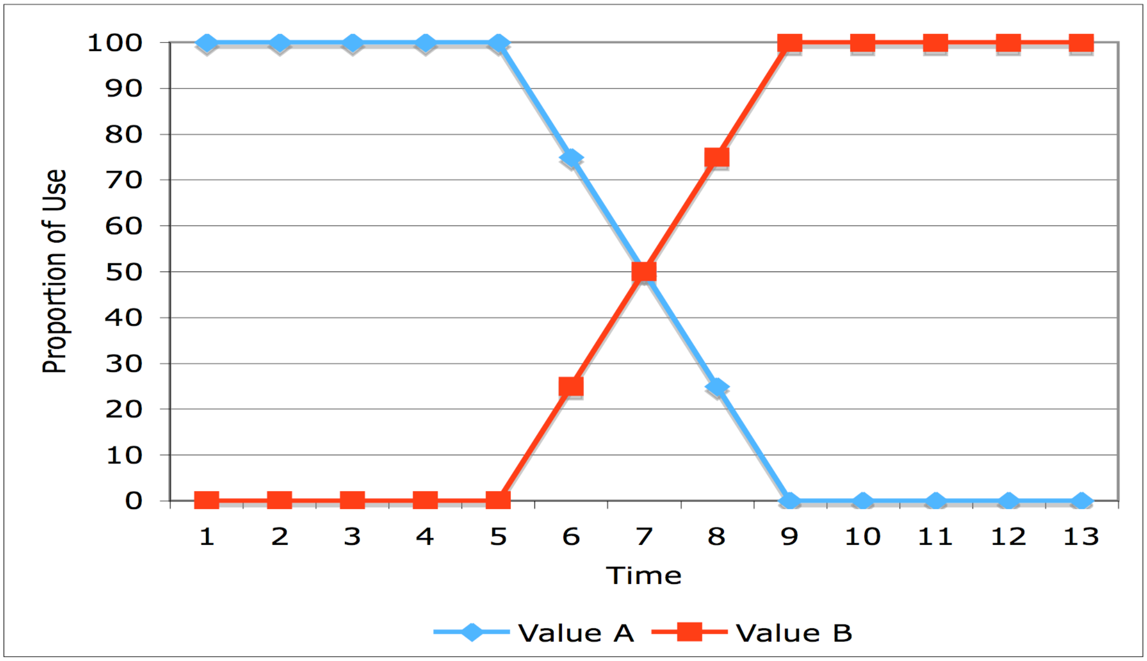

Figure 3: Idealized Trajectory of categorical acquisition

In principle, categorical acquisition occurs when one sentence type, based on the initial setting of the parameter, is used in 100% of children's productions, and then drops to 0% once the parameter is reset. This makes no allowance for noise, however. To accommodate noise in child language, we simply adopt the standard criterion (e.g., Brown 1973) that 90% 'correct' adult-like usage in obligatory contexts indicates that a sentence structure has been acquired. This means that an abrupt drop from (at least) 90% consistent usage of one kind of structure, to 10% (or less) consistent usage is evidence of a categorical transition from one value of a parameter to another. At the same time, the structure associated with the 'new' parameter value should have increased from 10% consistent usage to 90% during the same period of time. And, for the transition to be categorical, grammatical change must occur within a confined timeframe. There is no standard criterion for this aspect of categorical acquisition, but we suggest that the transition from one value to another should occur within a 3-month period, following which the non-adult value should not be exemplified more than 10% of the time.[2]

In practice, these criteria may run into practical complications, for example where one structure does not simply replace an alternative structure. The case of null subjects discussed by Hyams and Wexler (1993) is one such example. While subject omissions disappear almost completely from children's productions (constituting only 3-7% of children's productions), the emergence of overt pronouns does not reach 90% consistent usage, because lexical subjects are another option. In short, when optional sentence structures complicate the picture, changes in proportion of consistent usage may not be as dramatic as in Figure 3. Exactly what increase should be counted as categorical acquisition depends on the phenomenon being studied. In the example of Adam and Eve's development, evidence of parameter setting on a 'triggering' model consists of an over 50% increase in usage of the structure associated with a new parameter value, i.e., pronominal subjects.

4. Trajectory: The Variational Model

What course of acquisition is expected on a statistical learning model of parameter setting, such as the Variational model? This model supposes that children initially attempt to parse the linguistic input using two 'grammars', one with each value of the parameter operative in it. If one of these competing grammars parses the input successfully, that grammar is 'reinforced', increasing the probability that it will be used in the future. Assuming that the grammar with the alternative parameter value is unable to parse the same input, then that grammar is 'devalued', and its probability of being selected in the future is correspondingly reduced. Gradually, probability weights are adjusted until the grammar with the non-target parameter value is no longer a contender, and becomes obsolete. On this model, then, quantitative data from input frequencies can be used to estimate whether a parameter setting will be consolidated early or late.

In support of this proposal, Yang (2002) draws on the findings from the literature on child language. Reports from the literature suggest, for example, that French speaking children learn that French is a verb raising language by 1;8, (based on data from Pierce (1989)). The sentences that provide the informative data about which parameter setting is correct are called 'signature' sentences by Yang. For verb raising, the signature sentences are of the form V_{FIN} Neg/Adv. Using transcriptions of adult speech to children in the CHILDES database, Yang estimates that the V_{FIN} Neg/Adv signature sentences make up 7% of all sentences children acquiring French hear. Thus, Yang concludes, the frequency of signature input of an early set parameter must constitute at least 7% of the input data. On the other hand, if the requisite sentences are rare in the input data for some parameter, the Variational model would be forced to predict that the parameter would be set relatively late in the course of development. Drawing on Valian's (1991) summary of child data, which reveals null subjects not disappearing from children's productions until about 3 years of age, Yang (2002) concludes that the signature sentences must be rare. Yang assumes that the requisite input consists of sentences with expletive *there* subjects; such sentences cannot be parsed by the setting of the parameter that licenses null subjects. Yang's counts from the CHILDES database estimate that expletive *there* sentences comprise 1.2% of the adult input to children. Thus, as a working hypothesis, Yang proposes that there will be late parameter setting if the signature sentences comprise 1.2% or less of the input to children. The quantitative predictions are matched with further empirical data in Yang (2004). These data include Thornton's (1990) observation that children ask non-adult *wh*-questions such as "What do you think pigs eat?" until 4 or 5-years of age. The findings are accurately modeled on the statistical learning account, because adult long-distance *wh*-questions constitute only 0.2% of the input data. In short, the speed with which parameter values are adjusted in child grammars depends on the character of the input, according to the Variational model. Depending on the relative frequency of signature sentences, one parameter value may quickly rise to dominance, or there may be a prolonged struggle between the two values. The main point is that gradualness is expected in the rise and fall of many competing parameter values, rather than abrupt changes. This scenario contrasts with rapid ascent and descent of parameter values that is always expected on a triggering model, when parameters are switched from one position to the other. An idealized trajectory, based on the statistical learning implemented in the Variational model, is presented in Figure 4.

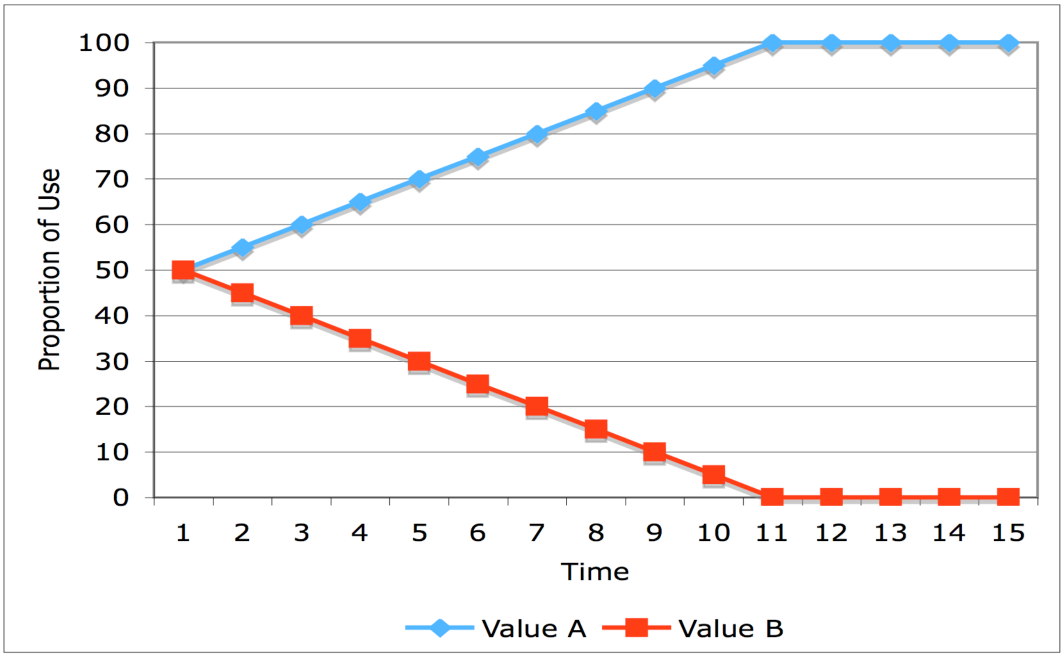

Figure 4: The trajectory of parameter setting on the Variational model

5. Conformity

Conformity is another criterion that will be invoked to distinguish among the alternative parameter-setting models. The Variational model expects the same developmental pattern for all children**.** The expectation of conformity is derived from two sources. First, children begin with both values of a parameter having equal weight. Thus, there is initially a 50-50 chance of either value being the target value at the earliest stages of development. Second, it is assumed that every child is exposed to the same distribution of structures in the ambient input, so the signatures of the target parameter value should appear in similar proportions for every child. Taken together, these features of model, and the input, should conspire to make every child display a similar learning curve.[3]

Conformity is not expected on the Structured Acquisition model. On this model, parameters are ordered, or at least partially ordered. One proposal about the hierarchical ordering of parameters is offered by Baker (2001;2005). At the top of the hierarchy is the parameter that draws a typological division between polysynthetic languages and the others. This parameter determines a range of parameters on each side of the hierarchy for the learner's subsequent consideration. As the learner traverses one side of the hierarchy or the other, the parameters that are subsequently encountered differentiate among fewer and fewer languages. On the Structured Acquisition model, delays in parameter setting are a logical consequence of the structure of the hypothesis space. As Baker (2005) says "…an efficient learner should learn in a structured way in which some parameters are entertained first and others later." (p.95). The broad typological parameters at the top of the hierarchy could even be set before the onset of production, as Wexler (1998) claims. Obviously, this is not necessarily true of parameters that are situated towards the bottom of the hierarchy. These minor parameters are seen to be fine-grained features of the local language, with the relevant parameters being set, presumably, after children begin to talk, and possibly much later than that (cf. Baker 2001, p.192-195).

As noted earlier, the Structured Acquisition model also accommodates parameter missetting. As a triggering model, children initially begin with a single parameter value, though either value can be selected. The model does not prevent the child learner who initially selects the wrong value for a parameter from stalling briefly at a particular point in the hierarchy as further input data is assessed, such that the parameter can be reset. However, there is no assumption of statistical learning, so the model anticipates that the trajectory should take the form of categorical acquisition. Although the hierarchy minimizes the burden of learning, wrong turns are not eradicated completely, and so the model allows for discrepancies between children in the timing of parameter setting. Thus the Structured Acquisition model does not require conformity of children.

The next section turns to the literature on children's acquisition of morphosyntactic properties, and examines why Wexler considers children's development to be outside the purview of parameter setting, whereas Yang embraces parameter setting as an explanation of optionality in child language.

6. Early Morphosyntax

Young children's developing knowledge of inflection across a diverse number of languages has been the subject of intense scrutiny in the last 15 years. The impetus for this research program was the observation from Romance and Germanic languages that, in the earliest stages of acquiring language, children sometimes fail to use inflected verbal forms in matrix sentences, as adults do, but permit the infinitival form of the verb. This occurs in situations when the intended interpretation clearly refers to an event in the present or in the past (e.g. Pierce 1992, Hyams and Hoekstra 1998, Poeppel and Wexler 1993, Wijnen 1997). This phenomenon has been called, by Wexler (1994; 1998), the optional infinitive stage of language development. It is called the root infinitive stage by Rizzi (1993; 2002).

In many language families, the utterances from child language that lack an inflected verb are readily identifiable because the verb has the morphological form reserved for the infinitive. English stands apart from Romance, Germanic and Slavic languages in this regard, because infinitives bear no special morphology. Rather, the verb form used for the infinitive in English is just the verb stem preceded by *to*. Such 'to + stem' forms do not appear in early child English, however (Goro 2004). Instead, 2-year-old English-speaking children use the verb stem alone. Instances abound of children producing utterances like 'Daddy go' instead of 'Daddy goes' or even 'Daddy to go.' Children's failure to use appropriate morphology on verbs that express tense and/or agreement was interpreted by Wexler (1994, 1998) to be the English instantiation of the optional infinitive phenomenon, and this interpretation of English-speaking children's data has been generally accepted. The range of research establishing the properties of English optional infinitive utterances is extensive and we cannot hope to review it all here. See Guasti (2002) for a comprehensive summary of the literature.

During the optional infinitive stage, English-speaking children 'optionally' produce utterances with no tense or agreement. In many children, this stage lasts until the child is 2-and-a-half or even 3 years old. So, the behavioral profile of this stage does not accord with very early parameter setting, and is not considered to be within the purview of VEPS. In various proposals, over the years, Wexler and his colleagues have argued that tense and agreement (or the mechanisms that govern them) are in some way deficient in young children's grammar. One example is the 'ATOM' (Agreement Tense Omission Model) model proposed by Schütze and Wexler (1996). This model contends that young children often fail to project either tense and/or agreement features in a syntactic derivation. Together with the assumption that nominative case is assigned by agreement, Schütze and Wexler make a number of predictions about the combinations of subject and verb that are licensed in child grammars at the optional infinitive stage. If the child assigns both tense and agreement features, as in the adult grammar, the 3rd person agreement marker will correctly appear on the verb. But if the child fails to assign the agreement feature in the course of the derivation, default case (i.e. accusative case) will appear on the subject (if it's a pronoun) and the verb will lack appropriate morphology, as in *Him cry*. Alternatively, if agreement is in place, but the tense feature is lacking, pronouns will manifest nominative case, but the 3rd person morphology will be omitted as in *He cry*. Still other properties of children's syntax are seen to follow from the optionality of tense and agreement features in the representation at this stage of language growth. As markers of tense and agreement, auxiliary verbs are often missing, and children do not use 'do-support'.[4]

For our purposes, it is useful to contrast the ATOM model with the Variational model. The Variational model accommodates the optional infinitive stage of language development because, on this model, children initially hypothesize dual grammars (or, equivalently, dual values for each parameter). Each value of a parameter begins with a 50/50 chance of 'success' at the start. As input is encountered, the weights of the alternative values are adjusted; input favouring one value increases the weight that was previously associated with that value and lowers the weight that was associated with the alternative value; ideally, both the increasse in one value and the decrease in the other value should be to the same degree. At the optional infinitive stage of language development, English-speaking children are seen to be vacillating in the use of tensed and non-finite forms of a verb, according to the Variational model. Children eventually encounter more evidence that verbs require tense in English. But this takes time because, as Yang calculates, there are only 8% more unambiguous finite verb forms than forms that are ambiguous in marking finiteness. Although the fluctuating early utterances may cause children's productions to look random, in fact the child is simply instantiating the various parameter values that underlie natural languages. Children's non-adult utterances are, therefore, completely consistent with Universal Grammar, and in keeping with the continuity hypothesis. In this respect, the Variational model is in agreement with the Structured Acquisition model, where children are also seen to hypothesize parameter values that represent properties of other adult languages (e.g. Crain and Pietroski 2002).

On the Variational model, Universal Grammar provides children with a parameter that categorizes languages into ones that exhibit overt tense morphology versus ones that do not. Languages in which infinitives are observed in matrix clauses are also languages that express tense overtly. Still other languages lack tense morphology, such as Chinese.[5] The child's task is to figure out if the local language expresses tense overtly or not. On the Variational model, the optional infinitive stage of child language is a manifestation of parameter missetting. The advantage of such a parametric account is that it maintains continuity between child and adult grammars, whereas the VEPS proposal violates the continuity hypothesis.

In support of the Variational model, Legate and Yang (2005) cite data demonstrating variation in the optional infinitive stage in three languages. In Spanish, the relevant phenomenon barely surfaces. Optional infinitives appear in Spanish-speaking children's speech in about 10% of verbs before 2 years of age, and this drops to below 5% by age 2;6 (Grinstead 1994). Children learning French produce optional infinitives more often. Between 15 and 30% were reported for three French-speaking children between 1;6 and 2;6 (Rasetti 2003). Finally, following Phillips (1995), Legate and Yang observe that Adam produces a considerable number of optional infinitives at 3;0 and even Eve, whose linguistic precociousness is legendary, was still missing verbal morphology from 50% of her utterances at 2;3, when her recordings stop.

Drawing on the Variational model developed in Yang (2002), Legate and Yang predict a positive correlation between the 'informativeness' of the input and the duration of the optional infinitive stage in a particular language. For example, fewer verbs express explicit tense morphology in English as compared to Romance languages. It is therefore anticipated that English-speaking children will take longer to 'set' the relevant parameter than children acquiring Romance languages. Searches of input to children from the CHILDES database support this prediction. In Spanish, adult input expresses tense 77.2% of the time, and does not express tense 22.8% of the time. This means that 54.4% of the input is informative about the setting of the parameter, giving the child "plenty of opportunity to learn that their language makes use of tense" (L&Y, p. 12). Likewise, adult input in French marks tense on 69.9% of the verbs, and tense is lacking on 30.1% of verbs, yielding 39.8% informative input. English-speaking children have a less informative input. Based on transcripts of input to Adam, Eve and Sarah, Legate and Yang calculate that 54.4% of adult sentences express tense, and 45.6% of adult sentences do not. Therefore the [+ Tense] setting of the parameter has only an 8.8% advantage over the competing value. This low proportion of useful data is used to explain the prolonged optional infinitive stage experienced by English-speaking children, as compared to French- and Spanish-speaking children.

To recap, Legate and Yang offer an account of the cross-linguistic variability in the optional infinitive stage that is consistent with the continuity hypothesis. It should be kept in mind that the Variational model entails conformity across children, since children are seen to be assigning weights to the different values for parameters in response to uniform data sets. In the next section, we introduce the two parameters that we will use to evaluate the different parameter-setting models of children's development of morphosyntax. Then we turn to the laboratory, where we describe a longitudinal study of the trajectory and developmental path of these parameters by four children. At that time we will ask about conformity across children.[6]

Three different models of parameter setting have been introduced. From this point forward, our goal is to explain the source of certain non-adult properties of children's speech. Our focus will be on the Variational model and the Structured Acquisition model. Because VEPS does not anticipate the kind of data we discuss, it will not play much of a role in the discussion. Now we turn to the two parameters that are the focus of our investigation of children's expression of verbal morphology.

7. Two Functional Parameters

The two parameters that we present are relevant for language learners who are traversing the non-polysynthetic side of the parameter hierarchy[7]. Both parameters are associated with functional categories, one with inflection, and the other with negation (cf. Borer 1984, Chomsky 1995). Because the two parameters govern functional categories**,** these parameters are considered to sit lower in the hierarchy than do more general parameters such as the polysynthesis parameter, the head directionality parameter, the optional polysynthesis parameter, and the verb attraction parameter (cf. Rizzi 2002). Therefore, these parameters are expected to be set later in the course of acquisition that the higher-level parameters, according to the Structured Acquisition model. Administering criteria proposed by Baker to distinguish parameters that are ordered from ones that are not, it turns out that the two parameters we propose are unordered with respect to each other and, therefore, sit side-by-side in the parameter hierarchy.[8]

The inflection parameter is based on Lasnik's (1995a, 1999) hybrid theory of verbal morphology. On this theory, languages select an inflection category that has the property of being *featural* or *affixal*. This choice between *featural* versus *affixal* determines, for each language, how the verb and its morphology combine in a derivation. Although Lasnik (1995) does not explicitly call this cross-linguistic difference a parameter, it lends itself readily to this analysis. On Lasnik's account, if a language selects an inflection category with featural properties (i.e., 'uninterpretable' features), then these features are generated in the inflection node in a derivation, and must be checked off by an appropriate category as the derivation proceeds. Typically, the main verb is the lexical item that raises to check off the uninterpretable features in INFL. So in French, for example, the main verb is inserted into the syntactic derivation already fully inflected, and it moves out of the verb phrase to INFL to check off its uninterpretable features.

Languages that select the affixal value of the inflection parameter have different requirements. In this case, affixal features are generated in the INFL node, and the affix (such as the 3rd person *s*) is inserted into this position. The affixal features generated in INFL have no syntactic requirement, however, so no movement takes place in the syntactic computation. Before the sentence is pronounced, however, the affix must join with a verb so that it is not a 'stray,' unattached affix (cf. Lasnik 1981). It is argued in the literature that the affix lowers onto the verb at PF (Bobaljik 1995, Lasnik 1999).[9] In the case of present tense, the lowering operation is visible only for the 3rd person morpheme; for morphemes associated with other persons, it is assumed that a zero (silent) morpheme lowers onto the verb. English does not manifest uniform behavior, however. Some verbs represent exceptions to the affixal setting of the inflection parameter. For example, auxiliary verbs and modals select a featural value for INFL. As in French, auxiliary verbs and modals are inserted into a sentence derivation already adorned with their morphology, and they raise to INFL to check off the uninterpretable features. The language learner thus has to acquire these particular verbal items as selecting a featural INFL.

The second parameter in the acquisition of verbal morphology concerns negation. This parameter is expressed as a binary choice for lexical items that express negation: the item is either a head or a specifier[10]. The choice between these options has an effect on potential word orders in the language. For example, in English, when negation is positioned in specifier position, the *s* affix can lower to the verb uninhibited. But if the negative item is generated in the head position, it has the potential block affixation**.** Thus although the inflection parameter and the negation parameter are separate parameters, they interact closely, with the negation parameter having some effect on the way in which inflection is expressed.

7.1 Four Languages

This section examines some representative examples of the alternative values for the inflection parameters and for the negation parameter, in adult languages. The four possible options that the two parameters yield are illustrated in Figure 5. The following section explores how these options might play out in the grammars of children learning English.

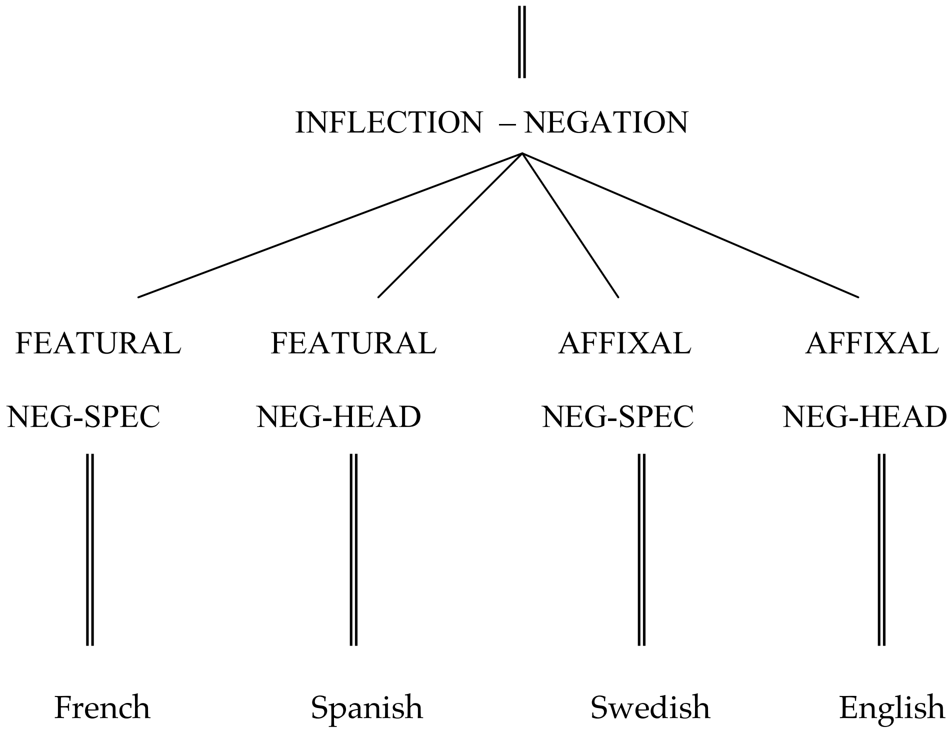

Figure 5: Two Functional Parameters

Spanish selects a featural setting for the inflection parameter, and negation is generated in head position. In Spanish, the negative lexical item, a head, is not independent, but raises along with the verb to INFL, as shown in (1). (In the examples, the origin of elements that have been moved is indicated by strikethrough).

(1) [IP Juan no habla [NEG ~~no~~ [VP ~~habla~~ italiano
Juan NEG speak-3sg Italian
'Juan doesn't speak Italian'

French also selects a featural setting of the inflection parameter. Like Spanish, the weak clitic form of negation (*ne*) is a head, and raises with the verb to INFL, but this form is often omitted in colloquial language. A second form of negation, namely the lexical item *pas*, is obligatory in negative sentences and is positioned in the specifier position. The example in (2) illustrates a sample derivation. The main verb raises to pick up the negative element *ne* in the head position, and bypasses *pas* in the specifier position as it raises to check its uninterpretable features in INFL.

(2) [IP Jean ne-parle [NEG pas ~~ne~~ [VP ~~parle~~ grec]]]
Jean NEG -speak not greek
'Jean doesn't speak Greek'

Swedish also positions negation in the specifier position, as in French. However, unlike French, Swedish selects affixal morphology. Therefore, the verbal affix in Swedish lowers over the negative item *inte* to merge with the main verb. This is most transparent in embedded clauses, where the V2 operation does not mask the operation of affixation. The following example, taken from (Tesan 2005), illustrates the word order of Swedish in embedded sentences.

(3) …att Lena inte köpte en ny bok igår
…that Lena not bought a new book yesterday
…'that Lena didn't buy a new book yesterday'
(adapted from Vikner 1995: 45, (28)

The fourth combination of negation and inflection is represented by English. English selects affixal morphology, and the negative items *not* and *n't* are heads. Before outlining their behavior, however, it is worth considering the negative adverb *never*. Unlike *not* and *n't*, *never* is positioned in the specifier position of the negation projection; therefore it functions much like *pas* in French and *inte* in Swedish. Since *never* is a specifier, the verbal affix can lower across *never* to the verb, yielding sentences like 'He never speaks French'.

(4) [IP He ~~s~~ [NEG never [VP speak-s French]]]

In contrast to *never*, the lexical item *not* is usually analyzed as a head (cf. Chomsky and Lasnik 1993). Consequently, an equivalent utterance like 'He not speaks French' is ruled out, because *not* blocks lowering of the affix onto the verb. This predicament calls for a quirky rescue operation: 'do-support'. To save the sentence derivation from crashing, *do* is inserted, to provide a host for the stranded affix. This is how the acceptable sentence 'He does not speak French' is derived.

(5) [IP He doe –s [NEG not [VP speak French]]]

The most common form of negation in English, however, is *n't*, which is assigned the status of an affix (Zwicky and Pullum 1983). The negative affix *n't* must join with a host auxiliary verb or modal (e.g., *can't*, *haven't*, *isn't* etc.). Since affixes are heads that attach to other heads, these modals and auxiliary verbs can provide the information that *n't* is an affix.

(6) [IP He doe –s –n't [NEG ~~n't~~ [VP speak French]]]

The next step is to investigate how these four parametric options might be reflected in English-speaking children's grammars.

8. Four Parametric Options in English

On the Structured Acquisition model, learning is guided by the architecture of the parameter hierarchy; the child is led through a structured set of options. If relevant evidence for the target parameter setting is not immediately forthcoming, however, children may hazard a guess, and pick the non-target value. In cases where two unordered parameters sit side-by-side on the parameter hierarchy, as we propose for the inflection and negation parameters, children are faced with four options, only one of which matches the local language. Thus, in principle, children have only a 25% chance of picking the right combination of parameter settings. In this section, we flesh out what sort of English utterances would arise on the different options, and what positive evidence children would need to jettison wrong parameter values.

8.1. Learnability

Both the Structured Acquisition model and the Variational model assume uniformity – i.e., that requisite data are available in the input in similar distributions for all children, to ensure that parameters are set to the adult value. The Variational model is concerned with the statistical frequency of the data that brings about parametric change, whereas the Structured Acquisition model has nothing to say on this matter. In the case of English morphology (which requires *do*-support, an unusual operation, cross-linguistically), it appears that the character of the input has some influence on how parameter setting takes place, for all parameters. For the Variational model, if decisive input is not readily available, then this entails prolonged acquisition for all children (because of the assumption of un iformity). For the Structured Acquisition model, ambiguous input means that children may have to guess which value of the inflection parameter to take as the initial setting. This does not entail late acquisition for all children, since children have a 50/50 chance of selecting the value that is consistent with the local language. So, the Structured Acquisition model anticipates slightly delayed parameter setting (awaiting decisions about higher level parameters), but prolonged acquisition is anticipated only for children who initially choose the wrong parameter value. So, conformity across children is not anticipated on this model for parameters that are associated with ambiguous input.

Consider now, the input that English-speaking children evaluate in trying to determine the English value for the inflection parameter. Affirmative sentences do not provide unambiguous data that confirm that English takes affixal morphology. A sentence like 'John speaks French' is ambiguous as to the nature of inflection: either the verb has raised, in which case the inflection category is featural, or the verb has affixal morphology, and has not raised – there is no way to tell. So, the learner must look elsewhere. Unequivocal data showing that English takes the affixal value of the parameter is presented in sentences with *do*-support, where the form of *do* is 3rd person: *does* or *doesn't*. From such examples, the learner can infer that the 3rd person *s* morpheme is generated higher than the main verb and requires a morphological host other than the main verb. Seeing that *do* is inserted to host the *s* morpheme informs the learner that English opts for the affixal value of the inflection parameter.

For the negation parameter, the fact that *n't* appears attached to modals and auxiliaries (*can't, shouldn't, haven't, isn't* etc.) suggests that it is a head. However, the knowledge that *n't* is a head doesn't help children implement this value of the negation parameter in sentences with main verbs. Children must be exposed to the specific lexical item *doesn't* to see that *n't* remains outside the verb phrase, with the *s* affix positioned higher than negation. So, in principle, *n't* attached to any modal or auxiliary provides the data for setting the negation parameter but, in fact, it may not be set until children discover *doesn't*. Of course, the discovery that *n't* is a head still does not guarantee that the negative morpheme *not* is also a head; it could be a specifier. Therefore, children could use *doesn't* in the same way as adults do but, at the same time, they could analyze *not* as a specifier. Our empirical findings suggest that once children acquire *doesn't*, they cease to use *not*, at least for a time. For now, we will simply assume that *doesn't* is the critical data that children need, and leave the continuing status of *not* in children's grammars as an open question.

Having established that *does* and *doesn't* constitute unambiguous data for learners to set the inflection and negation parameters, we can use the frequency of occurrence of these lexical items in the input to estimate whether these parameters are acquired early or late, according to the Variational model. To obtain an estimate of the frequency of these 'signature' inputs, we conducted a search of the adult input to Adam and Eve in the CHILDES database (MacWhinney 2000). Of the 30,882 adult utterances that were checked, 466 (1.5%) contained *does* and 296 (0.95%) contained *doesn't*. Both of these items suffice for children to set the inflection parameter to the affixal value. If the two figures are combined, then, there are 762 informative instances, which is 2.46% of the total utterances. On the Variational model proposed by Yang, parameters whose signature input appear with a frequency of occurrence of 2.46%, such as the inflection parameter, are expected to be set late in the course of acquisition.

Turning to the negation parameter, if we assume that any modal, or auxiliary with the *n't* affix is signature input for the parameter, then there are 3,618 relevant utterances in the input, out of total set of 30,882 utterances. This amounts to 12% of the input to these children. So, according to Yang's criterion, the negation parameter could be set early. However, as we saw, children need to witness *doesn't* in the input to see how negation is analyzed with main verbs, rather than with auxiliary verbs. If the relevant data is narrowed just to *doesn't*, then there are only 296 relevant utterances: 0.95% of the input. The prediction, again, would be late parameter setting[11].

8.2 Child English

On both the Variational model and the Structured Acquisition model, in principle, all four options from the diagram in Figure 3 could be instantiated in children's grammars. On the Variational model, all four options would initially vie for dominance in the learner's grammars, while on the Structured Acquisition model, just one option is expected to be contemplated at a time. These expectations for the two models only hold, of course, if there is a viable way to express these parameter values in English.

Let us begin by considering children's potential utterances, should they hypothesize that INFL has the featural value of the inflection parameter. If the child learning English selects the featural value, she will succeed in producing adult-like utterances with auxiliary verbs and modals, because these verbal elements raise in the syntax in the adult grammar of English. The hypothesis is problematic for main verbs, however. Main verbs cannot raise to check the uninterpretable features that are generated in the inflection node, because the English setting of the verb raising parameter requires verbs to stay inside the verb phrase. The verb raising parameter is situated higher in the parameter hierarchy than the inflection parameter, so it will already have been set at the point that children are considering the inflection parameter (cf. Wexler 1998). Thus the child confronts a dilemma. For main verbs, there is a conflict between the featural setting of the inflection parameter and the verb raising parameter, which prevents main verbs from raising out of the VP.

How can the uninterpretable features in the inflection category be satisfied when the main verb cannot raise? We propose that, as children strive for a solution that can be implemented in English, their utterances contain 'misplaced' morphology. This yields non-adult utterances such as: *The spider s fit in there*. More specifically, the proposal is that children project *s* as a phonologically weak auxiliary verb that raises to inflection to check off its uninterpretable features. The weak *s* auxiliary verb, like *be* and *have*, raises out of the verb phrase to check off the uninterpretable features in INFL. As a weak clitic-like element, the *s* auxiliary leans on its neighbors for support, but it need not attach to a verbal host. So, we take utterances like *The spider s fit in there* as evidence that children have misset the inflection parameter and erroneously hypothesized featural inflection for English.[12]

The featural setting of the inflection parameter can be combined with either setting of the negation parameter. But since either setting of the negation parameter yields the same surface word order when combined with featural inflection, it is difficult to identify which setting of the negation parameter the child has selected. Following usual grammatical practice, if negation is a specifier, the weak *s* auxiliary verb can raise to INFL, resulting in examples like *The spider s not fit in there*[13]. If negation is generated in the head of the phrase, the auxiliary verbs *have* and *be* are permitted to raise past negation (cf. Chomsky and Lasnik 1993), so the weak *s* auxiliary is also expected to raise above than negation -- again, this would generate sentences like *The spider s not fit in there*. Finally, if a child takes *don't* to be an unanalyzed negative chunk in head position, then utterances like *The spider s don't fit in there* would also be expected. In Figure 6, we summarize the range of possible child utterances, both affirmative and negative, that are consistent with featural inflection.

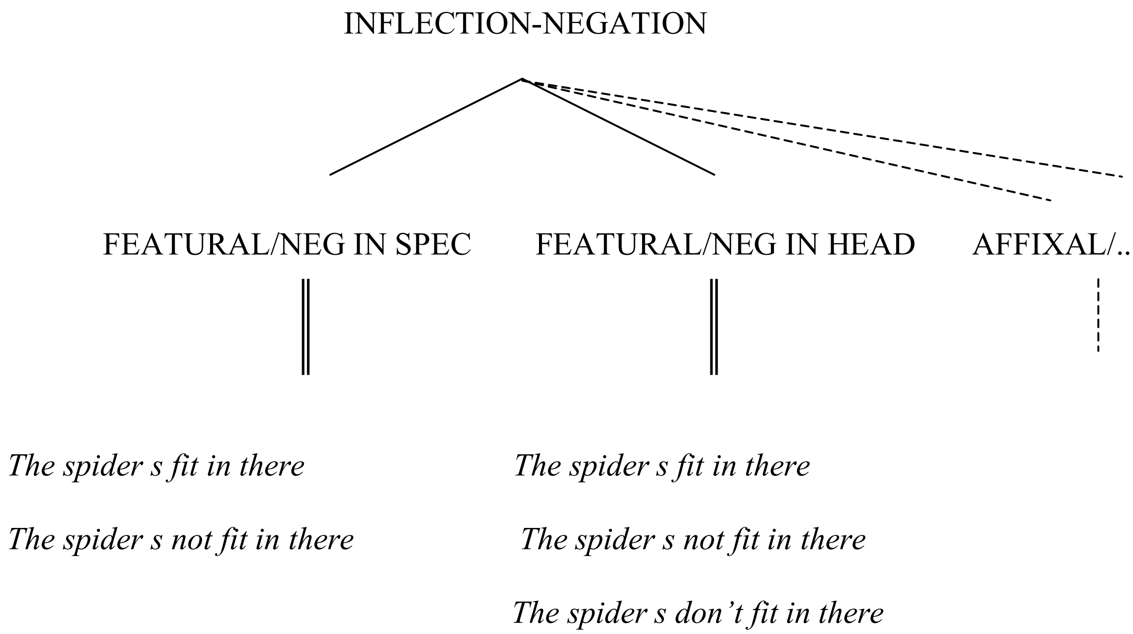

Figure 6: The utterances generated by the featural setting of the negation parameter, with and without negation

Whether the child produces an affirmative or a negative sentence, the orphan *s* morphology is a tell-tale sign that the child has a featural setting of the inflection parameter. The disappearance of the misplaced morphology, therefore, will serve to flag the fact that such a child has switched to the affixal value of the parameter, which is the correct setting for adult English.

If the child's initial value of the inflection parameter is affixal, the child faces an even more arduous journey to the adult grammar. This may be counterintuitive, because the affixal value is the target setting for English. Furthermore, the hypothesis that English selects the affixal value of the inflection parameter works fine for affirmative sentences; the affix is simply lowered onto main verbs, resulting in adult-like utterances such as *The spider fits here*. But if a child has not yet acquired *do*-support, the affixal value of the inflection parameter will prove problematic in negative sentences[14]. During the period before do-support is acquired, if the negative words *no* or *not* are taken to be positioned in the head of a phrase, then the affix is blocked from lowering past negation onto a verb inside the VP without violating the head movement constraint (Travis 1984, Chomsky and Lasnik 1991). Therefore, the child has no way to produce negative sentences without violating Universal Grammar, despite having the correct adult setting of the parameter.

Children who find themselves in this quagmire could proceed in a number of ways. The most efficient route to the adult grammar would be to retain the affixal setting of the inflection parameter, and to reconcile this with input that contains the verbal element *does*.[15] The observation that *do* supports the *s* affix in questions (*Does the spider fit in there*), in sentences with VP ellipsis (*Yes he does),* and in negative sentences (*The spider doesn't fit in there* would immediately propel the child to the target grammar. Children who are unable to adopt *does* into their lexicon, however, face a predicament. One way out for them would be to produce utterances with no verbal morphology at all, such as *The spider no/not fit in there*[16]. In this case, infinitives in main clauses can be seen as a last resort 'repair' option taken by children who lack do-support. A more UG compatible solution would be to try a different analysis, with negation as a specifier, on par with the negative adverb *never*. If this route is taken, the verbal *s* affix is free to lower over *not*, yielding utterances like *The spider not fits in there* (cf. *The spider never fits in there*.) It has been claimed that such utterances would flout the head movement constraint (Harris and Wexler 1996), and the few cases found in the CHILDES database have been deemed to be performance errors. However, the child data we have collected contradict this claim; we have observed many examples of *not* with an inflected verb. Assuming that children are treating negation as a specifier, the head movement *constraint* is not violated.

The production types that result if children choose the affixal setting of the inflection parameter are summarized in Figure 7.

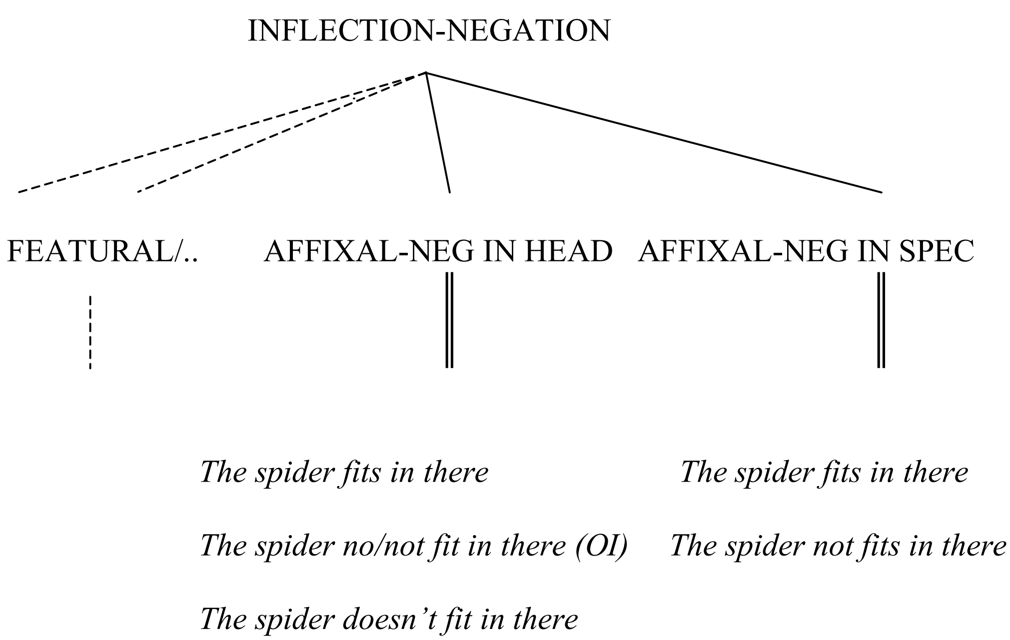

Figure 7: The utterances generated by the affixal setting of the inflection parameter with and without negation

With these predictions in hand, the next section outlines the details about the child subjects, methodology and the empirical data gathered in studies of young children's acquisition of inflection and negation. .

9. Acquisition of inflection and negation

The details of the longitudinal study conducted to examine children's development of inflection and negation are reviewed below.

9.1 Child Subjects

The four children visited the language acquisition laboratory starting at about age 2, and they continued to visit the lab every two weeks for roughly a year, at which point the verbal morphology of the children was close to adult-like. The number of sessions and the duration of participation for each of the children in the study is given in Table 2.

Subject	Age at beginning of study	Age at end of study	Number of sessions
CM	1;9.4	2;8.29	18
CW	2;0.12	3;0.8	18
SL	1;10.23	2;8.20	19
SF	2;1.9	3;8.03	31

Table 2: Participants' ages and duration of participation in the study

9.2. Methodology and Data

The child data were collected using elicited production techniques in addition to data from the children's spontaneous speech. Because of the experimental component of the study, our data differs from that reported in much of the literature on 2-year-old English-speaking children's morphosyntax. Most developmental theories are based on naturalistic data obtained using transcriptions contained on the CHILDES database (MacWhinney 2000). Naturalistic data are insufficient for a detailed study of inflection in English-speaking children, however, because toddlers' play is often restricted to 'here and now' situations, comprised of talk between 'you and me'. As a consequence, few utterances with 3rd person singular subject noun phrases are attested. Since only the verbs corresponding to the 3rd person subject expressions bear inflection in English, transcript data is unlikely to contain sufficient data with 3rd person subjects to reach firm conclusions about early acquisition of inflection. To rectify this problem, elicited production probes were used to boost the number of utterances with 3rd person subjects and utterances with negation. These techniques enabled us to increase the amount of relevant 3rd person data gathered for any one session, and therefore to follow children's development of verbal morphology more accurately than would have been possible using children's spontaneous speech.

The experimental protocols also revealed some types of utterances that have not been reported with any regularity before. In particular, sentences with misplaced morphology like *The spider s fit in there*, and ones with medial negation like *The spider not fits in there* have previously been mentioned only in passing, and have usually been counted as performance errors because of their paucity. However, the experimental techniques encouraged children to talk when they might otherwise not have spoken. This is particularly true of negative utterances, which are sparse in the CHILDES database. For example, Harris and Wexler (1996) searched the transcripts of 10 children who ranged in age ranged from 1;6 to 4;1, and found 52 sentences with 3rd person subjects in structures that contained *no* or *not* and a main verb (cf. H&W, table 5, p.16). Our study evoked 204 comparable structures from our 4 2-year-old child subjects over a considerably shorter period.

The elicited production procedures were simple. In order to elicit 3rd person subjects, the experimental workspace included a third person, in addition to the child and the experimenter. The third person was usually a puppet, and children were asked questions about the puppet using yes/no questions ("*Does the cat like milk*?"). Procedures to evoke negative sentences included a range of games to see, for example, where various objects fit. For example, a puppet might try to complete a puzzle, but would end up putting pieces in the wrong place. The child was encouraged to correct the puppet ("*It not goes there!*"). Or, the child subject was assigned the task of performing 'experiments' with a group of various objects, to see if they float, or squeak, of would stick to a magnetic board, and so forth ("*This one squeaks. This one not squeaks*"). The inclusion of these elicitation procedures resulted in a robust set of data for each child.

The details of the longitudinal data collected for the four children are summarized in the tables below. Table 3 gives the details of the affirmative sentences. Altogether, the four children produced 2,034 affirmative sentences with 3rd person subjects. Of these, 1372 contained verbs marked with 3rd person agreement morphology, and 662 were non-finite verbs. The focus of this paper is on the 1372 utterances in which 3rd person morphology was expressed, as it is only the finite sentences that are informative about the values children have adopted for the parameters of inflection and negation.

Type of Affirmative Utterance	Type of 3rd Person Singular Morphology	
Utterances with 3rd Person Morphology 1372(67%)	Misplaced Morphology 207(15%)	Adult-like Morphology 1167 (85%)
Utterances with Omissions 662(33%)		
Total Utterances: 2034		

Table 3: Total number of affirmative utterances produced by subjects (N=4)

The details of children's negative sentences are summarized in Table 4. As the table shows, the child subjects produced a total of 500 negative utterances with 3rd person singular subjects. Of these, 325 contained verbs with agreement morphology as well as some form of negation. These latter data are crucial in tracking children's settings of the negation parameter.

Type of Negative Utterance	Type of 3rd Person Singular Morphology		
Utterances with 3rd Person Morphology 331 (65%)	Misplaced Morphology 31(10%)	Medial Negation 97(29%)	Adult Do-support 202(61%)
Utterances with Omissions 175(35%)			
Total Utterances 506			

Table 4: Total number of negative utterances produced by subjects (N=4)

Summarizing the data from Tables 3 and 4, the four children produced a total of 2,540 sentences with 3rd person singular subjects. These utterances form the basis for our evaluation of the alternative parameter setting models. Before we proceed with the evaluation, a word is in order about the exceptional types of utterance that children produced.

9.3. Novel Utterances

We mentioned one kind of novel utterance earlier; for example *The spider s fit in there.* These utterances with ‘misplaced morphology’ have not been reported in previous literature as a grammatical option for children. The phenomenon was observed by Stromswold (1990) in the transcripts of Adam (in the CHILDES database), but Adam’s use was restricted to the pronoun *it* and did not show up with other 3rd person subjects. Instances of misplaced inflection have also been reported by Foley, Núñez del Prado, Barbier and Lust (2003), in a study using an elicited imitation methodology. In the child data we obtained, misplaced inflection was not limited to experimental situations. However, with the aid of elicited production techniques, children produced sufficient numbers of examples to demonstrate that the misplaced inflection is clearly a grammatical option for some children.

A number of safeguards were implemented to ensure that the misplaced *s* was not simply used to mark the subject noun phrase as plural (as in *The spiders fit in there*). All sessions with children were videotaped, to see whether children were referring to single objects or sets of objects. In addition, a range of NP types (i.e., common nouns, names, singular pronouns, and quantificational nouns like *everybody*) were elicited, to determine the range of NP types that children combined with the stray morpheme. Since names and quantificational NPs cannot be pluralized, the appearance of utterances like *Everybody s fit* and *John s fit* among children’s non-adult productions confirmed that the *s* morpheme was, indeed, associated with inflection and not a plural marker.

A note is also in order about the syntactic distribution of the *s* morpheme. This misplaced morpheme appeared only with 3rd person subjects in present tense contexts, and not in sentences with a modal or auxiliary verb. So no child produced a sentence like *The spider cans fit*, for example. Nor did any child produce an utterance like *The spider ed fit* with a misplaced past tense *ed* morpheme separated from the main verb. This last observation is somewhat puzzling, because both the 3rd person present and past tense morphemes express inflection. It may be that children did not have productive use of the past tense in the period of misplaced morphology, and when the optional infinitive phenomenon is observed, roughly from 2 to 3 years of age. Alternatively, a phonological constraint could be operative. Or, the theory may need refining. Since the answer is not clear cut, the issue must be set aside pending further research.

Utterances with medial negation, such as *The spider not fits in ther*e, were also observed, and for the first time, enough of these utterances were observed to conclude that they are consistent with children's grammars, and not performance errors. In a previous search of the CHILDES database, Harris and Wexler (1996) found few such occurrences, which invited the conclusion that they were performance errors. The present data demonstrate clearly that, at least for some children, medial negation utterances are a grammatical option, possibly representing a misset parameter.

10. Evaluation of the Models

This section discusses the three main criteria that distinguish between the Structured Acquisition model and the Variational model: (i) initial value, (ii) trajectory and (iii) conformity. In each case, the longitudinal data from the four child subjects will be used to assess how well the accounts stand up to the empirical findings. The inflection parameter is discussed first, and then the negation parameter.

10.1. The Inflection Parameter

Triggering models, including the Structured Acquisition model, anticipate that children will consistently apply one parameter value unless parameter resetting is required. As we noted, however, if the type of sentence that is indicative of one or other parameter value is optional, then its use may not reach the 90% correct usage criterion of grammatical knowledge. We witnessed this in children's use of null subjects, where children used both null subjects and lexical subjects, until pronominal subjects replaced the null subjects. The child production data relevant to the inflection parameter likewise shows two forms. On our analysis, this is because adult-like sentences such as *The spider fits* also appear at the stage when children produce non-adult utterances such as *The spider s fit*[17]. For children who have the featural value of the inflection parameter, there may be more than one way to realize the value[18]. Since there is no way to tell what analysis children are assigning to adult-like utterances (*The spider fits*) in the early stages, we have omitted adult-like utterances in the counts of featural inflection. But it should be kept in mind that this necessarily reduces the proportion of utterances representing the featural value of the inflection parameter in the graphics we present.

10.2 Trajectory

Children's trajectories for the inflection parameter are summarized in Table 5. As can be seen, the children chose one or the other value of the parameter as their starting point; two children selected the featural value of the parameter, and two children selected the affixal value. There was no child for whom both values seemed to be competing in the earliest stages of acquisition. This finding is not anticipated on the Varational model. Of the two children who selected the non-adult featural value, one child (S.L.) also exhibited abrupt parameter resetting, eliminating the misplaced morphology and switching to adult-like utterances. The other child (C.W.) exhibited a smaller drop in use of non-target utterances, but the drop itself was nevertheless quite precipitous.

We consider next the two children who selected the adult affixal value of the inflection parameter. One child (C.M.) rapidly converged on the adult grammar, while the other child (S.F.) meandered, taking well over a year longer to master do-support. This child initially set the parameter to the affixal value, then reversed his setting to the non-target featural value, and then reversed the setting yet again, finally deciding that English does, after all, take the affixal value of the parameter.

Subject	Initial Value	Trajectory	Parameter Stable
Child One: S.L.	Featural	Abrupt	2;4
Child Two: S.F.	Affixal	Gradual?	3;3
Child Three: C.W.	Featural?	Abrupt?	2;7
Child Four: C.M.	Affixal	None	2;0

Table 5: Summary of Initial Value and Trajectory for Inflection Parameter

The detailed trajectories for the individual children are shown in a series of graphs, which all show the decline of utterances with misplaced morphology as a percentage of all affirmative and negative utterances that contain an inflected verb. Since the adult utterances (*The spider fits*) do not, in principle, distinguish between featural and affixal morphology, they cannot be decisively used to show the introduction of affixal morphology. For this reason, the increase in adult-like utterances is not represented on the graphs.

The data for subject S.L. are depicted in Figure 8. Altogether, S.L. produced 590 affirmative and negative utterances, of which 144 have misplaced morphology. The data are graphed from the second session, since S.L. produced only one verb in the first session at 1;10;23[19]. S.L. started her sessions at 1;11.12 using featural inflection (*The spider s fit in there*) in 67% of her utterances in which inflection is expressed on the verb. This then increased to 87% at 2;1.9, despite the absence of evidence in the input corresponding to this setting of the parameter. By 2;3;16, just 2 months later, S.L.'s use of featural inflection had declined to 4% of utterances with an inflected verb, an 83%decline. Once the featural option dropped out, it did not constitute more than 5-6% of S.L.'s productions in any subsequent session. This kind of trajectory is not the gradual curve that is associated with statistical learning, and seems, instead, to be indicative of categorical change, as expected by the Structured Acquisition model.

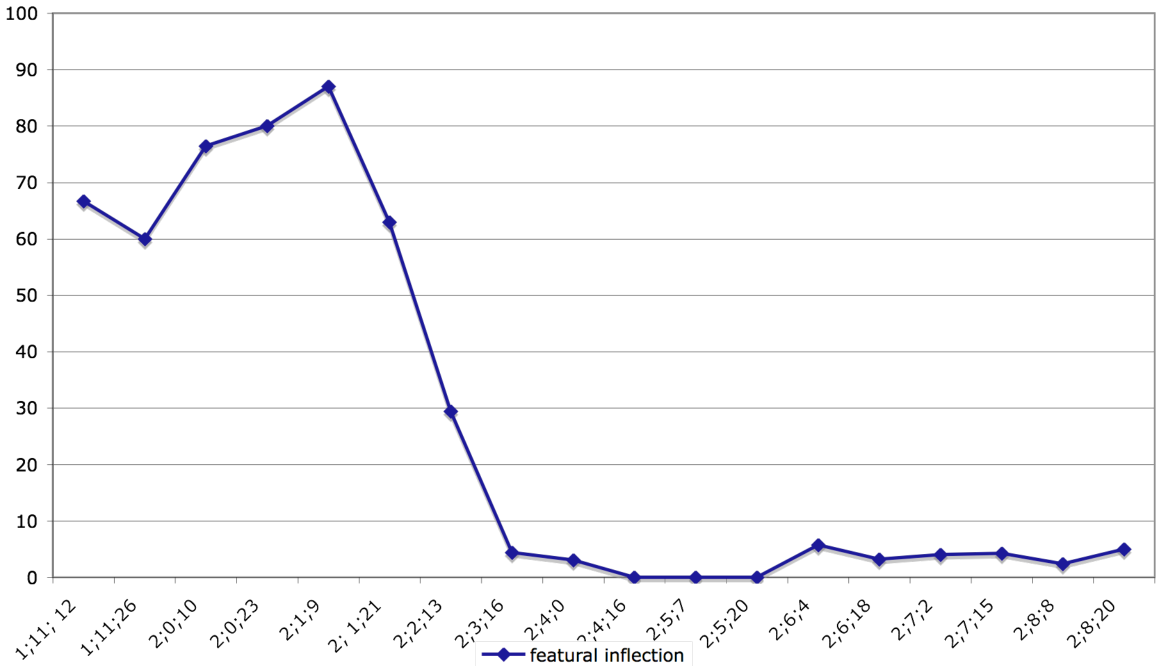

Figure 8: Proportion of featural inflection across sessions for S.L.

The graph in Figure 9 shows data from S.F. These data reveal a more chaotic path than the one taken by S.L., with non-target utterances extending over a longer period of time. During the time period indicated in the graph, S.F. produced 511 utterances with 3rd person subjects in which the verb was inflected, 39 of which have misplaced morphology. Initially, S.F. appears to have adopted the affixal value for the inflection parameter. Then, S.F. appears to switch to the featural value, only to switch back again. In the first session with productive use of inflected verbs, featural inflection was exhibited less than 10% of the time (if misplaced inflection is used as the yardstick). Featural inflection then rose gradually, taking several months to reach asymptote. Since there is no evidence for featural inflection in the input, this learning curve is not easily reconciled with the Variational model. Featural inflection reached about 43% use at 2;11;28. However, within three months, S.F.'s featural inflection had been eliminated, with the adult parameter setting becoming stable at about 3;3. Thus, although the trajectory is prolonged, when the parameter is set conclusively, the change takes place within 3 months. The timeline suggests that S.F. was able to ignore the distributional data in the input until almost 3 years of age, at which time parametric change had been instigated.

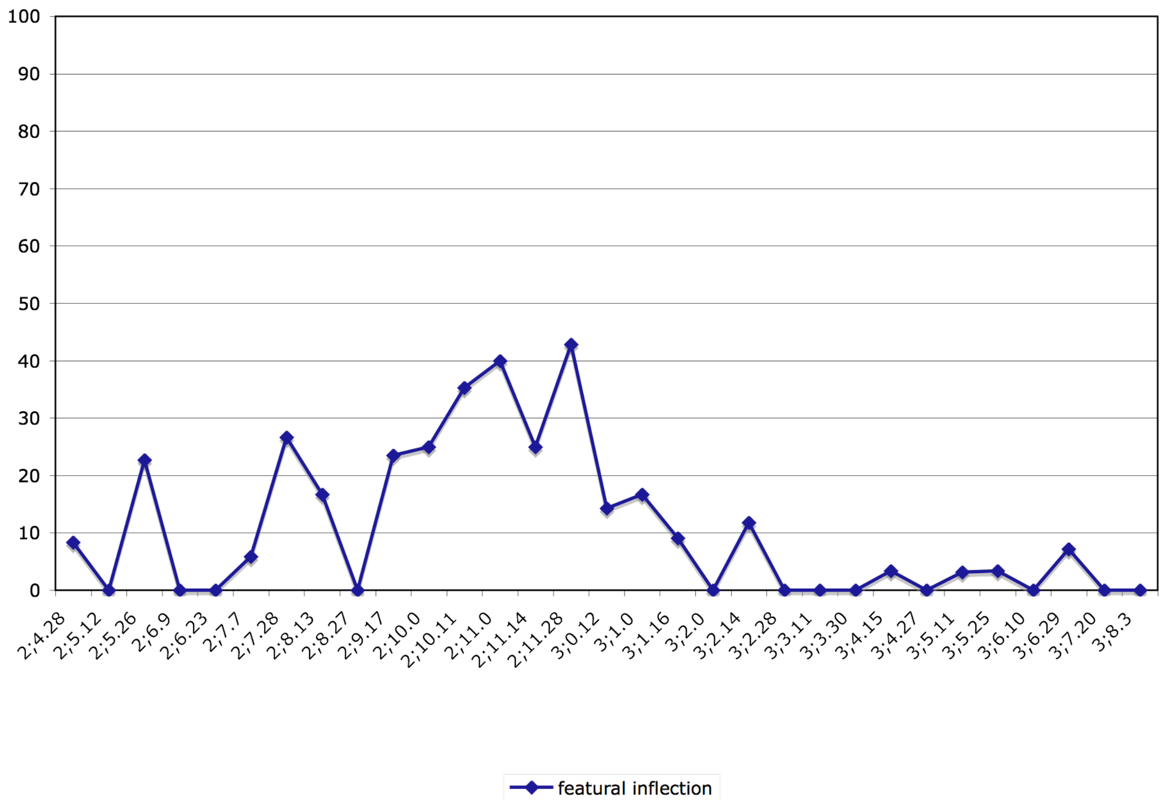

Figure 9: Proportion of featural inflection across sessions for S.F.

Figure 10 depicts the trajectory for C.W. C.W.'s use of featural inflection is graphed beginning with the first session at 2;0;12. In all of the sessions, she produced a total of 406 utterances with 3rd person subjects and a verb expressing inflection, of which 41 represent misplaced morphology. However, all indications are that the onset of her production of inflection had already begun before the first session at our language acquisition laboratory. During this session, C.W. used featural inflection in 23% of her utterances with an inflected verb. This rose to 38%, but never exceeded this percentage. Although C.W. used the featural option of the inflection parameter at most 38% of the time, as seen at age 2;1;6, the percentage had dropped to 0% by 2;3;24, i.e., in just two months. After that, its use remained below 10% in all but one of the sessions. Again, there is a fairly sharp change.

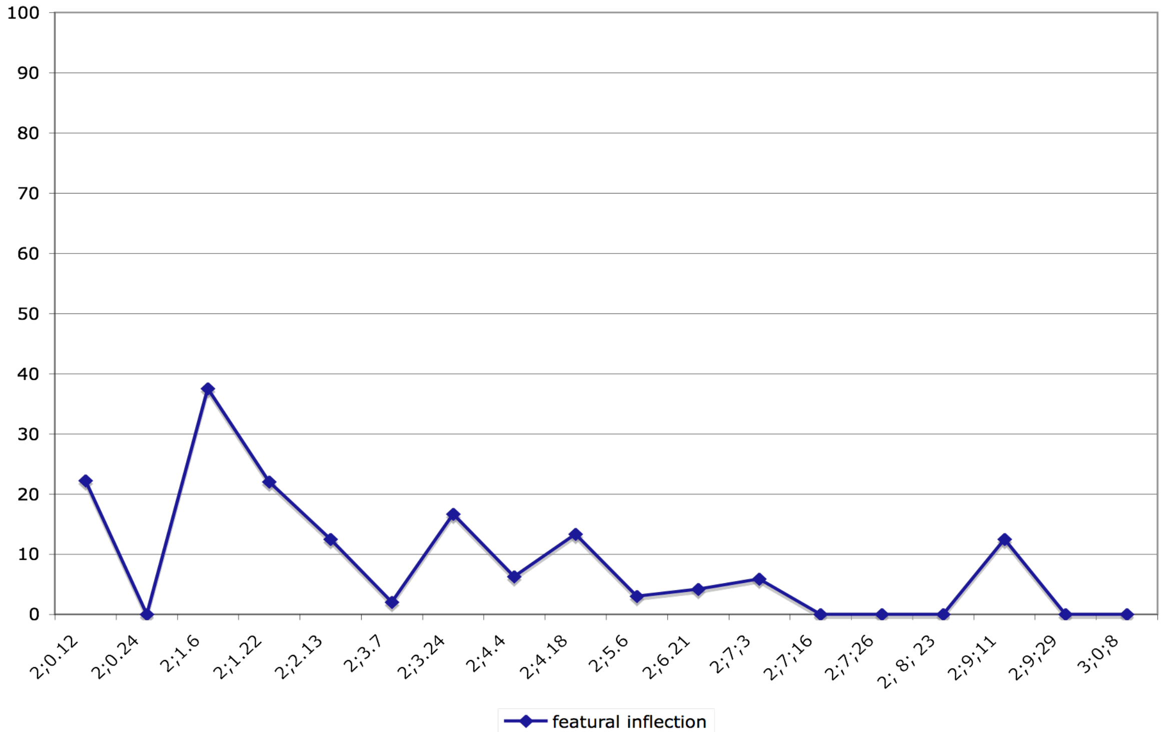

Figure 10: Proportion of featural inflection across sessions for C.W.

The graph in Figure 11 illustrates the pattern of development of the fourth child, C.M. During this time, C. M. produced 196 utterances with a 3rd person subject and inflected verb. The small peak in the graph at 1;11;25 represents the 5 examples C.M produced that can be interpreted as evidence of the featural value of the inflection parameter.[20] Thus C.M. had the adult value of the inflection parameter from the start, and no change in the parameter value was observed. It is our interpretation of C.M.'s data, then, that the inflection parameter was initially set to the affixal value, hence C.M.'s adult-like productions such as *The spider fits* are taken to unambiguously reflect the affixal parameter value, and for this reason, they are included on C.M.'s graph.

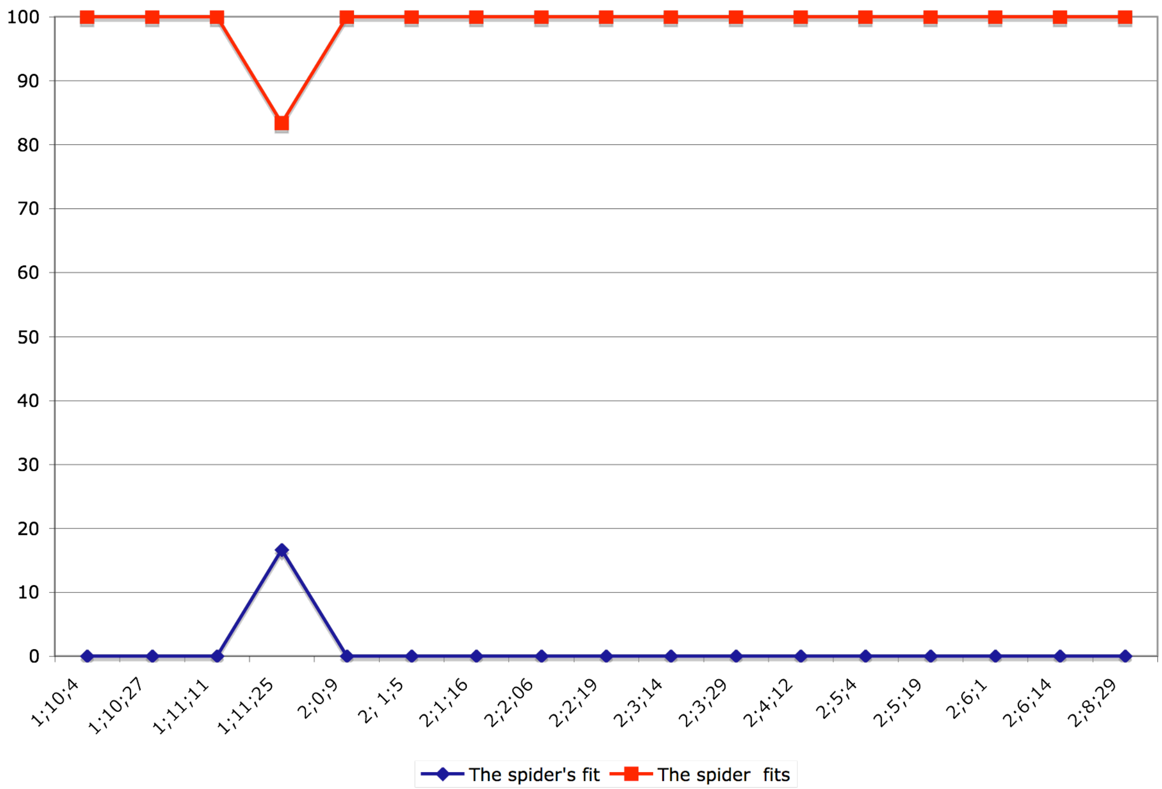

Figure 11: Proportion of featural inflection across sessions for C.M.

10.3 Conformity

Another distinguishing criterion is conformity in acquisition across children. This is expected on the Variational model, but not on the Structured Acquisition model. The profiles of the four children clearly do not display conformity. The children take different paths to the adult value of the inflection parameter, and achieve the adult value of the parameter at different rates. C.M. initially selected the affixal value and changed abruptly to become adult-like by 2;0. The children who initially selected the featural value (C.W. and S.L). switched within a few months to the affixal value. Moreover, one child, S.F., settled on the affixal value an entire year later than other children did. This child did not change to the correct value until he was over 3 years of age. This was not due to gradual learning, however. In fact, S.F. manifested a 'pendulum' learning curve, switching from the affixal value to the featural value of the inflection parameter, and then back again to the affixal value. To sum up, different children begin with different start values, take different paths, and reach the 'final state' at different rates and at different times. Conformity is not characteristic of children's behavior.

10.4 The Negation Parameter

The negation parameter gives the learner two options in assigning a position to negation in the phrasal structure of sentences. As before, the predictions of the Structured Acquisition model and the Variational model will be discussed for this parameter using the following three criteria: (i) initial value, (ii) trajectory and (iii) conformity.

10.5 Trajectory

The data indicate that, in the initial stages, children select one parameter value or the other, but not both values, of the negation parameter. S.L. hypothesizes the adult value with negation residing in head position, whereas the other 3 children begin with negation located in specifier position. Since S.L. begins with the adult value, the trajectory of parameter setting for S.L. is essentially flat, although she needs to acquire the lexical item *doesn't*. The productions of the 3 other children, who initially adopt the non-target value, exhibited abrupt change in values, as anticipated on the Structured Acquisition model. Moreover, the precipitous changes manifested by different children were initiated and completed at different times. There was no indication that the statistical distribution of structures or lexical items in the input was responsible for the trajectories of any of the children. If the assumption of uniformity of input is correct, then children's data corresponding to the negation parameter do not provide support for the Variational model. The data for the 4 children are summarized in Table 6.

Subject	Initial Value	Trajectory	Stability of *Doesn't*
Child One: S.L.	Neg-in-head	None	2;6
Child Two: S.F.	Neg-in-spec	Abrupt	3;7
Child Three: C.W.	Neg-in-spec?	Abrupt?	2;7
Child Four: C.M.	Neg-in-spec	Abrupt	2;0

Table 6: Summary of the Trajectory and Initial Value for Negation Parameter

The trajectory for each child is shown below in a series of graphs[21]. Recall that the same value of the negation parameter may have different surface manifestations, at different points in time, depending on the child's current hypothesis about the value of the inflection parameter. In particular, a child who has hypothesized the neg-in-spec value of the negation parameter might produce sentences of the form *The spider s not fit in there* at the stage at which the inflection parameter is set to the featural value, but later, when the parameter is switched to the affixal value, the same (neg-in-spec) value of the negation parameter would result in sentences of the form *The spider not fits there*. For the relevant children, two graphs illustrate the course of development. The first graph shows the varying surface manifestations of the hypothesized parameter value; the second graph collapses these variations of surface forms, to more clearly display the development of the neg-in-head value versus the neg-in-spec value of the negation parameter.

The data for S. L. are shown in Figures 12 and 13. There were only 5 sessions in which S.L. produced negative sentences bearing inflected verbs, so the data in the graphs is limited to these 5 sessions in which 29 instances of negation were produced with a 3rd person subject and inflected verb[22]. Although S.L.'s data are limited, it is clear that the adult neg-in-head value of the negation parameter was her initial hypothesis. This child did not use the item *not* at all. The few negative utterances S.L. produced incorporated *do* as a host for the head *n't*, in sentences of the from *The spider s don't fit*. These examples are interpreted as a reflex of the neg-in-head value of the parameter, combined with the featural value of the inflection parameter. Since S.L. did not mis-set the negation parameter, the graph does not reveal one value of the negation parameter being replaced by another. However, S.L does mis-set the inflection parameter. The effect of this is revealed in the sentences she produced that illustrate the neg-in-head value of the negation parameter across time. The different negative forms used by S.L. are given in Figure 12. Before the featural value of the inflection parameter is eliminated, S.L.'s negative sentences are of the form *The spider s don't fit*, but once S.L. acquires the affixal value of the inflection parameter, at around 2;6, her negative sentences contain *doesn't*. Since these two utterance types are both evidence of the neg-in-head value of the negation, it is reasonable to collapse them, which results in Figure 13. This figure illustrates that S.L. maintains a constant value for the negation parameter. In the session at 2;1;21, one of S.L.'s 4 utterances shows medial negation, with negation in the specifier position (i.e., *It don't squeaks*[23]*)*, hence the small peak in the graph.

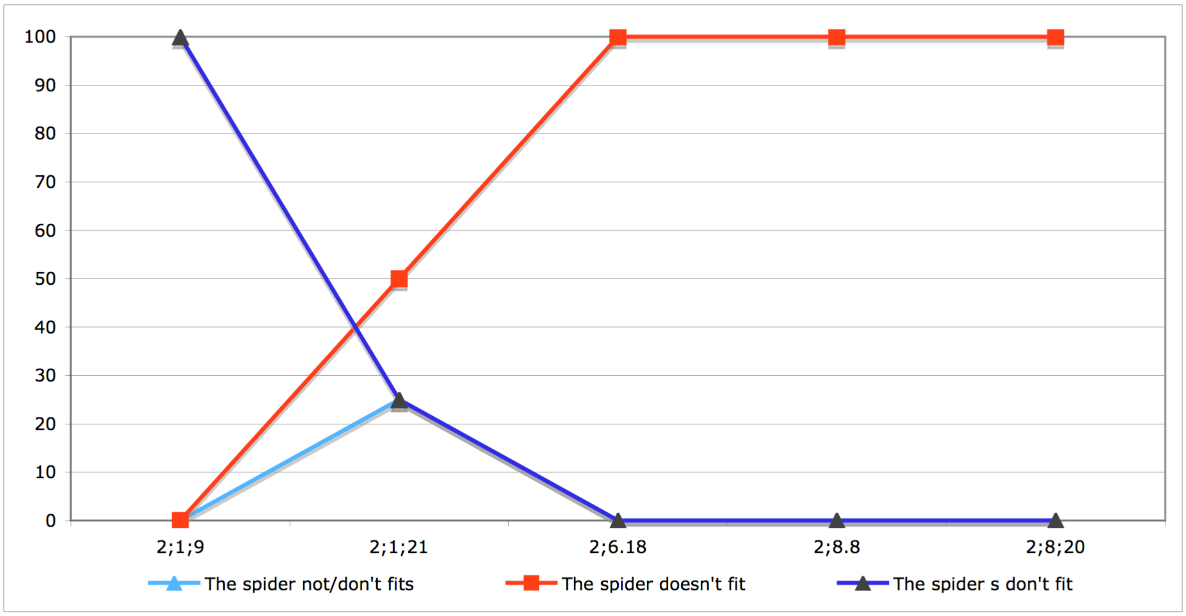

Figure 12: Negative forms used by S.L.

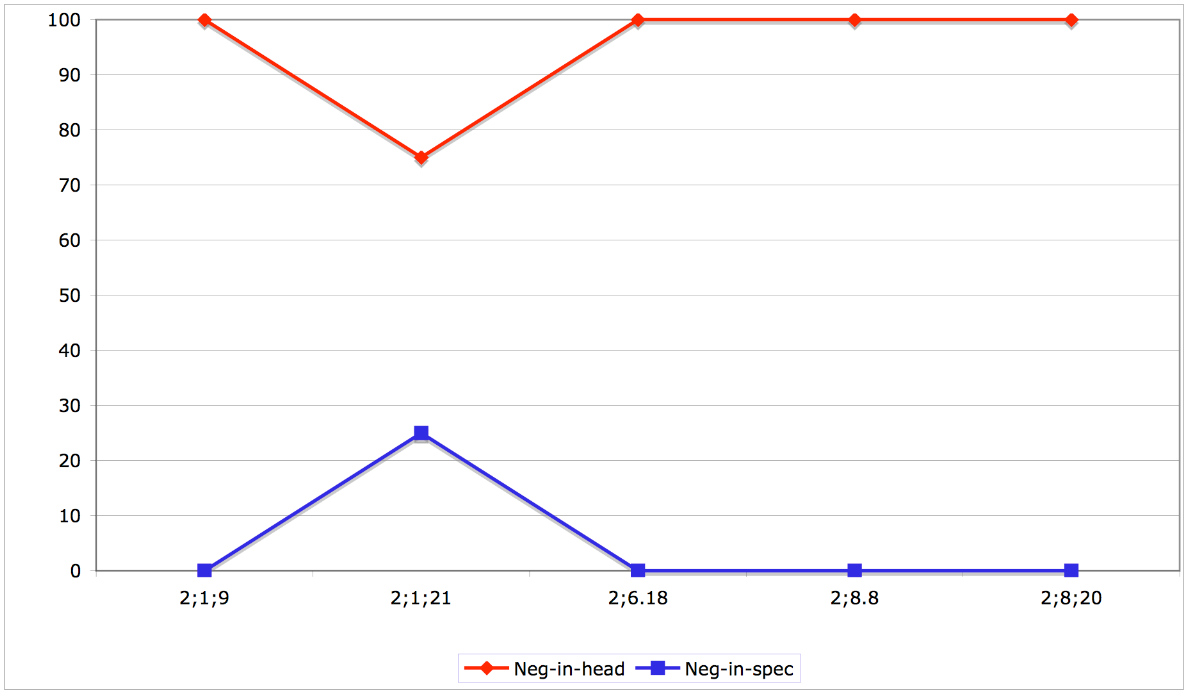

Figure 13: The trajectory of the two negation values in S.L.'s data

The data for the child S.F. are summarized in Figure 14. The profile appears chaotic because S.F. produces a variety of negative forms. Altogether, he produced 190 negative utterances with a 3rd person subject and inflected verb. However, as with S.L., the fluctuation for S.F. can be attributed to the value of the inflection parameter, which affects the form of S.F.'s negative sentences. During the first few sessions, S.F. had a single initial value for the negation parameter; 100% of S.F.'s productions exemplify the neg-in-spec value. Optionality in forms appears only later in the negative sentences produced by S.F. This is shown in Figure 14. However, the optionality exhibited by S.F. is evidence of his change in values for the inflection parameter, and does not involve the negation parameter. S.F. starts with the affixal value of the inflection parameter, but then switches to the featural value (perhaps in order to permit him express negation). At that point, S.F. produced utterances with misplaced inflection, as in sentences of the form *The spider s not fit in there*. Later, S.F. reverted to the affixal value of the inflection parameter and finally, *doesn't* appears.

In presenting the developmental trajectory of S.F., we have combined the later negative utterances with featural inflection (*The spider s not fit in there*) and the earlier medial negation utterances (*The spider not fits in there*) in Figure 15, because both forms reflect a constant neg-in-spec value for the negation parameter. Once these alternative forms are combined, the chaotic peaks in the earlier graphic representation flatten out considerably. As Figure 15 shows, S.F. uses the neg-in-spec value of the negation parameter until about age 3;3[24]. S.F. apparently ignored relevant input for many months. Finally, at about 3 years of age, S.F.'s grammar abruptly changed. The change culminated at about 3;3. In the session at 3;2;28, S.F. produced 12 examples with medial negation. A month later, when he was 3.;3.30, medial negation had disappeared, and S.F. produced 23 cases of *doesn't* in a single session.

Again, the evidence from S.F. is difficult to reconcile with the Variational model, first, because the positive input appears to have no impact on S.F.'s productions for many months, and second, when change does take place, it is swift.

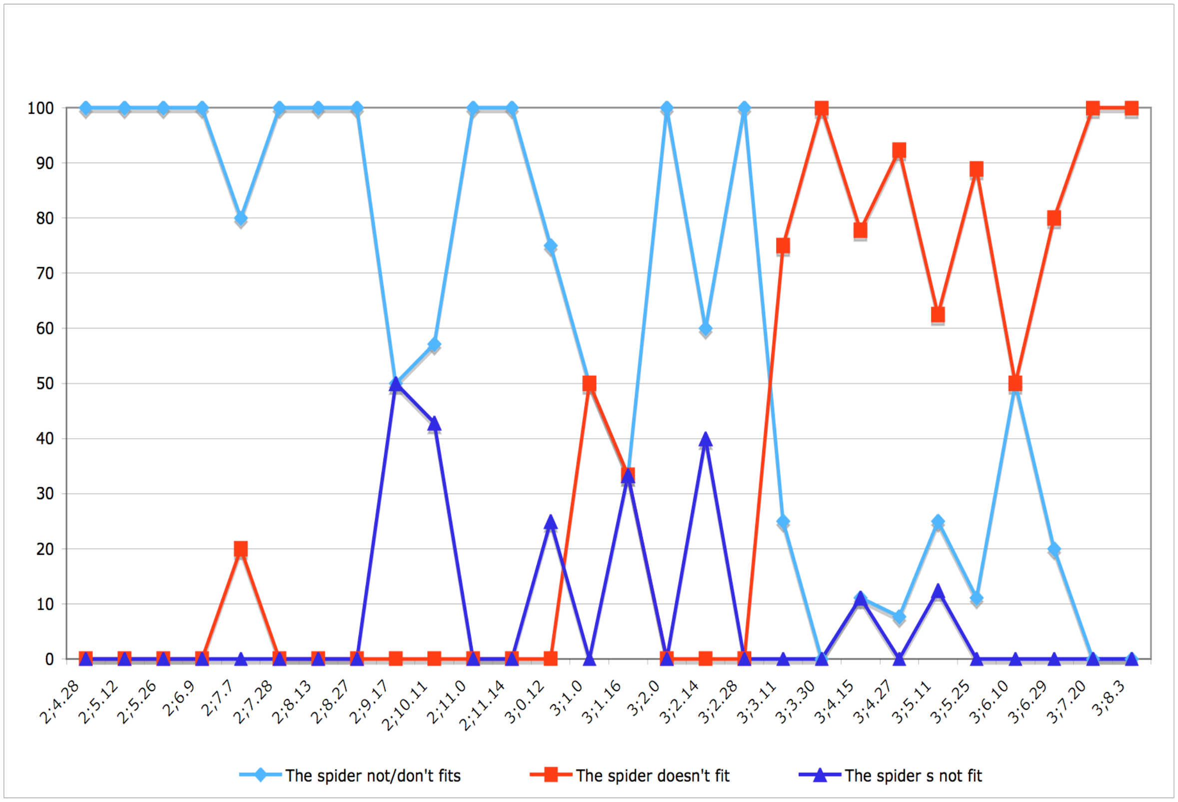

Figure 14: Negative forms used by S.F.

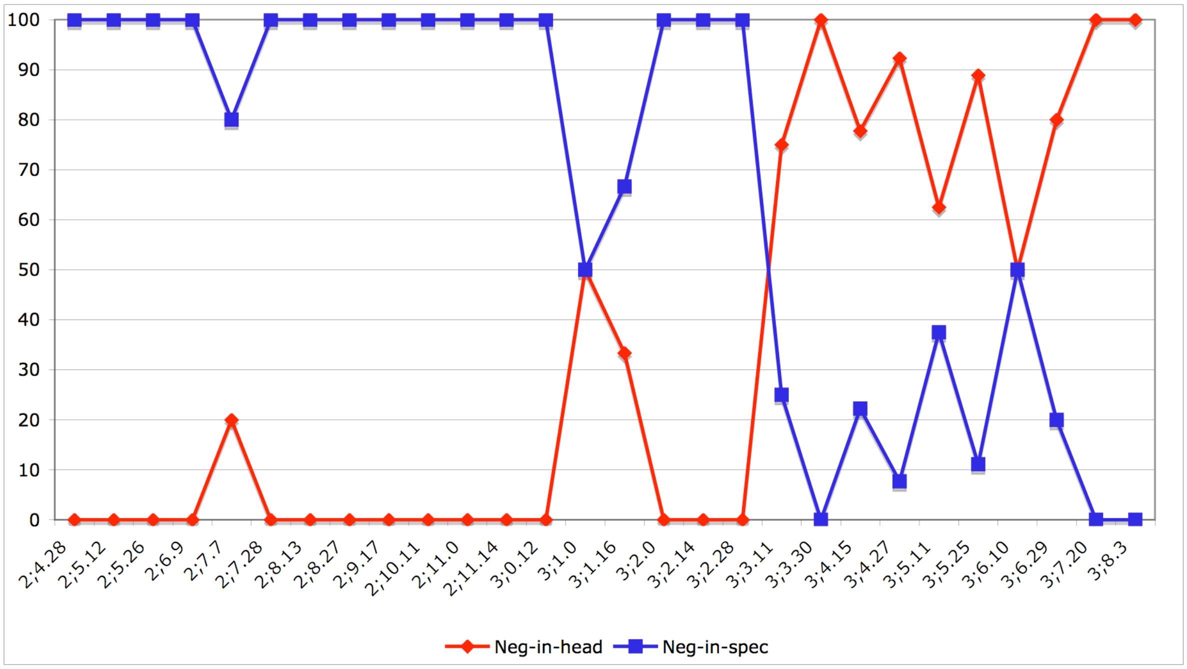

Figure 15: The trajectory of the two negation values in S.F.'s data

Subject C.W. used a variety of negative forms, as shown in Figure 16. Altogether, C.W. produced 69 negative utterances with a 3rd person subject and inflected verb. C.W.'s data do not reflect the onset of her production, so it is not possible to be certain of her initial value of the negation parameter. Judging from Figure 16, it seems most likely that the initial value of the parameter was neg-in-spec. In the first session recorded, there were four utterances with inflected negation; 3 with misplaced morphology and one adult-like example with *doesn't*. As with S.F. the optional forms are more likely to be the product of the inflection parameter, rather than the negation parameter. At first, C.W. appears to use both medial negation (i.e. the affixal value of the inflection parameter) and misplaced morphology (the featural value). If the medial negation utterances and the negative utterances with misplaced morphology are collapsed, as we did with S.F.'s data, and both utterance types are taken to represent the neg-in-spec option of the negation parameter, the pattern shown in Figure 17 emerges. There is sharp change between 2;2 and 2;3 as the neg-in-spec value of the parameter is switched to the neg-in-head value and utterances with *doesn't* begin to appear. Once the neg-in-spec value of the negation parameter has been replaced, utterances with *doesn't* suddenly appear; there are no examples with *doesn't* in the session at 2;02;13, but it is a constituent of 9 of the 10 sentences of negation produced by C.W. in the session at 2;4;18. The trajectory in Figure 16 shows the precipitous change, here within 2 months, that is anticipated by the Structured Acquisition model.

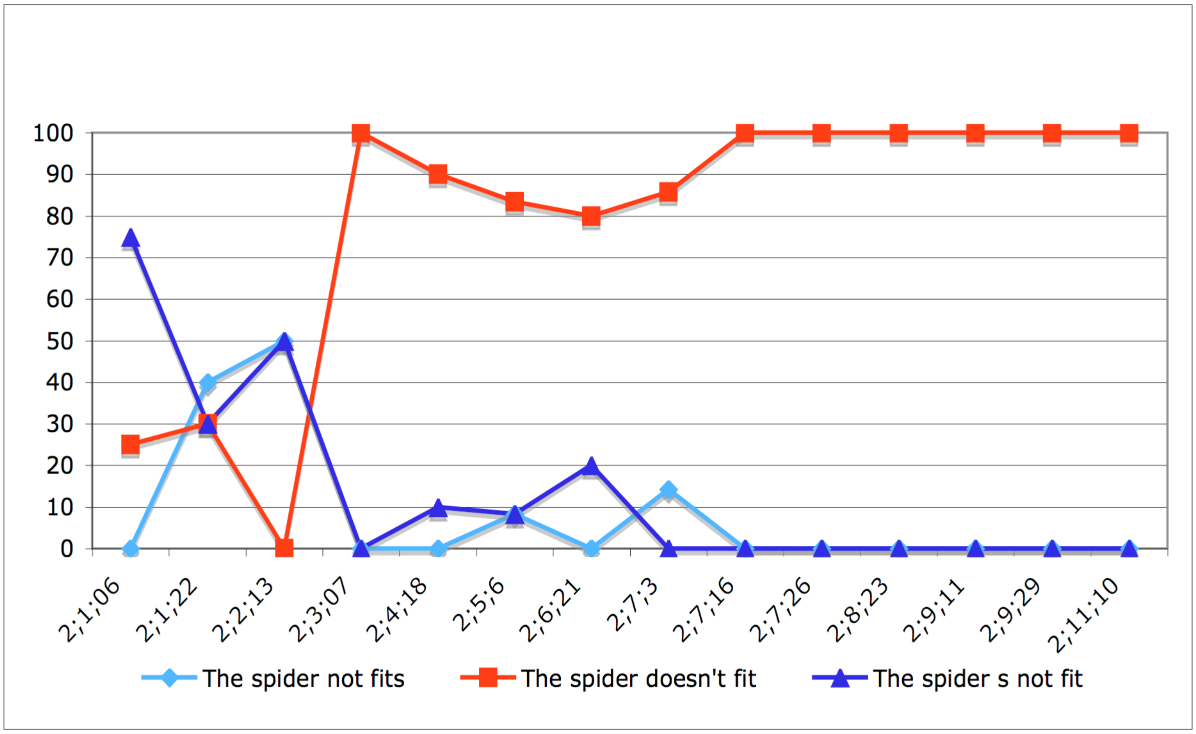

Figure 16: Negative forms produced by C.W.

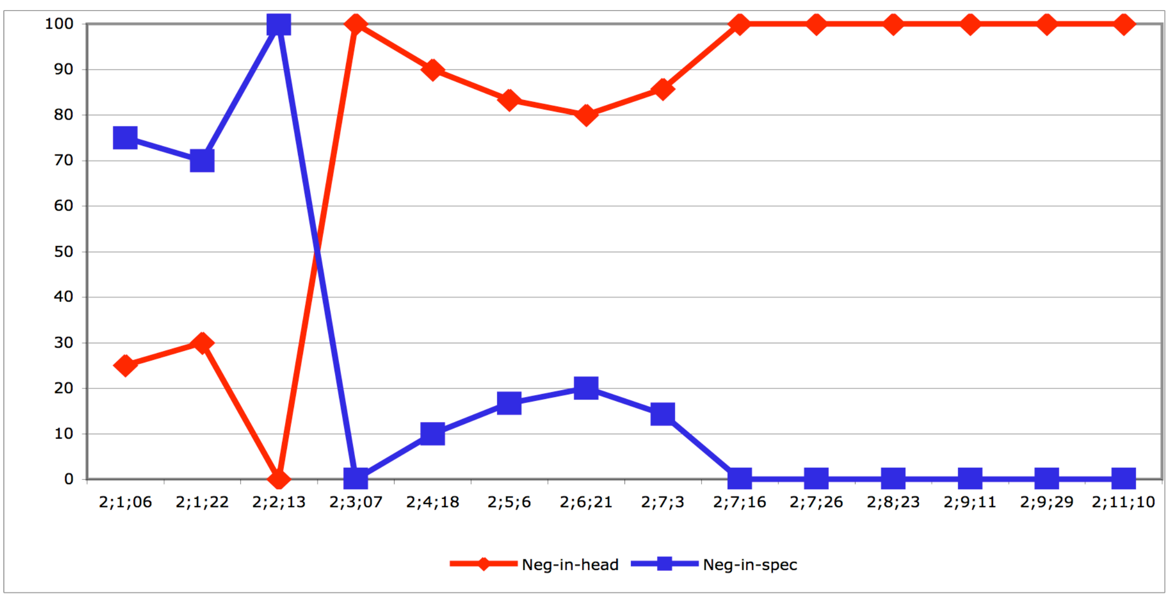

Figure 17: The trajectory for the two negation values in C.W.'s data

The trajectory for the negation pattern for the fourth child, C.M., is shown in Figure 18. C.M. produced 43 utterances with a 3rd person subject and inflected verb in total. C.M. initially selected the neg-in-spec value of the negation parameter, using only this option in the session at 1;10;27, when she produced 3 instances of medial negation. Grammatical change was initiated almost immediately, and medial negation rapidly disappeared, and was completely gone within 3 months. Recall that for the inflection parameter, C.M. hypothesized the affixal value of the inflection parameter from the start. While this would be an unfortunate choice before do-support is acquired, C.M. took heed of the input early, and quickly became adult-like, acquiring *doesn't* by age 2;1. Another interesting observation is that, at 1;11;11, C.W. produced 50% medial negation sentences and 50% adult-like sentences, with do-support. In fact, in the first half of the session, C.W. produced 6 utterances containing medial negation, and in the second half, C.W. produced 6 adult-like utterances. In other words, the abrupt change from one parameter value to the other took place within a single session at the lab.

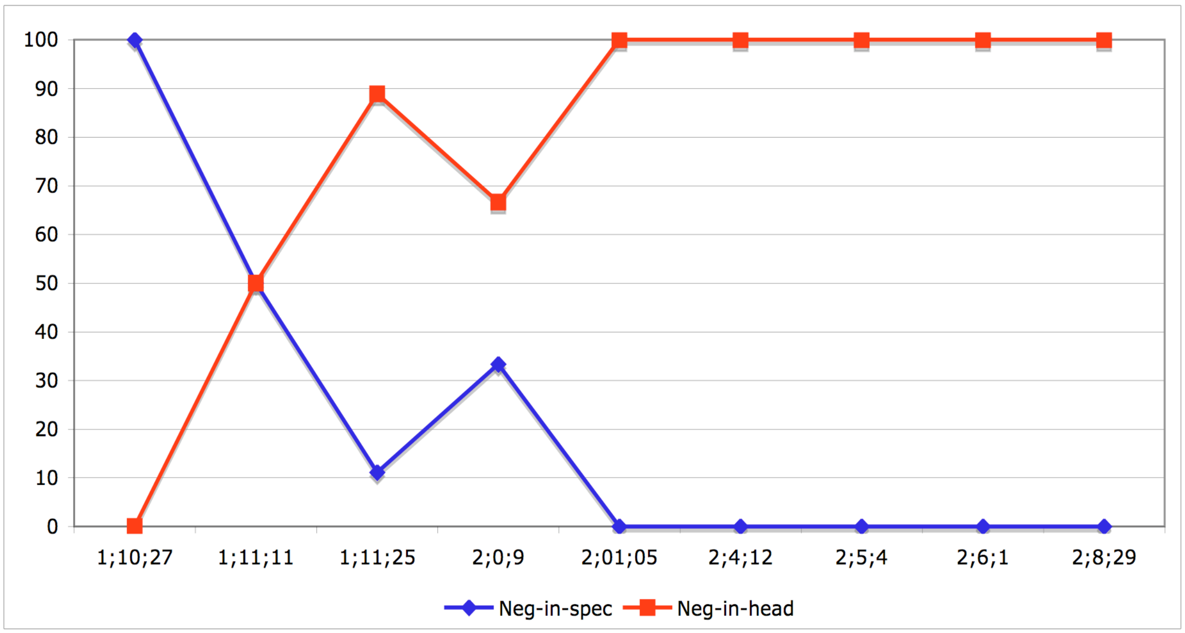

Figure 18: The trajectory for the two negation values in C.M.'s data

10.6. Conformity

It should be clear that the data do not fit neatly with the criterion of conformity. Three of the children initially misset the negation parameter, while one child started with the adult neg-in-head value of the parameter. The three children who had misset the parameter made abrupt changes in switching the parameter value to neg-in-head, but the change was initiated at different times for different children. For example, C.M. initiated change at about 2 years, while S.F. waited until about 3 and a half years of age. Thus it appears that the parameter setting mechanism of different children does not responding in the same way to the presumably uniform statistical distribution of sentence structures in the positive input. One possibility to consider about the source of the timing differences is that children were delayed by the course they had taken in setting parameters that sit higher on the hierarchy.

11. Conclusion

Beginning with Saffran, Aslin and Newport (1996), the last decade has seen a series of research studies showing that children are endowed with a learning mechanism that is sufficiently powerful to assist them in word segmentation, and even in the detection of phrasal units (Saffran 2001; 2002). Yang (2002; 2004) has proposed that such learning mechanisms can also be paired with Universal Grammar to assist the language learner in keeping tally of the input data necessary for setting parameters. Granting that learners employ a statistical learning mechanism for certain tasks, the empirical thrust of the present paper was to assess the claim that children make use of such a mechanism in setting parameters. To address this question, we investigated children's acquisition of two parameters, to see whether the learning path in child language development assumed the gradual curve associated with statistical learning over time or, instead, if the path of language development resembled the sharp edges associated with setting and resetting parameters, in keeping with the 'switch' metaphor. The empirical findings from our longitudinal study of four children's development of inflection and negation do not support the proposal that statistical learning is driving children's parameter setting. Our empirical findings show, instead, that children initiate grammatical change at some point in time, and when change is initiated, it takes hold quickly, and is brought to closure within 3 months. These observations leave open the possibility that the mechanisms used to set parameters are specific to the language faculty, and do not consist of domain general statistical learning mechanisms. At this point, we do not fully understand the mechanisms that set grammatical change in motion, but they are apparently sensitive to the child's internal grammatical development, and do not directly reflect children's linguistic experience.

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Endnotes

[1] The exact formulation of the parameter has been much debated, and is not important for our purposes. See Rizzi (2002) for a new approach.
[2] Recall that Eve's change takes place in 5 months, rather than 3 months, but it should be noted that she is considerably younger than Adam. It may be that in the future, another consideration will be the age of the child at the time of setting the parameter.
[3] A statistical learning model can be adjusted to accommodate individual variation, but only by abandoning uniformity. This may not be unreasonable, in some cases. Input related to certain linguistic structures that lie at the periphery, such as use of metaphors and idioms, or semi-productive structures (like the 'time away' construction mentioned in Goldberg (2003)) might differ across speakers. On the other hand, it is unlikely that such peripheral constructions are used for setting parameters. The parameters studied in this paper are concerned with 'core' grammar – the functional categories of inflection and negation. These morphosyntactic properties are unlikely to differ significantly across speakers. Thus for the parameters that concern us, the Variational model expects conformity across children, whereas the Structured Acquisition model does not.
[4] More recently, Wexler (1998) has recast the model in more Minimalist terms. We cannot do justice to the model here. The main idea is that the child is unable to carry out feature-checking as adults do, due to a developmental constraint, and this results in the child's production of optional infinitives. Once the child's system of constraints mature, the verbal morphology becomes adult-like. Thus, both Schütze and Wexler (1996) and Wexler (1998) claim children's early syntax must 'grow' into adult syntax.
[5] Chinese has morphology (particles) expressing aspect, but this is considered to be a separate issue.
[6] The optional infinitive stage of child language has proven to be a huge research enterprise, and we cannot do it justice in this paper. Moreover, in view of the parameters we investigate (one on types of morphology, one on negation), the remainder of the paper concentrates on children's productions of finite utterances. We wish to make it clear, however, that we would not analyze the optional infinitive stage of child language as an instance of maturation or of parameter setting. In our view, optional infinitives are produced by children when they are either unsure of, or cannot implement a parameter setting. We will demonstrate this below, using children's sentences with negation in the period that precedes *do*-support. Following Tesan (2005) optional infinitives can be analyzed as adult-like derivations in which the agreement morpheme is not realized at spell-out, due to a deletion repair mechanism (Lasnik 2001). As such, optional infinitives are expected to disappear from children's speech once the parameters for inflection and negation are set. This prediction is upheld in the data we have gathered, but this must remain a topic for another paper.
[7] It is possible that polysynthetic languages allow no choice in these properties; for example, it may be that negation must be a head in these languages.
[8] According to Baker (2005) "a parameter Y is subordinate to another parameter X if and only if Y influences just one of the languages types defined by X" (p. 123)
[9] The parameter is closely related to the verb raising parameter, but it is considered to be independent of it.
[10] For a different formulation of the parameter, see Tesan (2005) where the binary settings of the negation parameter are also considered to be *affixal* and *featural*.
[11] The frequencies were calculated as follows. Using CLANX, all utterances in the adult tiers of Adam and Eve's files (i.e. MOT, FAT, COL, RIC, and URS) were gathered into a file. A number of utterance types were eliminated from the data set, including fragments of various kinds (NP, AP, PP and other nonsentential utterances), and any utterance that contained xxx in the transcription. In the 30, 882 utterances that remained, we searched for any occurrence of *does/doesn't*, including occurrences of emphatic *does/doesn't* in affirmative sentences, and occurrences of these auxiliaries in both questions and VP ellipsis structures. The results for the input in the two children's files are as follows:
Adam
Total number of adult utterances: 20,862

Total number of adult *does*: 408 (1.95%)
Total number of adult *doesn't*: 226 (1.08%)
Total number of adult *does/doesn't*: 634 (3.03%)

<u>Eve</u>
Total number of adult utterances: 10,020
Total number of adult *does*: 58 (0.57%)
Total number of adult *doesn't*: 70 (0.69%%)
Total number of adult *does/doesn't*: 128 (1.27%)

[12] Children were found to combine the stray morpheme with a range of NP types, including names and quantificational NPs. Since such NPs cannot be pluralized, the utterances like *Everybody s fit* and *John s fit* are evidence that children's non-adult forms were not plural marking, but some form of *s* morpheme that was associated with inflection (see section 9.3).

[13] In the syntactic literature, it is assumed that auxiliary verbs *have* and *be* can raise past the negative head without movement being blocked. It has been suggested this can happen because these verbs (or at least *be*) is semantically transparent. Although various accounts can be offered, it is basically a stipulation. Recall that when it comes to lowering of the affix over negation, the opposite assumption is made – that the negative head blocks movement.

[14] The auxiliary verbs and modals are exceptions, of course, but children treating all verbs in a uniform way could presumably also lower an affix onto an auxiliary verb or a modal, without causing the derivation to crash. Our data set does not show evidence of this, because there are no examples like *The spider cans fit here*, or *The spider be-s fit here*. Somehow, children must figure out that modals and auxiliaries behave differently early on.

[15] We are assuming, for the moment, that the learner is not using a statistical mechanism to set the parameter.

[16] Another option would be to sidestep violating the head movement constraint by placing negation outside the sentence, with utterances like *No the spider fit here*. Only one subject in our study, S.L. used this option, but it surfaced before she was producing full sentences.

[17] When children hypothesize the featural option, the *s* morphology is a clitic-like element. Cross-linguistically, clitics are much freer than affixes in where they may be positioned, and they may lean to the left or right in the sound stream. Keeping these properties in mind, in the featural stage, children could have two possible realizations of the clitic; one preceding the main verb in *The spider s fit*, and one after the verb in *The spider fit s*. This behavior would be similar to Polish person-number agreement marker smy (acute on s), which can appear on any constituent preceding the verb (but to no element following it (Franks and Banski, 1998; Witkos 1998 (acute on s).).

[18] Notice that the optionality does not represent two different parameter settings.

[19] In all of the children's graphs for featural inflection, the graph starts from the session in which 5 or more utterances containing inflected verbs were used.

[20]C.M.'s graph shows her data from the third session. The first two sessions are not graphed as they had only two inflected verbs each, one with misplaced inflection in each session.

[21] The graphs start with the session in which the child first produced two or more instances of negation with an inflected verb. After that, the data for any session with negation and an inflected verb was included in the graph.

[22] The data set is small because S.L. resisted producing negative sentences until she acquired do-support. When elicited production techniques were used to probe negation, her preferred strategy was to use covertly negative elements like *only* or *just* to answer questions. For example, in response to a question like "Does your daddy drink milk?", rather than answering the question with negation, she would say "Only S.L. drinks milk".

[23] This is considered to be medial negation if *don't* is taken to be a chunk that expresses negation. This is the case for S.L. This child did not use *not* at all. She did use *no* as a form of sentence external negation in the earliest recordings, however.

[24] One might try to challenge the decision to take negative items with misplaced morphology, like *The spider s not fit in there* as reflecting neg-in-spec. As pointed out, such utterances can be the product of either setting of the negation parameter. If the utterances with misplaced morphology were taken to reflect neg-in-head, then S.F's data would show more gradual acquisition of the neg-in-head parameter value, although the medial negation would still drop abruptly. S.F. would also be allowing the item *not* to be sometimes positioned in the head and sometimes in the spec, rather than reserving different items for the different positions.